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Open Science

Open Science Philosophy

Open science encompasses unrestricted access to scientific research articles, access to data from public research, and collaborative research enabled by information and communication technology tools, models, and incentives. Broadening access to scientific research publications and data is at the heart of open science. The objective of open science is to make research outputs and its potential benefits available to the entire world and in the hands of as many as possible:

- Open science promotes a more accurate verification of scientific research results. Scientific inquiry and discovery can be sped up by combining the tools of science and information technologies. Open science will benefit society and researchers by providing faster, easier, and more efficient availability of research outputs.
- Open science reduces duplication in collecting, creating, transferring, and re-using scientific material.
- Open science increases productivity in an era of tight budgets.
- Open science results in great innovation potential and increased consumer choice from public research.
- Open science promotes public trust in science. Greater citizen engagement leads to active participation in scientific experiments and data collection.

Open Science Index

The Open Science Index (OSI) currently provides access to over thirty thousand full-text journal articles and is working with member and non-member organizations to review policies to promote and assess open science. As part of the open science philosophy, and by making open science a reality; OSI is conducting an assessment of the impact of open science principles and restructuring the guidelines for access to scientific research. As digitalization continues to accelerate science, Open science and big data hold enormous promise and present new challenges for policymakers, scientific institutions, and individual researchers.

OSI is helping the global scientific research community discover, evaluate, and access high-quality research output. Renowned for its editorially curated and refereed collection of the highest-quality publications, OSI has always been and will remain free-of-charge.

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Open Science

Open Society

An open society allows individuals to change their roles and to benefit from corresponding changes in status. Open science depends to a greater or lesser extent on digital technologies and innovations in structural processes by an open society. When realized, open science research and innovation can create investment opportunities for new and better products and services and therefore increase competitiveness and employment. Open science research and innovation is a key component of thematic open science priorities. Central to the open science digital infrastructure is enabling industry to benefit from digital technology and to underpin scientific advances through the development of an open society. Open science research and innovation can also contribute to society as a global actor because scientific relations can flourish even where global relations are strained. Open science has a critical role across many areas of decision making in providing evidence that helps understand the risks and benefits of different open science choices. Digital technology is making the conduct of open science and innovation more collaborative, more global, and more open to global citizens. Open society must embrace these changes and reinforce its position as the leading power for science, for new ideas, and for investing sustainably in the future.

It is apparent in open society that the way science works is fundamentally changing, and an equally significant transformation is taking place in how organizations and societies innovate. The advent of digital technology is making research and innovation more open, collaborative, and global. These exchanges are leading open society to develop open science and to set goals for research and innovation priority. Open science goals are materializing in the development of scientific research and innovation platforms and greater acceptance of scientific data generated by open science research. Open science research and innovation do not need help from open society to come up with great ideas, but the level of success ideas ultimately reach is undoubtedly influenced by regulation, financing, public support, and market access. Open society is playing a crucial role in improving all these success factors.

Open Science

Open science represents a new approach to the scientific process based on cooperative work and new ways of diffusing knowledge by using digital technologies and collaborative tools. These innovations capture a systemic change to the way science and research have been carried out for the last fifty years. Science is shifting from the standard practice of publishing research results in scientific publications after the research and reviews are completed. The shift is towards sharing and using all available knowledge at an earlier stage in the research process. Open science is to science what digital technology is to social and economic transactions: allowing end users to be producers of ideas, relations, and services and in doing so, enabling new working models, new social relationships and leading to a new modus operandi for science. Open science is as important and disruptive as e-commerce has been for the retail industry. Just like e-commerce, the open science research paradigm shift affects the whole business cycle of doing science and research. From the selection of research subjects to the carrying out of research, to its use and re-use, to the role of universities, and that of publishers are all dramatically changed. Just as the internet and globalization have profoundly changed the way we do business, interact socially, consume culture, and buy goods, these changes are now profoundly impacting how one does research and science.

The discussion on broadening the footprint of science and on novel ways to produce and spread knowledge gradually evolved from two global trends: Open Access and Open Source. The former refers to online, peer-reviewed scholarly outputs, which are free to read, with limited or no copyright and licensing restrictions, while open source refers to software created without any proprietary restriction and which can be accessed and freely used. Although open access became primarily associated with a particular publishing

or scientific dissemination practice, open access already sought to induce a broader practice that includes the general re-use of all kinds of research products, not just publications or data. It is only more recently that open science has coalesced into the concept of a transformed scientific practice, shifting the focus of researchers' activity from publishing as fast as possible to sharing knowledge as early as possible. Open science is defined as the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process. As a result, the way science is done in the future will look significantly different from the way it is done now. Open science is the ongoing evolution in the modus operandi of doing research and organizing science. This evolution is enabled by digital technology and is driven by both the globalization of the scientific community and increasing public demand to address the societal challenges of our times. Open science entails the ongoing transitions in the way research is performed, researchers collaborate, knowledge is shared, and science is organized.

Open science impacts the entire research cycle, from the inception of research to its publication, and on how this cycle is organized. The outer circle reflects the new interconnected nature of open science, while the inner circle shows the entire scientific process, from the conceptualization of research ideas to publishing. Each step in the scientific process is linked to ongoing changes brought about by open science, including the emergence of alternative systems to establish a scientific reputation; changes in the way quality and impact of research are evaluated; the growing use of scientific blogs; open annotation; and open access to data and publications. All institutions involved in science are affected, including research organizations, research councils, and funding bodies. The trends are irreversible, and they have already grown well beyond individual projects. Theses changes predominantly result from a bottom-up process driven by a growing number of researchers who increasingly employ social media in their research and initiate globally coordinated research projects while sharing results at an early stage in the research process.

Open science is encompassed in five schools of thought:

- the infrastructure school, concerned with technological architecture
- the public school, concerned with the accessibility of knowledge creation
- the measurement school, concerned with alternative impact assessment
- the democratic school, concerned with access to knowledge
- the pragmatic school, concerned with collaborative research

According to the measurement school, the reputation and evaluation of individual researchers are still mainly based on citation-based metrics. The h-index is an author-level metric that attempts to measure both the productivity and citation impact of the publications of a scientist or scholar. The impact factor is a measure reflecting the average number of citations to articles published in an academic journal and is used as a proxy for the relative importance of a journal.

Numerous criticisms have been made of citation-based metrics, primarily when used, and often misused, to assess the performance of individual researchers. These metrics:

- are often not applicable at the individual level
- do not take into account the broader social and economic function of scientific research
- are not adapted to the increased scale of research
- cannot recognize new types of work that researchers are performing

Web-based metrics for measuring research output, popularized as altmetrics, have recently received much attention: some measure the impact at the article level, others make it possible to assess the many outcomes of research in addition to the number of scientific articles and references. The current reputation and evaluation system has to adapt to the new dynamics of open science and acknowledge and incentivize

engagement in open science. Researchers engaging in open science have growing expectations that their work, including intermediate products such as research data, will be better rewarded or taken into account in their career development. Vice-versa, the use, and reuse of open data will require appropriate codes of conduct requiring, for example, the proper acknowledgment of the original creator of the data.

These ongoing changes are progressively transforming scientific practices with innovative tools to facilitate communication, collaboration, and data analysis. Researchers that increasingly work together to create knowledge can employ online tools and create a shared space where creative conversation and collaboration can occur. As a result, the problem-solving process can be faster, and the range of problems that can be solved can be expanded. The ecosystem underpinning open science is evolving very rapidly. Social network platforms for researchers already attract millions of users and are being used to begin and validate more research projects.

Furthermore, the trends towards open access are redefining the framework conditions for science and thus have an impact on how open innovation is produced by encouraging a more dynamic circulation of knowledge. It can enable more science-based startups to emerge thanks to the exploitation of openly accessible research results. Open science, however, does not mean free science. It is essential to ensure that intellectual property is protected before making knowledge publicly available in order to subsequently attract investments that can help translate research results into innovation. If this is taken into account, fuller and broader access to scientific publications and research data can help to accelerate innovation. Investments that boost research and innovation in open science would benefit society with fewer barriers to knowledge transfer, open access to scientific research, and greater mobility of researchers. In this context, open access can help overcome the barriers that innovative organizations face in accessing the results of research funded by the public.

Open innovation

An open society is the largest producer of knowledge, but the phenomenon of open science is changing every aspect of the scientific method by becoming more open, inclusive, and interdisciplinary. Ensuring open society is at the forefront of open science means promoting open access to scientific data and publications alongside the highest standards of research integrity. There are few forces in this globe as engaging and unifying as science. The universal language of science maintains open channels of communication globally. Open society can maximize its gains through maintaining its presence at the highest level of scientific endeavor, and by promoting a competitive edge in the knowledge society of the information age. The ideas and initiatives described in this publication can stimulate anyone interested in open science research and innovation. It is designed to encourage debate and lead to new ideas on what and open society should do, should not do, or do differently.

An open society can lead to a research powerhouse; however, open society rarely succeeds in turning research into innovation and in getting research results to the global market. Open society must improve at making the most of its innovation talent, and that is where open innovation comes into play. The basic premise of open innovation is to open up the innovation process to all active players so that knowledge can circulate more freely and be transformed into products and services that create new markets while fostering a stronger culture of entrepreneurship. Open innovation is defined as the use of purposive inflows and outflows of knowledge to accelerate internal innovation. This original notion of open innovation was primarily based on transferring knowledge, expertise, and even resources from one company or research institution to another. This notion assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they seek to improve their performance. The concept of open innovation is continually evolving and is moving from linear, bilateral transactions and collaborations

towards dynamic, networked, multi-collaborative innovation ecosystems. This means that a specific innovation can no longer be seen as the result of predefined and isolated innovation activities but rather as the outcome of a complex co-creation process involving knowledge flows across the entire economic and social environment. This co-creation takes place in different parts of the innovation ecosystem and requires knowledge exchange and absorptive capacities from all the actors involved, whether businesses, academia, financial institutions, public authorities, or citizens.

Open innovation is a broad term, which encompasses several different nuances and approaches. Two main elements underpin the most recent conceptions of open innovation: the users are in the spotlight and invention becomes an innovation only if users become a part of the value creation process. Notions such as user innovation emphasize the role of citizens and users in the innovation processes as distributed' sources of knowledge. This kind of public engagement is one of the aims of open science research and innovation. The term 'open' in these contexts has also been used as a synonym for 'user-centric'; creating a well-functioning ecosystem that allows co-creation and becomes essential for open innovation. In this ecosystem, relevant stakeholders are collaborating along and across industry and sector-specific value chains to co-create solutions for socio-economic and business challenges. One important element to keep in mind when discussing open innovation is that it cannot be defined in absolutely precise terms. It may be better to think of it as a point on a continuum where there is a range of context-dependent innovation activities at different stages, from research to development through to commercialization, and where some activities are more open than others. Open innovation is gaining momentum thanks to new large-scale trends such as digitalization and the mass participation and collaboration in innovation that it enables. The speed and scale of digitalization are accelerating and transforming the way one designs, develops, and manufactures products, the way one delivers services, and the products and services themselves. It is enabling innovative processes and new ways of doing business, introducing new cross-sector value chains and infrastructures.

Open society must ensure that it capitalizes on the benefits that these developments promise for citizens in terms of tackling societal challenges and boosting business and industry. Drawing on these trends, and with the aim of helping build an open innovation ecosystem in open society, the open society's concept of open innovation is characterized by:

- combining the power of ideas and knowledge from different actors to co-create new products and find solutions to societal needs
- creating shared economic and social value, including a citizen and user-centric approach
- capitalizing on the implications of trends such as digitalization, mass participation, and collaboration

In order to encourage the transition from linear knowledge transfer towards more dynamic knowledge circulation, experts agree that it is essential to create and support an open innovation ecosystem that facilitates the translation of knowledge into socio-economic value. In addition to the formal supply-side elements such as research skills, excellent science, funding and intellectual property management, there is also a need to concentrate on the demand side aspects of knowledge circulation, making sure that scientific work corresponds to the needs of the users and that knowledge is findable, accessible, interpretable and reusable. Open access to research results aims to make science more reliable, efficient, and responsive and is the springboard for increased innovation opportunities, e.g. by enabling more science-based startups to emerge. Prioritizing open science does not, however, automatically ensure that research results and scientific knowledge are commercialized or transformed into socio-economic value. In order for this to happen, open innovation must help to connect and exploit the results of open science and facilitate the faster translation of discoveries into societal use and economic value.

Open Science

Collaborations with global partners represent important sources of knowledge circulation. The globalization of research and innovation is not a new phenomenon, but it has intensified in the last decade, particularly in terms of collaborative research, international technology production, and worldwide mobility of researchers and innovative entrepreneurs. Global collaboration plays a significant role both in improving the competitiveness of open innovation ecosystems and in fostering new knowledge production worldwide. It ensures access to a broader set of competencies, resources, and skills wherever they are located, and it yields positive impacts in terms of scientific quality and research results. Collaboration enables global standard-setting, allows global challenges to be tackled more effectively, and facilitates participation in global value chains and new and emerging markets.

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Scholarly Research Review

The scholarly research review is a multidimensional evaluation procedure in which standard peer review models can be adapted in line with the ethos of scientific research, including accessible identities between reviewer and author, publishing review reports and enabling greater participation in the peer review process. Scholarly research review methods are employed to maintain standards of quality, improve performance, provide credibility, and determine suitability for publication. *Responsible Peer Review Procedure:* Responsible peer review ensures that scholarly research meets accepted disciplinary standards and ensures the dissemination of only relevant findings, free from bias, unwarranted claims, and unacceptable interpretations. Principles of responsible peer review:

• Honesty in all aspects of research
• Accountability in the conduct of research
• Professional courtesy and fairness in working with others
• Good stewardship of research on behalf of others

The responsibilities of peer review apply to scholarly researchers at all stages of peer review: Fairness, Transparency, Independence, Appropriateness and Balance, Participation, Confidentiality, Impartiality, Timeliness, Quality and Excellence, Professionalism, and Duty to Report.

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• Scholarly Research Review Identities: Authors and reviewers are aware of each other's identity

• Scholarly Research Review Reports: Review reports are published alongside the relevant article

• Scholarly Research Review Participation: The wider academic community is able to contribute to the review process

• Scholarly Research Review Interaction: Direct reciprocal discussion between author(s) and reviewers, and/or between reviewers, is allowed and encouraged

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• Scholarly Research Review Final-version Reviewing: Editorial revision of the language and format is conducted on the final version of the manuscript for publication

• Scholarly Research Review Platforms: The scholarly research review process is independent of the final publication of the manuscript and it is facilitated by a different organizational entity than the venue of publication

All submitted manuscripts are subject to the scholarly research review process, in which there are three stages of evaluation for consideration: pre-review manuscripts, chair-review presentation, and final-review manuscripts. All submitted full text papers, that may still be withstand the editorial review process, are presented in the conference proceedings. Manuscripts are tracked and all actions are logged by internal and external reviewers according to publication policy. External reviewers' editorial analysis consists of the evaluation reports of the conference session chairs and participants in addition to online internal and external reviewers' reports. Based on completion of the scholarly research review process, those manuscripts meeting the publication standards are published 10 days after the event date.

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Wasif Jawharriyeh and the Identity-forming Spaces of Late Ottoman Jerusalem

Feyza Daloğlu

***Abstract*—** This paper scrutinizes the Ottoman years of Wasif Jawharriyeh's memoir, The Storyteller of Jerusalem, within the framework of citadinite, employed by the Open Jerusalem Project. Open Jerusalem Project uses the term citadinite to describe "the dynamic identity relationship city dwellers have with each other and their urban environment." While Jerusalem and Jerusalemite identity have usually been analyzed within religious, national, or colonial frameworks, citadinite offers a fresh perspective by turning its lens to the urban identity of its citizens in the 19th and 20th centuries to overcome the shortcomings of usual frameworks. Wasif Jawharriyeh is a proud Jerusalemite and a Greek Orthodox Arab, who spent his childhood and teenage years under the Ottoman Empire. His memoir reveals a great deal of urbanity and a strong sense of Jerusalemite identity which appears to be favored over other forms of identities - Arab, Christian - in the late empire years. Through citadinite, this paper aims to discuss aspects of Jerusalemite identity and key points of urban life in the late Ottoman holy city with the guidance of a very lively and social Ottoman citizen and at that time a young musician, Wasif Jawharriyeh.

***Keywords*—** arab memoir, cityscape, jerusalem identity, ottoman city, urban life

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A Social Identity Analysis of Ottoman and Safavid Architects in the Historical Documents of the 16th to 17th Centuries

Farzaneh Farrokhfar, Mohammad Khazaie

Abstract— The 16th and 17th centuries coincide with the classical age of Ottoman art history. Simultaneously with this age and in the eastern neighborhood of the Ottoman state, the Safavid Shiite state emerged which, despite political and religious differences with the Ottomans, played an important role in cultural and artistic exchanges with Anatolia. The harmony of arts, including architecture, is one of the most important manifestations of cultural exchange between the two regions, which shows the intellectual commonalities of the two regions. In parallel with the production of works of art, the registration of information and identities of Ottoman and Safavid artists and craftsmen has been done by many historians and biographers, some of whom, fortunately, are available to us today and can be evaluated. This research first intends to read historical documents and reports related to the architects of the two Ottoman state in Anatolia and Safavid states in Iran in the 16th and 17th centuries, and then examines the status of architects information records and their location in the two regions. The results reveal the names and identities of some Ottoman and Safavid architects in the 16th and 17th centuries and show the method of recording information in the documents of the two regions. This research is done in a comparative historical method and the method of collecting its resources is a documentary library.

Keywords—Classical era, Ottoman architecture, Safavid architecture, Central Asian historical documents

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Affordable Housing in the Context of Inadequate Housing Polices in Croatia

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***Abstract*—**During the transition period in Croatia, the state lost control over the housing sector, which fell into the hands of citizens, getting closer to the neo-liberal type of housing system determined by the out-of-control market and a crucial role of the private actors (investors and developers). Croatia thus became one of the post-socialist countries with the largest share of private ownership as a tenure status over flats and in which the process of housing privatization has brought many changes. In the context of strong processes of privatization and financialization of housing and the reduced role of state, there were many new aspects hindering the resolving of housing rights and problems. According to the 2011 census, 88.9% of flats in Croatia became private property or co-ownership. In the beginning of the 2000s subsidized housing for particular categories of inhabitants through the so-called POS model (State-Subsidized Housing Construction) started primarily in the capital Zagreb. This model was not systematic enough and until the present day it has appeared only periodically, answering to the existing demand insufficiently. It involved subsidized purchase, but not rental options except in some isolated cases. Subsidized flats for the young and other threatened social groups further deepen the problems, because it does not open the country's housing policy to new solutions. Therefore, for particular groups of citizens, such as fixed-term employees, mostly younger, then unemployed or poorer citizens, and other marginal groups, the opportunity to obtain their own housing may be hindered, primarily due to the process of mass privatization. This also has brought a significant increase in the number of private construction companies that were building even more than was the demand for housing units. In the period of transition, a close connection of the state and the private sector, construction companies and banks is particularly emphasized, both in Croatia and in other transition countries. In the Croatian context, affordability nevertheless refers to the option of purchase and to creditworthy citizens, and not to the other models, such as public rental housing or social housing which remain the models of caring for the threatened groups of citizens, and not the broader population. So, affordable housing in the post-socialist context has a very one-sided meaning that cannot be compared to the same concept in Western European countries. All of the above points to inadequate housing policy in Croatia in the post-socialist period, which is not in line with affordable housing for all.

***Keywords*—**affordable housing, Croatia, post-socialist context, privatization of housing, inadequate housing policy, threatened groups of citizens.

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Research Methodology and Mixed Method (Qualitative and Quantitative) for PhD Construction Management – Post-Disaster Reconstruction

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***Abstract*—** PhD. Construction Management methodology and mixed methods are organised to guide the researcher to assemble and assess data in the research activities. Construction management research is close to business management and social science research. It also contributes to researching the phenomenon and answering the research question, generating an integrated management system for post-disaster reconstruction in construction and related industries. Research methodology and methods drive the research to achieve the goal or goals, contribute to knowledge, or increase knowledge. This statement means the research methodology, mixed methods, aim, objectives, and processes address the research question, facilitate its achievement and foundation to conduct the study. Mixed methods use project-based case studies, interviews, observations, literature and archival document reviews, research questionnaires, and surveys, and evaluation of integrated systems used in the construction industry and related industries to address the research work. The mixed methods (qualitative and quantitative) define the research topic and establish a more in-depth study. The research methodology is action research, which involves the collaboration of participants and service users to collect and evaluate data, study the phenomenon, and research question(s) to improve the post-disaster reconstruction phase management.

***Keywords*—** *Methodology, Mixed-Method Qualitative and Quantitative, PhD. Construction Management Research, Post-Disaster Reconstruction*

I. Introduction

The methodology and mixed methods for the research are planned to direct the researcher to draw together and assess the research activities. It also contributes to researching the phenomenon and answering the research question to generate an integrated management system for post-disaster reconstruction in construction and related industries. Thus, the research methodology is action research that involves collaboration with participants and service users to develop an integrated management system framework to improve post-disaster reconstruction phase management. Bhasin (2019) and Dawson (2002) explained that a research methodology is a systematic approach that guides the research to collect and evaluate data in the research process; the procedure contributes to studying the phenomenon and answering the research question.

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In addition, Kothari (2004) explained that research methods or techniques are used for researching the course of studying the problem or research question. UKEssays (2018) three types of research methods: qualitative, quantitative, and mixed methods, define the research topic, question, and establish a more in-depth understanding of the study to generate the integrated management framework. Bhasin (2019), Creswell (2009) and Invalid source specified that research methods are implemented to gather research data, the use questionnaires or interviews to answer the study. The use of mixed methods as the research method is to combine qualitative and quantitative research strengths.

More importantly, using one or other qualitative or quantitative approaches is inadequate to address the complexity. Qualitative studies require as much effort and rigour as quantitative studies, and data collection alone often stretches over many months. Numerous novice research students thought naively and assumed that qualitative studies are more straightforward or, in some other way, more manageable than quantitative designs. Therefore, using one or the other, i.e., qualitative or quantitative methods, is insufficient to address the complexity of the PhD construction management research question. More importantly, the research question addresses a complex study involving service users (participants) and participants in the construction industry and others from related sectors to answer the problem or question.

In addition, Kothari (2004) explained that research methods or techniques are used for researching the course of studying the problem or research question. UKEssays (2018) three types of research methods: qualitative, quantitative, and mixed methods, define the research topic, question, and establish a more in-depth understanding of the study to generate the integrated management framework. Bhasin (2019), Creswell (2009) and Invalid source specified that research methods are implemented to gather research data, the use questionnaires or interviews to answer the study. The use of mixed methods as the research method is to combine qualitative and quantitative research strengths.

II. METHOD

The method part of the paper would illustrate how the research methodology and mixed methods for PhD Construction Management – To Generate Integrated Management System for Post-Disaster Reconstruction Phase Management organised to guide, assemble, and assess data in the research activities. The steps of the method are:

1) Literature,
2) Case Studies – Research Methods (Qualitative and Quantitative),
3) Paper Purpose Statement - Methodology and Mixed Methods Development,
4) Forming Research Methodology – Mixed Methods Framework,
5) Research Aim and Objectives,
6) Research Question Statement - Mixed Methods,
7) Research Methodology – Mixed Methods, Preparation,
8) Planning, and Organising,
9) Designing of Questionnaires and Surveys Research Question,
10) Research Survey Questionnaires and
11) Data Collection and Analysis Using Mixed Method Design (Qualitative and Quantitative).

III. Literature

Methodology and Mixed Methods

The methodology and mixed methods are a set of principles (sources), tools (implements), and practices (ways) that will be used to guide processes to achieve a particular goal, the research goal, and the contribution to knowledge (a methodology is more prescribed). Methodology and mixed methods procedures will also help generate an integrated management system for post-disaster reconstruction phase management. Construction management research is part of business management; it follows and uses management consultancy and management research skills.

As Lancaster (2005) explained, students need to understand the main approaches to researching this area and know data collection and analysis techniques. Lancaster (2005) again suggested using and applying management research's main techniques to real-world management issues and problems centred on a consultancy type of project than management research. The study generates an integrated management system centred on a management consultancy research approach on real-life management problems in post-disaster reconstruction phase management.

As Wood (2013) pointed out, a methodology is prescriptively made up of phases, tasks, aim and objective, qualitative and quantitative methods, techniques, and tools for the study. Subsequent Research, Association for Institutional (2007) stated that a combination of qualitative and quantitative which mixed methods in a single project could be compelling. The objectives in the research methodology and methods, as illustrated in Figure 1 Part A, breaks down the aim into objective parts and address each piece separately, as pointed out by Dudovskiy (2018). These form necessary steps to undertake the research. Van De Water (2017) confirmed that successful research engagement is a set of clearly defined and meaningful objectives, narrowing and focusing the research and ensuring that the findings are relevant to researchers

Qualitative research methods are widely used in social sciences research, allied to the Built Environmental – Construction Management science research. Zou et al. (2014) pointed out that standard research methodologies embraced in social science research are quantitative, qualitative, and mixed methods, contributing to knowledge or increasing knowledge.

Furthermore, Bilaua et al. (2017 stated that the research methodology is theory and used to analyse the research data. It also justifies the procedural framework applied in producing research data and reviews towards knowledge creation. Therefore, the methodology and research design for conducting research should be guided by the research question(s), study aims, and objectives. More importantly, Draffin, 2012, stated that an excellent methodology is adaptable to the condition to generate an integrated management system and takes the research clearly through the steps to produce quality and consistent outcomes. The research aims to undertake a post-disaster reconstruction phase management study to develop an integrated management system; objectives would guide the task to achieve the purpose and contribute to knowledge. Thomson (2014) stated that the project's overall intention signals what and where researchers aspire. Furthermore, Thomson (2014) highlighted objectives indicate what the researcher actually and really will do to get to the point of it all.

IV. CASE STUDIES – RESEARCH METHODS (QUALITATIVE AND QUANTITATIVE)

Case studies are general popular research methods used for business management and social science research, are closely related to construction management research methods in the Built Environment. Amaratunga et al. (2002), Daniel et al. (2020) and Knight & Ruddock (2008) wrote that construction management is a relatively new field that draws from a wide range of established disciplines in the natural, social sciences, engineering, and management. Furthermore, Researchers within the built environment disciplines have increasingly drawn on a plurality of social methods to enrich their research. Dudovskiy (2018) stated advantages of the case study research method embrace data collection and analysis within the context of the phenomenon. Also, Dudovskiy (2018) pointed out that integration of qualitative and quantitative data in data analysis, which can capture complexities of real-life situations so that the phenomenon can be studied in greater depth. Creswell & Poth (2017) and McCaslin (2003) suggested that a qualitative case study provides an in-depth examination of the procedure based on a diverse array of data collection materials. Furthermore, the researcher situates this system or case within its larger context or setting (Creswell and Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches 2017).

V. Paper Purpose Statement - Methodology and Mixed Methods Development

The Research PhD methodology and mixed methods development illustrate how the researcher would gather and evaluate data in the research activities, interviews, observations, documents reviews, and involvement of participants and service users in construction and related industries. In addition, this part of the study aims to explore better ways to apply the methodology and mixed methods to generate an integrated management system. The aim is to explain by using the research design framework as a tool warrants that the data gathered will help answer the research question more successfully. Betts (n.d.) and the University of Wisconsin (n.d.) confirmed that the purpose statement clearly defines qualitative or quantitative research objectives and stated the paper's purpose, scope, direction, what to expect in a study, and the specific focus.

VI. Forming Research Methodology – Mixed Methods Framework

The Research Methodology is formed to help the researcher generate an integrated management system for the post-disaster reconstruction construction phase in construction and related industries. The illustration in Fig.2, Parts A & B Junctures for PhD Construction Management Research Design Framework – for PhD. Construction Management Research Design, Parts A Junctures formed the links used to develop the research question. Which also would contribute to the Research Methodology:- Mixed Methods Framework. A good research design framework ensures that the data received will answer the research question more effectively. Gavin, (2016) states that the research question aligns with methods (quantitative, qualitative, or mixed) and a specific design supported by the methodology. As LATHAM (2016) explains, the research design framework section is designed to help researchers create a custom research methodology for their particular project. Part A Juncture layout the steps to formulate the Research Question consider four of the steps in consideration of the research methodology and methods:- Review Literature (Research Area) for the identified problem /phenomenon, study the research problem in the Development of Integrated Management System for Post-Disaster Reconstruction Management and outline the Research Problem. Draft 2 the Research Question (Part A2). Explore the theoretical research setting related to the problem/question, which references Part A1 (Part A 3) and research design and scrutinises applicable Research Methodology and Methods (Part A 4).

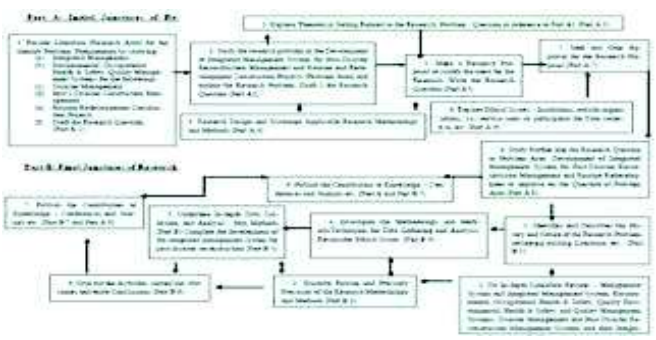


Figure. 2. The two parts A & B Junctures for PhD. Construction Management Research Design

The parts of the research methodology framework illustrated in Figure 2. are linked to the previous and subsequent features. Thus, all the aspects are connected to the research methodology conceptual framework. The research methodology is used to drive the research to achieve the goal or goals, contribute to knowledge or increase knowledge, and generate an integrated management system for post-disaster reconstruction phase management, as illustrated in Figure 1. This statement means the research methodology, methods, aim, objectives, and processes address the research question, facilitate its achievement and foundation to conduct the study. Pro-Academic-Writers.com (2020) expressed the opinion that research methodology is special techniques and various procedures implemented to define (drive), choose, process, and make an analysis of data about a subject you've chosen. Pro-Academic-Writers.com (2020) concluded that the research work methodology part/section helps others evaluate a paper's reliability and genuineness. Dudovskiy (2018) layout that methodology is a philosophical framework; it also describes the study's design methods, approaches, and details. Besides the research methodology framework promoting achievement, its formulation considered that other researchers would repeat it in the Built Environment and closely related research field. ELLIS (2008) stated an essential point; it is an approach to doing something with a defined set of rules, methods, test activities, deliverables, and processes that typically solve a specific problem. Additionally, methodologies demonstrate a well-thought-out, defined, repeatable approach. Finally, UKEssays (2018) pointed out that the research methodology is a design process consisting of a step-by-step approach leading to substantial research results.

Description of the Methodology: the methodology framework in Figure 3 is discipline-specific in the Built Environment - Construction Management Science. It specifies the research operations, how it will be undertaken, how to interpret these operations' results in the research question, and answer the research question, Affairs, Dean's Office - Student Academic (2012). Figure 1 illustrates the research methodology that lays out the aim, objectives, and methods in determining the PhD's span, extent, and overall direction. The PhD Construction Management Research to generate integrated management for post-disaster reconstruction in the construction industry within construction-related sectors. Insights (2019) explained and supported that the research objective describes what the research is trying to achieve.

Furthermore, Insights (2019) and Water (2020) pinpointed that objectives summarise the researcher's accomplishments through the project and provide direction to the study. Insights (2019) suggested that the research objective must be achievable; for example, it must be framed considering the available time, infrastructure required for research, and other resources. Before forming research objectives, the researcher should read about all the research areas' developments and find gaps in knowledge that need to be addressed. And help to drive all aspects of the methodology, instrument design, data collection, analysis, and ultimately the recommendations. Correctly creating research aim and objectives is one of the most critical aspects of the study (thesis). The research aims to

answer the research question; research objectives divide the aim into several parts and address each component individually, as illustrated in Figure 1. The goals indicate what needs to be studied, and research objectives comprise steps that address how the research aim will be achieved (research-methodology.net n.d.). The research methodology and methods are a process and investigation that contribute to post-disaster reconstruction management practice discipline, the body of knowledge that shape and guide academic (Higgs, Horsfall and Grace 2009).

The methodology in Figure 3, which is made up of research aim, objectives, and methods, is the approach that is the central aspect of the exploration to answer the research question and contribute to knowledge. As the research aim and objectives decide choice, complexity, and the general trend of the study. Dudovskiy (2018) maintained that the rule is to have one purpose and several research objectives to assist the study's achievement, as shown in the research methodology framework below. The mixed-methods section of the framework assists in addressing research aim and objectives and achieving research aim in contributing to knowledge. Khoo (2005) states that after the excellent question is set and the question has been well evaluated, the next set is to formulate research objectives. Doody & Bailey (2016) state that the first step of any study is developing the research question and the aim and objectives.

VII. Research Question Statement - Mixed Methods

The research question developed is-: Generate an Integrated Management System Framework for Post- Disaster Reconstruction – Integrating Disaster Management, Environmental, Occupational Health & Safety, Quality Management Systems into Post-Disaster Reconstruction Phase Management for Improvement of Post-Disaster Reconstruction Phase Management in the Construction and Related Industries. The aim and objectives considered in the methodology and methods illustrated in Figure 3 are specific, statement purpose, intent, and reflection on the question to help achieve the project's goal. Dudovskiy (2018) and SOLENT ONLINE LEARNING (n.d.) explained that aim is what the researcher hopes to realise and provide the answer; objectives are the action(s) taken to achieve the purpose. Dudovskiy (2018) and SOLENT ONLINE LEARNING (n.d.) concluded that aim is the statement of intent and divides research aim into written in broad terms. SOLENT ONLINE LEARNING (n.d.) stated that, on the other hand, several objectives address each portion separately and define measurable outcomes, e.g., what steps will be taken to achieve the desired result. Using the following words as illustrated in Figure 3: (A) Explore, (B) Focus on the identification of the barriers, (C)Measure the Critical Success Factors, (D) To investigate the differences and linkages, and (E) Develop an Integrated Management as in the objective's statements are specific and reflects on the above research question. SOLID ONLINE LEARNING (n.d.); stated that writing the objectives, the research will use strong positive statements and strong verbs such as collecting, constructing, classifying, developing, developing, measuring, producing, revising, selecting, and selecting, and synthesise. The weak verbs are: appreciate, consider, inquire, learn, know, understand, be aware of, appreciate, listen, and perceive.

Figure 3. Research Methodology and Methods

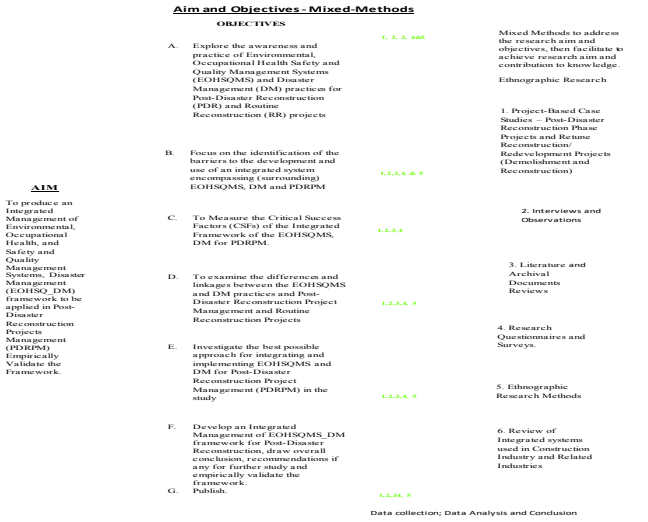
VIII. Research Methodology – Mixed Methods

The research mixed-methods approach within the methodology is used to define the research question and establish a more in-depth understanding of it to solve the problem and generate an integrated management system framework for post-disaster reconstruction. Research mixed methods are made up of two types qualitative research method and quantitative research method. The qualitative research method is designed to reveal the observable facts, insight into the research case studies, etc., under investigation. A quantitative research method is a systematic approach used to collect quantifiable data by performing computational, mathematical, or statistical techniques for the phenomena under study. Collected data from the qualitative research method would be descriptive, and it is easy to draw inferences from it. On the other hand, data collected through the quantitative research method would be numerical (Bhasin 2019).

The selected mixed-method (qualitative and quantitative) is a qualitative-driven mixed-method design, descriptive theoretical, with the core component, is inductive. Morse & Niehaus (2011), stated in their review of their textbook titled Mixed Method Design: Principles and Procedures, define mixed methods as combining one or more methodological approaches or practices. A second method is drawn from a single research study to access some part of the phenomenon of interest that cannot be accessed by using the first method alone. The research overall drives discovery, exploration as a means for contributing to knowledge or finding something out, which helps develop an integrated management tool for post-disaster reconstruction phase management. Morse & Niehaus (2009) and Hughes (2006) stated that quantitative and qualitative research provides a general picture; quantitative analysis plugs

the gaps in a qualitative study; if not, all issues are amenable solely to a quantitative or a qualitative investigation.

Mixed Methods- addresses the research aim and objectives and helps collect data, analysis achieves the contribution to knowledge. It is constructed as illustrated in Figure 4. in steps 1, 2, 3, 4, 5 and 6. Mixed-method is part of applied research, which is part of social science that seeks to improve the post-disaster reconstruction phase management and generate an integrated management system for the construction industry and related industries. Amaratunga et al. (2002), Daniel et al. (2020) and Knight & Ruddock (2008) stated that construction management research draws from well-establish natural, social sciences, engineering, and management disciplines. Furthermore, Researchers within the built environment disciplines have increasingly drawn on a plurality of social methods to enrich their research.



1. Project-Based Case Studies – Post-Disaster Reconstruction Phase Projects and Retune Reconstruction/ Redevelopment Projects (Demolishment and Reconstruction) – process studies of reconstruction phase management system, for change management, generate an integrated system as a new way of managing post-disaster reconstruction phase projects. As pointed out by Creswell & Poth (2017) and Gerdin et al. (2010), the case is a bunded system or object of study; it might be an event, a process, or a program and change management: the coordination of a structured period of transition from situation A to situation B to achieve lasting change within the organisation.
2. Interviews and Observations –types of interviews and observations selected will help obtain the most valuable information to generate the integrated management framework and achieve the study's contribution to knowledge. Lancaster (2005) maintained that interviews are a crucial category of gathering data through questioning and are acknowledged as the most effective way of collecting data in social science.

The interviewees will be made up of participants and service users in the construction industry and related industries in a series of phases in its process. This process is confirmed by (Creswell & Poth (2017), stating interviewing might be viewed as a series of steps in a procedure. A

Observation is one of the selected processes to collect data to answer the study question. The observation type is indirect observation through the recorded descriptions of the studies to generate an integrated management system framework. Ciesielska & Jemielniak (2018) wrote that indirect observation research collects information in videos or written descriptions of events. Construction management research is close to research in social science and business management and management consultancy. Ciesielska & Jemielniak (2018) and Lancaster (2005) agree that observation is an important research method in social sciences, including management research and consultancy, for generating primary data. It is the most diverse; the choice must fit the research problem and the scientific context. Furthermore, Ciesielska & Jemielniak (2018) identify a comparison of the four main types of observations-participant, direct, indirect, and nonparticipant as illustrated in Table 1. below.

Table 1. The four types of observations, source Ciesielska & Jemielniak (2018)

Comparison Four Main Types of Observations				
Type	Participant	Direct	Indirect	Nonparticipant
How?	Observing from an insider perspective, as an active participant of a group or organisation. It requires complete cultural immersion (although only temporarily) while sustaining an analytical mindset	Active observing of events unfolding in front of our eyes to record behaviour in the environment where it naturally occurs. Usually requires some immersion in the field of study but not necessarily in the culture itself	Research through collecting information, for instance, in the form of videos or written descriptions of events. Also, self-ethnography, remembering events and environments to analyse them	Observation from an outsider perspective without interacting with subjects of observation. The researcher may take the position of an "alien" from a different planet or reality in order to achieve a distance from the well-known
When?	Useful when insider's point of view is essential and to gain access to tacit knowledge	In-depth understanding of a social group or an organisation but from an external/ independent point of view.	Useful when the direct observation wasn't possible when the events naturally occurred.	Useful when observing a well-known reality, for example, a public place, and there is a need for regarding it from a new perspective

3. Literature and Archival Documents Reviews – The literature review is the groundwork for understanding what other researchers have written and done. The literature review explores the identification of critical issues essential to the research question, as Teddlie & Tashakkori (2009) stated. To help develop an integrated management system for environmental, health, and safety and quality and disaster management system in post-disaster reconstruction and points out gaps and appraises the strength and weakness of the literature related to the research question. It makes the current knowledge clear, offering new insights, isolating significant problems to be solved. The literature review is to justify the research area and identify the value of the research question. The nature of the contribution to be achieved presents a logically argued case founded on a comprehensive understanding of the current knowledge about the topic of study. Thus, the research question guides the literature search and leads the review into the relevant literature (Craswell (2005); Jesson et al. (2011); (Machi & McEVOY (2012) and Raina et al., (2004)).

The document analysis or review starts with the research topic is the qualitative part of the mixed methods. Then, it moves on to the research question to generate an integrated management system for post-disaster reconstruction in the

construction industry and related industries. Bowen (2009) and Qestionpro.com (n.d.) explained that documentary research is defined as the research conducted through official documents or personal documents as the source of information. On the other hand, they also stated that document analysis is qualitative research; the researcher interprets documents to give voice and meaning around a research topic and research question.

IX. Preparation, Planning, and Organising

The preparation, planning, and organising for research mixed method document review and analysis contribution to answering the research question to generate an integrated management system is essential to make it work. Bowen (2009) confirmed this in his article, which examines the function of documents as a data source in qualitative research. He stated that document analysis procedure in actual research experiences and the preparation required before document analysis is performed is a task in itself. Bowen (2009) also said, document analysis in mixed-methods studies combines quantitative and qualitative research techniques, sometimes including document analysis. Rossman and Wilson (1985) stated that combining quantitative and qualitative methods surveys (to collect quantitative data) and open-ended, semi-structured interviews with reviews of documents (as the primary sources of qualitative data. Also, Sogunro (1997) suggested that questionnaires can combine with interviews, document analyses, and direct observations to examine the impact of training on leadership development. Which is reflected in the post-disaster reconstruction phase of management or leadership (Bowen 2009).

4. Research Questionnaires and Surveys and Applied Ethnographic Research. Questionpro.com (n.d.) stated the difference between questionnaire versus survey which are:
    I. A survey is defined as evaluating experiences or opinions via questions.
    II. A questionnaire is a collection of written or printed questions with an answer choice to conduct a study.

Also, Surbhi (2017) highlights that surveys and questionnaires are the two methods of acquiring data, from the respondents, based on interrogation. Surbhi (2017) again stated that both methods gather primary data to collect information on social issues. Surbhi (2017) also confirmed that surveys are the conventional way of carrying out research in which the respondents are questioned concerning their awareness, motivations, demographics, and other characteristics. The research question is to generate an integrated management system framework about specific issues under the questionnaires method. Surbhi (2017) confirmed that, conversely, questionnaires are a tool for acquiring data on a particular topic, which involves distributing forms that comprise questions relating to the case under study.
Questionnaires are selected to collect the research data; construction management research is related to business and management research areas. Rowley (2014) reported that research questionnaires are widely applied in gathering information and data in business and management studies and social science. He went on to say that a lot of effort goes into creating a good research questionnaire that collects the data that answers your research questions and attracts a reasonable response rate. He also pinpointed that research questionnaires refer to questionnaires used as part of an academic research project.

Marking up the research questionnaires or choosing research questionnaires is based on seeking experiences, opinions, and processes of an integrated management system development and use for post-disaster reconstruction phase management, routine construction phase management in the construction industry, and related industries. Rowley (2014) stated that questionnaires are primarily used in conducting quantitative research, where the researcher wants to count the frequency of occurrence of opinions, experiences, and processes. But Dudovskiy (2018) argues that questionnaires can be classified as both quantitative and qualitative methods. Also, he stated that classification of depending on the nature of questions which are:

I. Answers obtained through closed-ended questions with multiple choice answer options are analysed using quantitative methods.
II. Answers obtained to open-ended questionnaire questions are analysed using qualitative methods, and they involve discussions and critical analyses without using numbers and calculations.

Besides, Rosen & Olsen (2006) also mentioned that consideration must be made to the quality, framing, and asking the research questionnaires or questions. Because quality, communicating, and asking would substantially affect research service users and participants to answer and how they responded. Also, Dudovskiy (2018) wrote that questions need to be formulated clearly, straightforwardly, and logically presented. Dudovskiy (2018) goes on to suggest that research questionnaires have advantages and advantages:

I. Advantages of research questionnaires include the increased speed of data collection, low-cost requirements, and higher levels of objectivity compared to many alternative primary data collection methods.
II. However, research questionnaires have certain drawbacks, such as selecting random answer choices by respondents without adequately reading the questions. For example, respondents cannot usually express their additional thoughts about the matter due to the absence of a relevant question.

The main questions of the research questionnaire are to be included in the submission of the conference presentation and journal paper to serve as a researcher's self-report. Improving research questionnaires is through greater openness and cooperation. Rosen & Olsen (2006) agreed to this that:

I. To post complete questionnaires on a personal, university, or study website concurrent with publication.
II. Key question(s) be included in a print article if the essential exposure or outcome is determined from self-report.

Surveys and research questionnaire methods applications would be used during the research would help know the understanding, experiences, and processes used by service users and participants to develop and use an integrated management system within the construction industry and related industries. In addition, the researcher, service uses, and participants need to know the research ethics, quality, relevance, and acceptability, and reputation of the research is necessary. Slattery et al. (2011) wrote that surveys with questionnaires play a vital role in decision-making and policy-making. In addition, surveys with questionnaires may be the only method for gathering data on rare or unusual events (such as research to improve post-disaster reconstruction phase management with service uses and participants' involvement). To support the above Patterson, et al. (2014) claims that incorporating 'lived experience' is advanced to improve the quality, relevance, acceptability, and ethical status research lived experience for this research, including service users and participants. Patterson et al. (2014) said support for the concept and practice of involvement is far from universal. Therefore, service users, participants, and researchers need such information to optimise the process and outcome of involvement. More importantly, to support the above researcher in the study would consider the external suitability of the research outcome or knowledge contribution. In addition, the research can be duplicated in a general or specific environment. Houser & Bokovoy (2006) agreed that external validity (suitability) links knowledge through analysis using knowledge in practice. Also, they mentioned that external validity refers to the ability to generalise the findings from a research study to other situations, such as to generate an integrated management system for post-disaster reconstruction phase project management.

Review of Integrated Systems used in Construction Industry and Related Industries-

- Determine, plan and obtain the documents for the integrated system's framework for construction project management documents from service users and participants, whether public or private, if private access, to requested access.

X. Designing of Questionnaires and Surveys Research Question

This assembling information is to assist in the development of an integrated management framework. Mathers et al. (2007) and Kowalska (n.d.) confirmed that questionnaires can be created for a precise drive and are completed by parties. Also, they stated questionnaires could include an array of different style questions. The formation and use of questionnaires are convenient for collecting valid comparable data from many individuals, such as the research service users and participants. Undertaking the study, the researcher aspect that questionnaire and survey stand as two different processes or means used for obtaining information from the research participants and service users to answer the research question. This acceptance is highlighted by Surbhi (2017), saying that surveys and questionnaires are the two methods of acquiring data; both ways are used to gather primary data from respondents (such as research participants and service users) based on the questionnaires and surveys questions. Also, Surbhi (2017) wrote that, on the other hand, questionnaires are a tool for acquiring data on a particular topic, such as post-disaster reconstruction phase improvements, which involves distributing forms that comprise questions relating to the case under study. The comparison chart in Table 2 below illustrates that difference.

Table 2. Comparison survey and questionnaire chart source: Surbhi (2017)

COMPARISON CHART		
BASIS FOR COMPARISON	SURVEY	QUESTIONNAIRE
Meaning	A survey refers to collecting, recording, and analysing information on a particular subject, an area, or a group of people.	A questionnaire implies a form containing ready-made questions delivered to people to obtain statistical information.
What is it?	Process of collecting and analysing data	Instrument of data collection
Time	Time-consuming process	Fast process
Use	It is conducted on the target audience	It is distributed or delivered to the respondents,
Questions	Open/close-ended	Closed-ended
Answers	Subjective or Objective	Objective

A. Research Survey Questionnaires

The research survey questionnaires would be designed and done using essential practice:

a. Considering the research aim and objectives in the design of survey questionnaires (questions)
b. Determine the service uses and participants to meet the aims and objectives of the research
c. Do try survey practice outside the research service uses and participants

Determine methods and principles of gathering and analysing data. Burgess (2001) suggested and supported the designing of survey research, saying that the basic process of survey research can be outlined.

XI. Data Collection and Analysis Using Mixed Method Design (Qualitative and Quantitative)

Research methodology – the mixed-method selection is based on that PhD. Construction Management research within the Built Environment is closely related to Social Science. Which does not lend itself to hypothesis testing and statistical analysis; the mixed method is suitable for the research to develop or generate an integrated system for the post-disaster reconstruction management phase. That is the post-disaster reconstruction phase management intervention to improve management structure by generating an integrated management framework. Moreover, Wisdom & Creswell (2013) explained that mixed methods could be a model procedure to assess complex interventions. In addition, Wisdom & Creswell (2013) pointed out that researchers (evaluators) may choose from five main mixed methods designs depending on the research problems (questions) they want to answer and resources available for the evaluation.

B. Available Documents from Participants and Service Users

Note: Habitat for Humanity (2012) expressed that disaster management is an ongoing process, from preparations that would reduce risks, response to mitigation based on lessons learned. In reality, phases of disaster management take place concurrently (all together or integrated). Again stated, for instance, the recovery phase, which includes reconstruction of disaster management, starts day one after a disaster. Lloyd-Jones et al. (2016) maintained that reconstruction is an integral part of pre-disaster planning. It is part of more comprehensive development, disaster recovery, and disaster risk management, which should all be included in an integrated, coordinated, and continuous sustainable development process. In addition, Lloyd-Jones et al. (2016) stated that disaster reconstruction is complex and part of the broader recovery strategy to generate the framework for sustainable recovery.

Post-disaster redevelopment planning by the governments or states identifies documents that would contribute to study areas. The source is Florida Department of Community Affairs & Florida Division of Emergency Management (n.d.); Lloyd-Jones et al., (2016) and Community Planning Workshop - Community Service Center University of Oregon, (2010). The post-disaster reconstruction management phase identified documents: Oxfam G.B." s Guidelines for Post Disaster Housing Reconstruction-TOPIC GUIDE Effective Post-disaster Reconstruction Programs Management-The Sphere Handbook Source: OXFAM (2003); Lloyd-Jones et al. (2016) and Sphere Association (2018).

Qualitative measurement would be strong descriptions based on the questions in an interview model from participants and service users from construction and related industries. Quantitative would measure independent and dependent variables; the option selected is the Likert scale survey. In quantitative deductive studies stated above, the measurement would be in nominal or ordinal data limits to non-parametric statistical analyses, measure variables and analyse relationships. As explained and confirmed by LATHAM (2016), quantitative measures the independent and dependent variables; there are two main options for quantitative measurement in management studies: (a) the Likert scale survey and (b) direct measurement using other methods. In qualitative methods, the word measure seems odd. McLeod (2019), the final form of the Likert scale is a five (or seven) point scale that allows the individual or organisation to express how much they agree or disagree with a particular statement (an integrated management system framework). Within qualitative studies, the measurement is often rich qualitative descriptions" based on the responses to the questions in an interview guide. These would determine observation type, structured or systematic data collection methods involving specific variables (independent and dependent variables) with a pre-outlined schedule.

As Dudovskiy (2018) mentions, the observation data collection method could be structured or unstructured. Similarly, data collection is conducted using specific variables and a pre-defined schedule in structured or systematic observation. On the other hand, unstructured observation is conducted in an open and accessible manner because there would be no pre-determined variables or objectives. The analysis measurement plan should be consistent with the conceptual framework and research question (LATHAM 2016).

The overall approach, Conceptual Framework and Data Analysis for the research data collection and analysis: The comprehensive approach - for the research data collection methods would be driven from, and consistent with, the general research practice, the preliminary research plans that proposed a Likert scale survey. For the conceptual framework - the research methodology components, the data collection methods will focus on collecting data about the constructs, variables, and context factors identified in the conceptual framework.

The data analysis options stated above will be determined by the type and level of data collected. The type of analysis required in the above will answer the research questions. And identify the type of data needed to perform the necessary analysis. More complex and prolonged than separately methods because of the use of mixed methods. Finally, the researcher set up the interpretation, computation and analysis model, i.e. using MAXQDA qualitative data analysis. The MAXQDA is a powerful tool for qualitative and mixed methods research, which research community that spans the globe uses MAXQDA (Gizzi and Rädiker 2021).

XII. Assessment Research Methodology and Mixed Methods Formation

The work insight above in the development of methodology and mixed methods for the research to generate integrated management for the post-disaster reconstruction phase management would contribute to working with responders from construction and related industries, and the researcher as illustrated in Figure 3. Research Methodology and Methods and Figure 4. Aim and Objectives - Mixed Methods.

XII. Conclusion

The research case stud in construction management is within the built environment close to business management and social science; construction management is a relatively new field that draws from a wide range of established disciplines in the natural, social sciences, engineering, and management.

The Research Methodology is created to help generate an integrated management system for the post-disaster reconstruction construction phase in construction and related industries. Research Design Framework formed the links used to develop the research question. Which also would contribute to the Research Methodology:- Mixed Methods Framework. The research design framework section is designed to help create a custom research methodology for their particular project. The research mixed-methods approach within the methodology is used to define the research question and establish a more in-depth understanding to solve the problem and generate knowledge. It also addresses the research aim and objectives and helps collect data, analysis and contributes to the study.

Planning and procedures for the observation study method is an indirect observation undertaken by analysing written descriptions of events and internal organisation documents, which fits the study to answer the research, as direct observation studies would not be achievable.
Surveys and research questionnaire methods applications would help know the understanding, experiences, and processes used by service users and participants. Measurement mixed methods qualitative and quantitative, the qualitative measurement would be qualitative, stung qualitative descriptions based on the responses to the questions in an interview model from research responders. Then quantitative would measure independent and dependent variables; the option selected is the Likert scale survey. The overall approach is a conceptual framework and data analysis for the research data collection and analysis. That would be driven by the preliminary research plans that proposed a Likert scale survey consistent with the general research practice.

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3D Printed Elastomers via Sequential Network Formation

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***Abstract*—**The use of vat photopolymerization techniques to produce 3D printed elastomers has gained increasing interest in both academic as well as industrial research. The advantage of additive manufacturing lies in the production of complex and individual devices with high spatial resolution. However, the major challenge that needs to be addressed is the dichotomy between viscosity restrictions and mechanical performance, i.e. rubber elasticity. Conventional vat photopolymerization 3D printers are only able to process materials with low viscosities. These are usually based on oligomeric acrylates, diluted with co-reactive monomers and thus lead to highly crosslinked thermosets. This contrasts with the nature of typical elastomeric materials that are either based on a high molecular weight polymer with only few chemical or physical crosslinking points or highly phase-separated thermoplastic elastomers (TPE). The poster will present a novel concept to print elastomers by a sequential network formation. A polyurethane-based building block is dispersed in an acrylic phase that enables the printing process by scaffold formation. In a subsequent tempering step, the system undergoes a curing reaction, leading to the formation of elastomeric materials with high elongation at break and good elastic property retention. The curing kinetics is examined by photo-rheology. Hysteresis cycles and dynamic mechanical analyses are performed and discussed to characterize the elastomeric-like material properties.

***Keywords*—**Elastomers, Photo-rheology, Sequential Network Formation, Vat Photopolymerization

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Biocompatible Polymers for Actinide Skin Decontamination

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***Abstract*—** Nuclear terrorist attacks is an increasing threat all over the world, forcing countries to consider new measures to effectively rescue the population, which includes finding solutions in the case of contamination, which can be external (healthy skin without absorption) or internal (healthy skin with absorption, damaged skin, inhalation, ingestion). Additionally, human contamination by radionuclides can also occur in nuclear installations whose safety must be ensured at reactor level, during reprocessing, fuel fabrication, transport of nuclear materials or even during dismantling operations (civil or military), all these stages presenting a risk of contamination. Unfortunately, currently used chelating molecules proved to show significant limitations: toxicity, liquid formulations promoting the spread of contamination, need for flushing with water after use. As a result, it is essential to develop new external decontamination strategies.

In this context, the objective of the reported work is to synthesize original biocompatible copolymers functionalized with bisphosphonic acid groups, the latter being known in the literature to efficiently complex radionuclides. The copolymers developed will lead to hydrogels, thus avoiding runoff and not requiring rinsing, which will facilitate their use on operation sites (the principle of use of these gels is shown in scheme 1). To achieve that goal, different types of copolymers were synthesized: some by ring opening polymerization (ROP) based on poly(ethylene glycol) (PEG) and functionalized poly(ε-caprolactone) (PCL); others by reversible addition-fragmentation chain transfer (RAFT) with poly(N-isopropylacrylamide) (PNIPAAm), poly(acryloylmorpholine) (PNAM) and poly(N-acryloxysuccinimide) (PNHSA). These systems were chosen because they are known to be biocompatible and to form hydrogels. Then, ligands containing bisphosphonic acid functions were grafted onto these copolymers, in different proportions (10%, 25% and 50%), in order to provide them their complexing properties.

Hydrogel formation studies show that copolymers containing PNIPAAm form gels at 37 °C (body temperature) with a percentage of 20 and 30 wt% in water and at 20 °C with a percentage of 30 wt% in water. Regarding the copolymers based on PCL and PEG, the gels were obtained in the presence of an excess of bisphosphonate ligand thanks to the formation of intermolecular chemical bonds.

Subsequently, analyzes of complexations with several radionuclides were carried out by isothermal titration calorimetry (ITC) and inductively coupled plasma mass spectrometry (ICP-MS). The neodymium (Nd), cerium (Ce), thorium (Th) and uranium (U) elements were chosen as they cover properties of actinides. Obtained results showed that at pH 5.5 (pH of the skin), the various polymers synthesized had good complexing properties of these elements and that the complexation also increased with the amount of bisphosphonic acid functions. In addition, it is worth mentioning that the same polymers containing no bisphosphonic acids exhibited zero complexation, highlighting the effectiveness of bisphosphonate groups in complexation.

In conclusion, various valuable systems of copolymers forming hydrogels and containing bisphosphonic acid functions have been prepared, and could be easily and efficiently used for skin decontamination.

Scheme 1. Principle of use of phosphonated polymers for actinide complexation.

***Keywords*—** Biocompatible polymers, complexation, decontamination, phosphonated polymers.

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Poly(trimethylene carbonate)/Poly(ε-caprolactone) Phase-separated Triblock Copolymers with Advanced Properties

Nikola Toshikj [a], Michel Ramonda [b], Sylvain Catrouillet [c], Jean-Jacques Robin [d], Sebastien Blanquer [e]

Abstract**—**Biodegradable and biocompatible block copolymers have risen as the golden materials in both medical and environmental applications. Moreover, if their architecture is of controlled manner, higher applications can be foreseen.

In the meantime, organocatalytic ROP has been promoted as more rapid and immaculate route, compared to the traditional organometallic catalysis, towards efficient synthesis of block copolymer architectures. Therefore, herein we report novel organocatalytic pathway with guanidine molecules (TBD) for supported synthesis of trimethylene carbonate initiated by poly(caprolactone) as pre-polymer. Pristine PTMC-*b*-PCL-*b*-PTMC block copolymer structure, without any residual products and clear desired block proportions, was achieved under 1.5 hours at room temperature and verified by NMR spectroscopies and size-exclusion chromatography. Besides, when elaborating block copolymer films, further stability and amelioration of mechanical properties can be achieved via additional reticulation step of precedently methacrylated block copolymers.

Subsequently, stimulated by the insufficient studies on the phase-separation/crystallinity relationship in these semi-crystalline block copolymer systems, their intrinsic thermal and morphology properties were investigated by differential scanning calorimetry and atomic force microscopy. Firstly, by DSC measurements, the block copolymers with $\chi_{AB}N$ values superior to 20 presented two distinct glass transition temperatures, close to the ones of the respecting homopolymers, demonstrating an initial indication of a phase-separated system. In the interim, the existence of the crystalline phase was supported by the presence of melting temperature. As expected, the crystallinity driven phase-separated morphology predominated in the AFM analysis of the block copolymers. Neither crosslinking at melted state, hence creation of a dense polymer network, disturbed the crystallinity phenomena. However, the later revealed as sensible to rapid liquid nitrogen quenching directly from the melted state. Therefore, AFM analysis of liquid nitrogen quenched and crosslinked block copolymer films demonstrated a thermodynamically driven phase-separation clearly predominating over the originally crystalline one. These AFM films remained stable with their morphology unchanged even after 4 months at room temperature. However, as demonstrated by DSC analysis once rising the temperature above the melting temperature of the PCL block, neither the crosslinking nor the liquid nitrogen quenching shattered the semi-crystalline network, while the access to thermodynamical phase-separated structures was possible for temperatures under the poly (caprolactone) melting point.

Precisely this coexistence of dual crosslinked/crystalline networks in the same copolymer structure allowed us to establish, for the first time, the shape-memory properties in such materials, as verified by thermomechanical analysis. Moreover, the response temperature to the material original shape depended on the block copolymer emplacement, hence PTMC or PCL as end-block. Therefore, it has been possible to reach a block copolymer with transition temperature around 40°C thus opening potential real-life medical applications.

In conclusion, the initial study of phase-separation/crystallinity relationship in PTMC-*b*-PCL-*b*-PTMC block copolymers lead to the discovery of novel shape memory materials with superior properties, widely demanded in modern-life applications.

Keywords**—** biodegradable block copolymers, organocatalytic ROP, self-assembly, shape-memory

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Hydrothermal Synthesis of Ag-doped Bismuth Oxyhalides Hierarchical Nanostructured 3D used for Photocatalysis

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***Abstract*—**The new family of bismuth oxyhalides, semiconductors, are very interesting for their characteristic hierarchical structures, optical properties, promising industrial applications and remarkable photocatalytic activities under visible light illumination, In this research, a series of Ag-doped BiOI photocatalysts containing different Ag contents was synthesized by a simple hydrothermal method. The photocatalytic activities of the undoped BiOI and Ag-doped BiOI products under visible light were evaluated through the decolorization of orange G (OG) in an aqueous solution. The result shows that Ag-doped BiOI micro flowers revealed the highest decolorization efficiency, 95%, to degrade OG under visible light within 180 min.

***Keywords*—** Semiconductors, Photocatalysis, Synthesis, Polluants, Irradiation

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Photocatalytic Degradation of Naproxen in Water Under Solar Irradiation Over $Nife_2o_4$ Nanoparticle System

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Abstract

To optimize water purification and wastewater treatment by heterogeneous photocatalysis, we used NiFe2O4 as a catalyst and solar irradiation as a source of energy. In this concept an organic substance present in many industrial effluents was chosen: naproxen ((S)-6-methoxy-α-methyl-2-naphthaleneacetic acid or 2-(6-methoxynaphthalenyl) propanoic) a non-steroidal anti-inflammatory drug. The main objective of this study is to degrade naproxen by an iron and nickel catalyst, the degradation of this organic pollutant by nickel ferrite has been studied in a heterogeneous aqueous medium, with the study of the various factors influencing photocatalysis such as the concentration of matter and the acidity of the medium. The photocatalytic activity was followed by HPLC-UV andUV-Vis spectroscopy. A first order kinetic model appropriately fitted the experimental data.The degradation of naproxen was also studied in the presence of H_2O_2 as well as in an aqueous solution.The new hetero-system $NiFe_2O_4$/oxalic acid is also discussed.The fastest naproxen degradation was obtained with $NiFe_2O_4/H_2O_2$. In a first-place, we detailed the characteristics of the material $NiFe_2O_4$ which was synthesized by the sol-gel methods, using various analytical techniques: visible UV spectrophotometry, X-ray diffraction, FTIR, cyclic voltammetry, luminescent discharge optical emission spectroscopy.

Keywords: Naproxen, Nickelate, photocatalysis, oxalic acid

Analysis of Incidences of Collapsed Buildings in the City of Douala, Cameroon from 2011-2020

T.G.L. J. Bikoko, J. C. Tchamba, S. Amziane

***Abstract*—**This study focuses on the problem of collapsed buildings within the city of Douala over the past ten years, and more precisely within the period from 2011 to 2020. It was carried out in a bid to ascertain the real causes of this phenomenon, which has become recurrent in the leading economic city of Cameroon. To achieve this, it was first necessary to review some works dealing with construction materials and technology as well as some case histories of structural collapse within the city. Thereafter, a statistical study was carried out on the results obtained. It was found that the causes of building collapses in the city of Douala are: Neglect of administrative procedures, use of poor quality materials, poor composition and confectioning of concrete, lack of Geotechnical study, lack of structural analysis and design, corrosion of the reinforcement bars, poor maintenance in buildings, and other causes. Out of the 46 cases of structural failure of buildings within the city of Douala, 7 of these were identified to have had no geotechnical study carried out, giving a percentage of 15.22%. It was also observed that out of the 46 cases of structural failure, 6 were as a result of lack of proper structural analysis and design giving a percentage of 13.04%. Subsequently, recommendations and suggestions are made in a bid to placing particular emphasis on the choice of materials, the manufacture and casting of concrete as well as the placement of the required reinforcements. All this guarantees the stability of a building.

***Keywords*—**Collapse buildings, Douala, structural collapse.

I. Introduction

THE collapse of a building is indicative of a problem which must be investigated starting from the preliminary studies to the construction phases through the design (architectural design, structural design etc.), the administrative procedure (obtaining building permit etc.) and inspection by the municipality or city council [1]. Reference [1] studied some aspects of construction technology that lead to the collapse of buildings in Yaoundé and Douala over the period from 2010 to 2014. They concluded that the absence of a study of the foundation soil, inadequate preliminary works, use of poor quality concrete and environmental factors is at the origin of this phenomenon. Reference [2] stated that causes of failures and collapses fall into five general areas, namely design deficiencies, construction deficiencies, material deficiencies, administrative deficiencies and maintenance deficiencies. Reference [3] examined structural failure in buildings under construction in Akure, Nigeria in order to make proposals to reduce and possibly stop the incessant cases of building collapse. Studies carried out by [4], Reference [5] and Reference [3] show that the use of inferior materials can lead to the ruin or even the collapse of buildings. Reference [6] estimated that the degradation of buildings made of reinforced concrete materials during the construction phase could occur due to: corrosion of the reinforcement caused by carbonation and chloride attack, and also cracking due to overloading. Reference [7] stated that the lack of follow-up by the local authorities after the issuance of the building permit, constructions in swampy areas, heavy rain, design errors/faulty design, erosion, cavitation, poor workmanship, amongst others factors are causes of structural failure of buildings in Cameroonian cities. Reference [8] analyzed and classified the different causes that lead to the collapse as being poor design, failure of the foundations, unnecessary overloads from a combination of other factors and finally the engineers responsibility resulting from a negligence of proper structural calculations and implementation.

Reference [9] discussed the factors that determine the degree of loss of human life during collapse of structures. To estimate the number of human lives lost during an earthquake for type ''b'' buildings they proposed the model:

$$K_{sb} = D5_b[M1_b * M2_b * M3_b 2 * (M4_b + M5_b)]$$

Where: D5 is the number of collapse buildings, M1 the number of people per building, M2 is the occupancy of the building at the time of the earthquake, M3 is the number of occupants trapped during the earthquake, M4 is the number of deaths during the collapse, M5 is the number of deaths after the collapse.

This study focuses on the collapse of reinforced concrete frame buildings within the city of Douala. In this context, the investigation of the causes will begin with the administrative procedure then to the design and construction. The quality of the materials used and the workmanship can also cause enormous problems for the supporting structure of a building. This is accentuated when the monitoring and control of the execution of the work is not always well done, which nevertheless play the role of support to avoid the accumulation of production errors that could lead to the worst. A building, once completed, is affected by the problems of degradation, aging, corrosion, various attacks, etc., in short, upkeep or maintenance. The influence of the environment in which a

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building is located can also be detrimental to it, such as floods, earthquakes, landslides, etc. [10]. So the probable causes of collapses are numerous and of various kinds. Therefore, we present some aspects during the construction phase that lead to the stability of a building during the investigation time, as well as some cases of collapse identified in Cameroon and in particular in Douala.

II. DESCRIPTION OF THE CITY OF DOUALA

Douala is a city located on the estuary of the Wouri river and located 30 km from the Atlantic Ocean with coordinates of 4°253 N latitude and 9°4215 E of longitude within the Gulf of Guinea in the Cameroon coastal (Littoral) region. The city extends over an area of 410 km^2 divided into 6 districts such as Douala 1, Douala 2, Douala 3, Douala 4, Douala 5 and Douala 6. Its demography in 2019 was 3.6 million inhabitants giving a population density of 8.874 inhabitants/Km^2. Douala has an altitude of 17 m with a monsoon type climate characterized by a temperature on average of 26.2°C and very abundant rainfall particularly during the rainy season spanning from June to October and a relative humidity of 99%. The dry season spans from the month of October to May and has a relative humidity of 80%. A summary of the climate data is given in Table I.

TABLE I
AVERAGE TEMPERATURES AND PRECIPITATION OF THE CITY OF DOUALA (Source: waterbase)

Month	Jan.	Feb.	Mar	Apr	May	Jun	July	Aug	Sept	Oct.	Nov.	Dec.
Average minimal temperature (°C)	22.44	25	24.44	2.44	23.89	23.89	23.33	23.33	23.33	23.33	23.89	23.89
Average maximal temperature (°C)	30	30.56	30.56	30	29.44	27.78	26.67	26.67	27.22	27.78	28.89	30
Precipitation (mm)	50.8	81.3	195.6	226.1	307.3	477.5	622.3	627.	581.7	419.1	154.9	55.9

III. HISTORICITY OF CAUSES AND CONSEQUENCES OF SOME CASES OF COLLAPSED BUILDING STRUCTURES IN DOUALA

Douala has witnessed some number of building collapse, amongst others are: On May 09, 2014, a four-storey building collapsed due to subsidence in Bonamouang in Akwa-Nord. On August 03, 2015 in Ndogbong suburb, the collapse of a five storey building occurred, damaging part of an opposite building. Just three weeks thereafter, on September 24, 2015 in the Nkongmondo suburb, the collapse of another five storey building occurred. A year later, on June 19, 2016, it was the turn of the Ndogbat suburb where a building collapse had caused the deaths of 05 people and many injuries (Figure 1). An accusing finger was pointed at the non-compliance with construction standards and the quality of building materials. As if that were not enough, on March 20, 2017, there was the collapse of a retaining wall resulting in 03 deaths and 03 injuries in Bonadouma-Home. This once again reveals the thorny issue of the granting of building permits and the poor quality of building construction standards as well as the lack of quality expertise in the city of Douala at every stage of the whole construction cycle in Douala. In February 2018, a building collapsed in the Koumassi neighbourhood, leaving a family homeless. Five months later, precisely in June 2018, there was yet another building collapse killing 05 people. On July 18, 2019, a 4 storey building located in the Ngangue suburb collapsed, killing the site manager. Local residents testified that the owner initially intended a two storey building, after which, two more floors were added. On August 21, 2019 in the Bonabéri-Sodico suburb, a two- storey building housing two church facilities and a primary school witnessed one of its sections collapse.

On January 13, 2020, in Ndogbong suburb, there was a partial collapse of one storey building, causing extensive material damage (see Figure 2). In fact, it was the first floor of the building that had collapsed and had fallen onto a nearby student hostel destroying about five rooms including their contents. Again, the cause of this was attributed to poor quality construction. The latest in these series of collapses took place in Beedi suburb, in front of the Douala General Hospital, on May 30, 2020, where a four-storey building collapsed, partially destroying a house nearby as well as a parked vehicle.

Fig. 1 Collapse of four- storeys building in the Ndogbat suburb

Fig. 2 Collapse of one storey building in the Ndogbong suburb

IV. METHODOLOGY

To achieve the goal assigned to this study, the methodology was conducted as follow:

- Firstly, we did a broad literature search through academic journals, conference proceedings, media reports, internet, and previous works of other authors on the subject matter.

- Secondly, we designed questionnaires and administered them to the various stakeholders within the construction industry such as real estate developers, architects, engineers and contractors in order to obtain an informed opinion on this collapse phenomenon which has become recurrent.

- Thirdly, we visited some building collapses site. We also interrogated the Douala city council, the Cameroonian National Civil Engineering Laboratory (LABOGENIE), Sol Solution Civil Engineering Laboratory, the Army Rescue, where consultations were carried out with various stakeholders. The discussions hovered around issues of structural collapse that have taken place over the past ten years in the city of Douala have been made.

- Fourthly, an inventory of the various cases of building collapses that have occurred in the city of Douala since 2011 was established, taking note of their exact dates, locations, suspected causes and casualties involved.

- Finally, the collected data were processed and analysed and some recommendations are suggested to reduce or minimize or limit building accidents in Cameroon.

V. ANALYSIS OF DATA AND DISCUSSION OF RESULTS

Table II presents some of the reported cases of building collapse within the city of Douala from 2011-2020 showing the dates of collapse, the building locations, the suspected causes as well as the casualties involved which reveal that 12 people died and 7 others were injured. It can also be seen from this table that the primary causes of this phenomenon, which has become recurrent in the leading economic city of Cameroon are: Wrong implementation of construction methods, adoption of wrong foundation, use of poor materials, poor concrete works followed by the secondary causes which are: faulty construction, lack of structural design, lack of soil study and finally the less common causes of: faulty design, lack of building permit etc.

TABLE II

SOME REPORTED CASES OF COLLAPSED BUILDINGS (STRUCTURES) IN DOUALA (2011-2020) ([1]; AUTHORS FIELD WORKS)

S/N	Building location	Type of building structure	Date of collapse	Suspected causes of building collapse	Number of lives lost/Injuries
1	Lapeyrere-Akwa	Four-Storey Residential Building Under Construction	July 17,2013	-Faulty Design -Faulty Construction -Use of poor materials	2 Died
2	Ndogbong	Five-Storey Residential Building under Construction	May 13,2013	-Foundation settlement	1 Died
3	Bépanda	Multi-Sport Complex Steel Truss Roof under Construction	January 7,2013	-Faulty Construction	Nil
4	Akwa-Nord	Four-Storey Residential Building under use though under Construction	May 18,2014	-Excessive loading - Faulty Design -Degradation due to environment	Nil

5	Kotto Village	Four-Storey Residential Building Under Construction	June 15,2012	-Erosion	Nil
6	Akwa-Sud	Residential Building Under Construction	April 11,2011	-Faulty Construction -Use of poor materials	Nil
7	Ndogbati	Collapse of a 3 storey building during construction	19 June 2016	- Wrong implementation of construction methods - Lack of structural design - Adoption of wrong foundation - Use of poor materials - Poor concrete works	05 Deaths
8	Bépanda	Building collapse during construction	07August2016	- Adoption of wrong foundation - Lack of soil study	Nil
9	Bonadouma Home	Collapse of retaining wall at the end of construction	20 March 2017	- Lack of building permit - Lack of soil study - Lack of structural design - Wrong implementation of construction methods - Adoption of wrong foundation	03 Deaths & 03 Injured
10	PAD Sté ALACAM	Collapse of a warehouse at the end of construction	27 June 2017	- Wrong implementation of construction methods - Adoption of wrong foundation	01 Death & 01Injured
11	Bonapriso	Collapse of a 3 storey building during construction	19 January 2018	- Wrong implementation of construction methods - Poor concrete works	Nil
12	Koumassi	Building collapse during construction	February 2018	- Lack of building permit - Lack of soil study - Lack of structural design - Adoption of wrong foundation - Wrong implementation of construction methods - Poor concrete works	Nil
13	Beedi	Collapse of a 3 storey building	30 May 2020	- Wrong implementation of construction methods	03Injured

when occupied	- Use of poor materials - Poor concrete works

VI. Causes of Building Collapses in Douala

As stated above, the collapse of a building is indicative of a problem which must be investigated starting from the preliminary studies to the construction phases through the design (architectural design, structural design etc.), the administrative procedure (obtaining building permit etc.) and inspection by the municipality or city council. The following factors listed below among others have been identified as the causes of building collapses in the city of Douala:

A. Neglect of Administrative Procedures

It is rare, and even impossible, to see a large-scale construction project in Cameroon, like those mentioned above, where the promoters have requested administrative procedures beforehand, or even after its completion. They can be committed either to obtain a building permit at the start of the project, or to obtain a certificate of conformity at the end, or for any authorization regarding land use. Construction works done without acquired a building permit would normally be deemed illegal [1], [11].

B. Choice and Quality of Materials

The degradation or deterioration of buildings depends on the quality of the materials used. This means that the poorer the quality of the materials, the more likely the building to degrade or deteriorate rapidly, in the worst case, collapse. Thus, to guarantee a good lifespan to our buildings, the inspection and monitoring services of the construction contracts will have to ensure the choice and the quality of the materials to be used.

C. Poor Composition and Confectioning of Concrete

Some of the construction sites in Cameroon used poor quality sand with high levels of organic matter and high salinity. Sand from the Wouri River was fraudulently delivered to construction sites intended for at least 3 story buildings. In some of these sites, it was observed that the cements used were from poorly preserved cement with the packaging often torn and the cement is being utilized ignorantly. Also, some of the reinforcements used were smaller than the prescribed nominal dimensions. It was also observed that the proportions of constituents in the concrete mix were not respected as well as non-respect of conditions of manufacture. At several construction sites we observed that a given quantity of ready mixed concrete was casted, and then 1h30 and 2 hours later a remaining portion of this concrete was remixed with added water then poured in concrete moulds. This practice reduce the compressive strength of concrete and greatly affect the concrete quality and Reference [12] stated that the compressive strength of re-mixing concrete with 1h30 and 2 hours time delay is lower than concrete prepared with a time delay of 30 minutes. The reduction in 28 days compressive strength was up to 28.28% when compared with the concrete prepared with 30 minutes delay in time [12].

D. Lack of Geotechnical Study

Out of the 46 cases of structural failure of buildings within the city of Douala, 7 of these were identified to have had no geotechnical study carried out, giving a percentage of 15.22%. For any building construction it is important to predict the likely behaviour of the supporting soil. This is in order to avoid any disaster during or after the construction phase.

E. Lack of Structural Analysis and Design

It was observed that out of the 46 cases of structural failure, 6 were as a result of lack of proper structural analysis and design giving a percentage of 13.04%. In this regards we can affirm that this does not greatly influence the total number of structural failure that have occurred within the past ten years in the city of Douala.

F. Corrosion of the Reinforcement Bars

Corrosion of steel reinforcement in concrete is one of the most important factors reducing the durability and the service life of reinforced concrete structures. It is characterized by a progressive loss of mass of metal and the formation of rust in presence of an environment containing chloride ions or carbon dioxide.

Corrosion of steel in reinforced concrete is the consequence of many interactions between structures and their environment (presence of chloride, carbon dioxide, humidity etc.), leading to the so called oxido-reduction reactions between reinforcement and oxygen content in the surrounding weather [13], [14]. The main consequences of this phenomenon are: concrete cracking and spalling, brownish staining, the decrease of the bond between concrete and the reinforcement, the reduction of the section of the reinforcement. The possible cause of cracking and spalling is: Poor workmanship during the construction phase.

G. Poor Maintenance in Buildings

Maintenance work includes preventive maintenance and corrective maintenance. Preventive maintenance aims to reduce the probability of failure or damage of a building and corrective maintenance is all the activities conducted after the failure of a building or the degradation of its function. It was observed that very few buildings undergo maintenance works in Cameroon after their service.

Other factors identified include:

• Lack of equipment in the construction industry

- Absence of professional supervision of site works
- Faulty construction methodology
- Illegal conversion of buildings
- Change of use of buildings
- Financial pressures
- The use of non-professionals in building construction
- Fire disaster

VII. RECOMMENDATIONS

The following measures would aid to reduce or limit building accidents in Cameroon:

- Getting the building permit before commencing construction on site
- Inspection of construction site should be enforced at the local government authorities and relevant government departments to ensure compliance with approved building plans.
- A preliminary geotechnical investigation should be carried out before design.
- Prohibiting the use of non-professionals in building construction.
- Construction materials quality control check should be made before using them into construction works.

VIII. CONCLUSIONS

This paper reports the analysis of incidences of collapsed buildings in the city of Douala, Cameroon from 2011-2020. The study concluded that, the causes of buildings collapse in the city of Douala from 2011 to 2020 are:

- Neglect of administrative procedures
- Use of poor quality materials
- Poor composition and confectioning of concrete
- Lack of Geotechnical study
- Lack of structural analysis and design
- Corrosion of the reinforcement bars
- Poor maintenance in buildings
- And other causes.

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Review on Quaternion Gradient Operator with marginal and vector approaches for colour edge detection

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Keywords: Gradient, Edge detection, color image, quaternion.

Abstract: Gradient estimation is one of the most fundamental tasks in the field of image processing in general, and more particularly for color images since that the research in color image gradient remains limited. The widely used gradient method is Di Zenzo's gradient operator, which is based on the measure of squared local contrast of color images. The proposed gradient mechanism, presented in this paper, is based on the principle of the Di Zenzo's approach using quaternion representation. This edge detector is compared to a marginal approach based on multiscale product of wavelet transform and another vector approach based on quaternion convolution and vector gradient approach. The experimental results indicate that the proposed color gradient operator outperforms marginal approach, however it is less efficient then the second vector approach.

1 INTRODUCTION

Edge detection plays a crucial role in image processing and image understanding. In image segmentation, certain specific parts of an image are extracted. Object extraction turns to be a critical task which requires a considerable attention since it helps to better understand and analyze an image, indeed, an efficient way of extracting an object in an image is often to detect and reconstruct its border.

Gradient estimation [1] is an essential task in image processing. The gradient was widely used in many applications such as edge detection [2-5], image segmentation [6,7], image recognition [8], face detection [9], etc.

In the case of edge detection, the implementation is done by thresholding gradient magnitudes or by locating local maximum values of gradient magnitudes. Gradient directions are matched to obtain object tacking and recognition using at the same time gradient magnitudes of the pixels on the model object edges.

For grayscale images, many gradient operators have been developed, however for color images, where each pixel is represented by trichromatic vector, this issue has not obtained the attention that it deserves.

Initial researches have considered marginal approaches which are inspired from grayscale operators. These approaches treat each chromatic component independently. However, it is more interesting to process color information vectorially.

In this context, Di Zenzo [10] proposes a first definition of the multispectral gradient in 1986. Cumani [11] relied on a second order derivation for an approach similar to that of Di Zenzo. On the other hand, several multiscale approaches have been studied, which generally rely on color invariance criteria [12], perceptual [13], etc. These approaches are based on the search for a break of homogeneity, from a point of view color this time.

Koschan and Abidi [14] and Chen et al. [15] have also chosen to classify methods of color edge detection in two categories: the first is that of synthesis methods, also known as monochromatic methods, which are listed in the category of marginal methods and the second concerns the vector methods.

In this paper, we are interested in color edge detection using the calculation of image gradients [16]. This approach is applied on color images without decomposing the color images into three channels.

In section 2, we analyze the concept of the gradient operator using quaternion representation for color images. Section 3 covers the details of the implementation of the proposed algorithm showing experiments illustrating results of the proposed gradient method applied on color images comparing with two other edge detectors. In section 4, we include quantitative evaluations illustrating the performance of our proposal, while some conclusions are drawn in Section 5.

2 METHOD: QUATERNION GRADIENT OPERATOR

The gradient operator proposed for color images is based on the square measurement of the local contrast variation of the color image function, which is similar to the Di Zenzo gradient method [16]. The Di Zenzo's gradient uses the

where c ϵ {r, v, b} and C ϵ {R, V, B}, that is, C is one of the R, V or B components in the RGB color space image.

Euclidean distance to measure the rate of change of an image function. On the other hand, the proposed gradient is computed with the change in brightness and chromatic variation measured by the quaternion rotation mechanism.

Hamilton discovered quaternions as an extension of complex numbers to four dimensions in 1843 [17]. A quaternion q has one real and three orthogonal imaginary components, and is usually represented in the following algebraic form:

$$q = a + bi + cj + dk \tag{1}$$

where a, b, c and d are scalar coefficients, and i, j and k are complex operators which obey the following rules:

$$i^2 = j^2 = k^2 = -1 \tag{2}$$

$$ij = -ji = k \tag{3}$$

$$jk = -kj = i \tag{4}$$

$$ki = -ik = j \tag{5}$$

A color image f(x, y) can be represented in the following quaternion form:

$$f_q(x,y) = R(x,y)i + V(x,y)j + B(x,y)k \tag{6}$$

The square of a local color change of fq(x, y) at a position (x, y) in any direction is given by:

$$\begin{aligned} &D(f_q(x,y), f_q(x+\varepsilon\cos\theta, y+\varepsilon\sin\theta)) \\ &= t\left|Q(f_q(x,y), f_q(x+\varepsilon\cos\theta, y+\varepsilon\sin\theta))\right|^2 \\ &+(1-t)\left|I(f_q(x,y), f_q(x+\varepsilon\cos\theta, y+\varepsilon\sin\theta))\right|^2 \end{aligned} \tag{7}$$

where $t \in [0,1]$ is the weight and denotes the importance of

For a RGB color image, f (x, y) represented by, the square of the color distance function in the direction which includes changes in chromaticity and luminance can be written as follows:

$$g(\theta) = E\cos^2\theta + 2F\cos\theta\sin\theta + H\sin^2\theta \tag{8}$$

where

$$\begin{cases} E = t\left(r_x^2 + v_x^2 + b_x^2\right) + (1-t)\left(k_1\dfrac{\partial R(x,y)}{\partial x} + k_2\dfrac{\partial V(x,y)}{\partial x} + k_3\dfrac{\partial B(x,y)}{\partial x}\right)^2 \\ F = t\left(r_x r_y + v_x v_y + b_x b_y\right) + (1-t)\left(k_1\dfrac{\partial R(x,y)}{\partial x} + k_2\dfrac{\partial V(x,y)}{\partial x} + k_3\dfrac{\partial B(x,y)}{\partial x}\right)\bullet \\ \left(k_1\dfrac{\partial R(x,y)}{\partial y} + k_2\dfrac{\partial V(x,y)}{\partial y} + k_3\dfrac{\partial B(x,y)}{\partial y}\right) \\ H = t\left(r_y^2 + v_y^2 + b_y^2\right) + (1-t)\left(k_1\dfrac{\partial R(x,y)}{\partial y} + k_2\dfrac{\partial V(x,y)}{\partial y} + k_3\dfrac{\partial B(x,y)}{\partial y}\right)^2 \end{cases} \tag{9}$$

$$c_x = \frac{\partial C(x,y)}{\partial x} - \frac{1}{3}\left(\frac{\partial R(x,y)}{\partial x} + \frac{\partial V(x,y)}{\partial x} + \frac{\partial B(x,y)}{\partial x}\right) \tag{10}$$

$$c_y = \frac{\partial C(x,y)}{\partial y} - \frac{1}{3}\left(\frac{\partial R(x,y)}{\partial x} + \frac{\partial V(x,y)}{\partial x} + \frac{\partial B(x,y)}{\partial x}\right) \tag{11}$$

where c ϵ {r, v, b} and C ϵ {R, V, B}, that is, C is one of the R, V or B components in the RGB color space image

In addition, the maximum value of g(θ), gmax (the gradient norm), and the direction that maximizes g(θ), θmax (gradient angle) is given by:

$$g_{\max} = \frac{1}{2}\left((E+H) + \sqrt{(E-H)^2 + (2F)^2}\right) \tag{12}$$

$$\theta_{\max} = \begin{cases} \operatorname{sgn}(F)\arcsin\left(\dfrac{g_{\max} - E}{2g_{\max} - E - H}\right)^{\frac{1}{2}} + k\pi, (E-H)^2 + \\ \text{not defined}, (E-H)^2 + F^2 = 0 \end{cases} \tag{13}$$

and $\theta_{\max}$ Satisfies the following constraints:

$$\theta_{\max} \in k\pi + \begin{cases} \left[0, \dfrac{\pi}{4}\right], F \geq 0 \,\&\, E - H \geq 0 \\ \left[\dfrac{\pi}{4}, \dfrac{\pi}{2}\right], F \geq 0 \,\&\, E - H < 0 \\ \left[-\dfrac{\pi}{2}, -\dfrac{\pi}{4}\right], F < 0 \,\&\, E - H < 0 \\ \left[-\dfrac{\pi}{4}, 0\right], F < 0 \,\&\, E - H \geq 0 \end{cases} \tag{14}$$

The sign of the function is given as follows :

$$\operatorname{sgn}(F)=\begin{cases}1, F\geq 0\\ -1, F<0\end{cases} \quad (15)$$

The proof of the theorem is in fact to solve the maximum value of Eq. (8), is given in [18].

3 APPLICATION IN COLOR EDGE DETECTION

We propose to apply the proposed gradient operator to enhance edge points of color images. This method uses the quaternion rotation mechanism to measure variations in color contrast.

In order to implement this approach, we chose some color images from the Berkeley segmentation dataset and benchmark [19].

The aim of this part is to see if this technique brings an improvement comparing to other methods. The qualitative assessment is presented in the figure below and the quantitative one will be the subject of the following paragraph. We compare the proposed approach with the multiscale product of wavelet transform approach (MP) [20, 21] and with quaternion convolution and vector gradient approach (QV) [22] as it is shown in the figure 1.

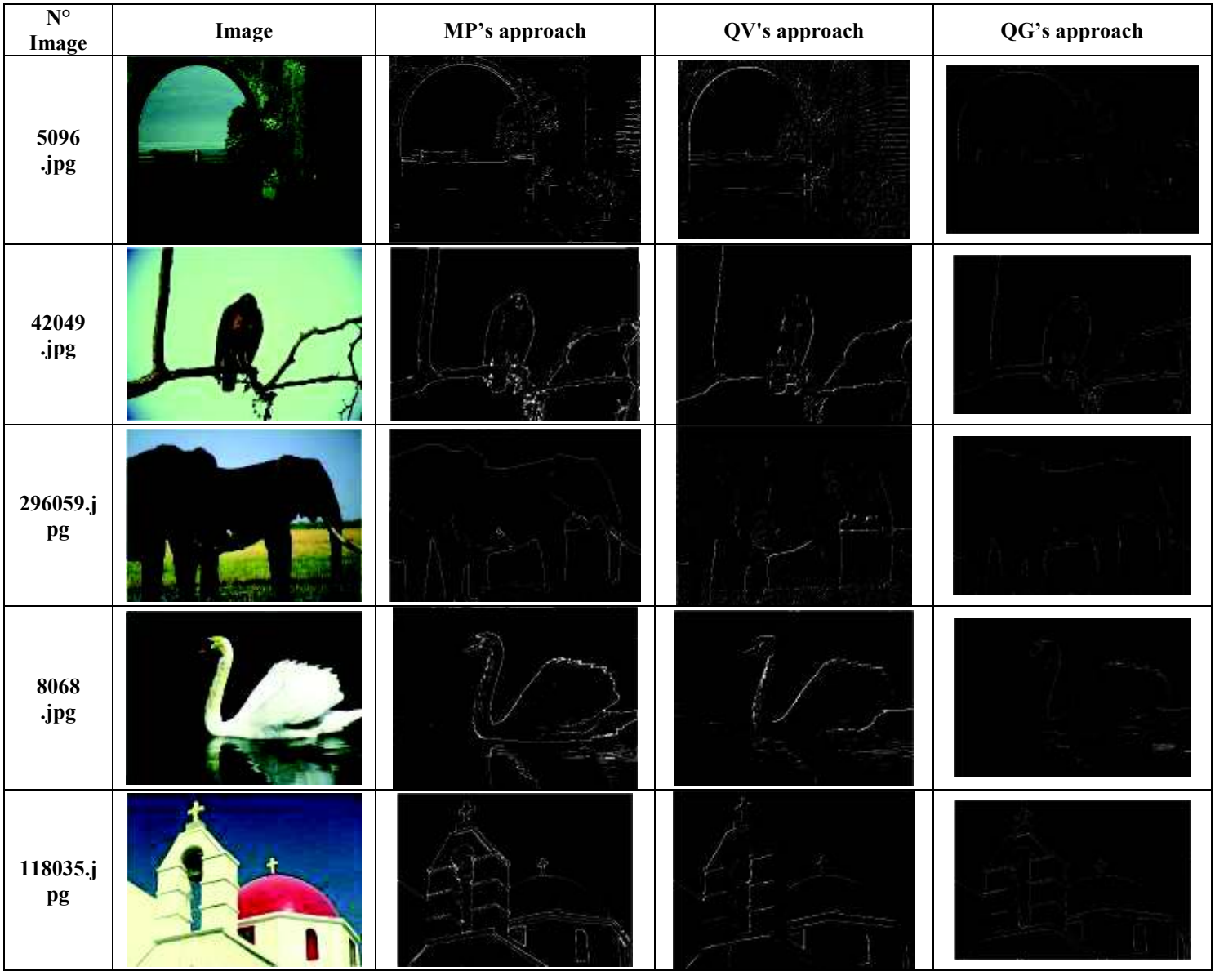

Figure 1: Comparison of edge detectors. From left to right: Image No., BSDS Image, MP's approach, QV's approach and QG's approach

The results obtained with the gradient operator approach (QG) show, in some cases, a considered number of missed detections; and more details detected in other cases. We compared this approach with a marginal approach based on multiscale product of wavelet transform and with a vector method based on quaternion convolution and vector gradient. We can conclude from the results shown in the figure above, that, our approach outperforms, in terms of quality of edge, and in other cases it is the others that go beyond it. In the following paragraph, we will evaluate our method in a quantitative way using the accuracy parameter.

$$Accuracy=((TP+TN)/(TP+TN+FP+FN))*100 \quad (16)$$

4 DISCUSSION: EXPERIMENTAL RESULTS

In this part, we have chosen the parameter of accuracy, which uses the true and false edges, and this to check the validity of the quaternion gradient approach in comparison with some of the existing edge detector techniques.

Where TP, TN, FP and FN are respectively True-Positive True-Negative, False-Positive and False-Negative edge points. The first category determinates edge pixel detected correctly as edge. The second defined non edge pixels which are extracted wrongly as edge pixel. The TN is the category of non-edge pixel detected correctly as non-edge pixel. Finally, the FN defined edge pixel detected wrongly as non-edge pixel.

These parameters are explained by the confusion matrix presented below.

The confusion matrix is commonly used to expose results for binary decision problems [23,24]. After a comparison done between the marked pixels produced by a classification method, we can define four cases as shown in the following table.

Table 1: Confusion matrix for the edge detection problem.

		Reality	
		Edge	Non-Edge
Classification	Edge	TP	FP
	Non-Edge	FN	TN

The following table presents the results of our assessment

Table 2: Comparison of accuracy parameter of the MP's approach, QV's approach and QG's approach

N° Image	MP's approach	QV's approach	QG's approach
	Accuracy (%)	Accuracy (%)	Accuracy (%)
5096.jpg	97,00	96,99	96,54
42049.jpg	96,30	97,07	96,72
296059.jpg	97,54	98,33	97,94
8068.jpg	97,70	98,00	97,91
118035.jpg	96,17	96,55	96,76
Average	96,94	97,39	97,17
Standard deviation	0.70	0.75	0.69

We note that the QG's approach outperforms MP's approach with an accuracy rate of 97,17% against 96,94%. However, the QV's approach has the best accuracy with a rate of 97,39%. We can conclude that vector methods are more suitable in terms of accuracy for color image edge detection against marginal methods. On the other hand, the QV method gives a better accuracy than that given by the QG's approach.

5 CONCLUSIONS

In this paper, a vector approach based on color gradient operator for edge extraction is presented. The proposed method uses quaternion rotation mechanism to measure the color contrast variations. The maximum of the contrast variation is resolved. The performance of this approach was tested and compared with a marginal and vector method. The experimental results show the effectiveness of the proposed gradient estimator against marginal method but it has not the best accuracy comparing with the other vector approach.

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BFDD-S: Big Data Framework to Detect and Mitigate DDoS Attack in SDN Network

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Abstract—The software-defined networking in recent years came into the sight of so many network designers as a successor to the traditional networking. Unlike traditional networks where control and data planes engage together within a single device in the network infrastructure such as switches and routers, the two planes are kept separated in software-defined networks (SDNs). All critical decisions about packet routing are made on the network controller, and the data level devices forward the packets based on these decisions.

This type of network is vulnerable to DDoS attacks, degrading the overall functioning and performance of the network by continuously injecting the fake flows into it. This increases substantial burden on the controller side, and the result ultimately leads to the inaccessibility of the controller and the lack of network service to the legitimate users. Thus, the protection of this novel network architecture against denial of service attacks is essential.

In the world of cybersecurity, attacks and new threats emerge every day. It is essential to have tools capable of managing and analysing all this new information to detect possible attacks in real time. These tools should provide a comprehensive solution to automatically detect, predict and prevent abnormalities in the network.

Big data though encompasses a wide range of studies, but it mainly refers to the massive amounts of structured and unstructured data that organizations deal with on a regular basis. On the other hand, it regards not only the volume of the data; but also that how data-driven information can be used to enhance decision-making processes, security, and the overall efficiency of a business.

This paper presents an intelligent big data framework as a solution to handle illegitimate traffic burden on the SDN network created by the numerous DDoS attacks. The framework entails an efficient defence and monitoring mechanism against DDoS attacks by employing the state of the art machine learning techniques in real time to read incoming data from different sources.

Keywords—Apache Spark, Apache Kafka, Big Data, DDoS attack, Machine Learning, SDN.

I. Introduction

THE Computers on the World Wide Web are connected using a standard protocol called the Internet. Today, people rely on the Internet for education, business, socialization, and entertainment, among many vital aspects of human life, sharing information, and e-commerce. We can claim that the Internet is the biggest revolution in the world of computing and communication.

Web threats, on the other hand, cause a wide range of jeopardies, including financial abduction, identity theft, loss of information or confidentiality, stealing the network resources, damage to the brand and personal reputation, declining consumer trust in e-commerce, online banking, and all different network services.

The traditional network structure initially has limitations such as complexity, inconsistent policies, lack of scalability, dependency on manufacturers, and a lack of symmetry between market demands and network capabilities. New concepts such as Cloud, virtualization, and changes in data consumption patterns, reveal weaknesses and limitations in traditional networks. With the advent of software-defined networks, new hopes have emerged for solving structural problems and resolve restrictions in traditional networks.

Software-defined networks are an emerging architecture that can fundamentally overcome the limitations of traditional networks [1]. Due to its centralized control, a software-defined network facilitates management, reduces hardware complexity, and gives the network environment a lot of flexibility and mobility [2].

Denial of service attacks is one of the threats that can seriously create an unexpected challenge for accessing the essential information by eligible users. By performing this kind of attack, the attackers attempt to disrupt the services by occupying a significant amount of available resources [3]. Although the technical complexity of these attacks is increasing day by day, the attackers do not need high technical knowledge and skills about the victim system and attack launch techniques to perform these attacks [4].

Hackers have enhanced their DDoS attack methods to extraordinary levels over the past decade. The emergence of the internet of things (IoT), pervasive connectivity, and now 5G networks are all components that have led to DDoS attacks' rapid expansion and complexity [5].

These kinds of attacks are growing day by day. One of the widespread denial of service attacks happened on October 21th, 2016 at Dyn. Dyn is an Internet infrastructure company that offers DNS service to the vast area of Europe and North America. Many users in North America, Europe, and several major websites, including Amazon and Fox News, were affected by the attack [6]. Moreover, the DDoS attack on the GitHub website caused many problems in a short period of time [7].

It is noteworthy that the distributed denial-of-service attacks on the SDN networks can be much more destructive due to a constant channel between the controller and the switches is maintained. The connection between the switches and the controller may provoke attackers to saturate this channel and disrupt the regular operation of the network [8].

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As a result of the large number of unknown flows arriving the controller, the controller's resources, such as CPU, memory, bandwidth, and so on, become vulnerable, and the network becomes unusable. In addition, the bandwidth of the communication line between the controller and data plane can be saturated by huge amount of these new traffic which will cause negative impact on the performance of the switches and disrupt SDN network functioning [9].

Since the flow table placed in the network devices, the data plane is also vulnerable to DDoS attacks. When the DDoS attacks launch, enormous packets are sent to the network switches from diverse anonymous sources. The defined rules for these arriving packets will be added to the flow table of the switches by SDN controller. the capacity of these flow tables is limited, therefore the flow table of the switch will be saturated after a while. As a result, no new rules can be added to the flow table, and no packets can be forwarded. Furthermore, once the buffer capacity saturated due to the DDoS attack, the all incoming network traffic drop automatically [10].

Adding Big Data to a company's security architecture can significantly improve its capability to identify, investigate, and potentially prevent DDoS attacks. Large amounts of data must be analysed and saved in order to properly evaluate DDoS attacks. The Big data ecosystem are capable of managing massive volumes of data for assessment and comparison.

Big Data analytics provide comprehensive investigation which can offer vision into a diversity of crucial information, whereas standard traditional security methods contain negligible logging information and only a few summary reports. It nearly appears that hackers were able to modify their methodologies to include cloud capability prior to enterprises switching from scale-up to scale-out architecture. As a result, even the most sophisticated security systems are unable to detect, prevent, or mitigate today's DDoS attacks. Big Data is a notion that can give companies knowledge into DDoS attacks and provide the tools they need to efficiently tackle the problem [11].

II. Related Works

In the last few years, several mitigation systems against DDoS flooding attacks have been reported in literature [12]. Due to the significance of security risks in software-defined networks, numerous methods have been proposed to detect these kinds of attacks; most of them rely on statistical solutions or machine learning methods. In some statistical solutions, entropy has been used to detect the attack [13].

Although entropy is a proper analytical method, it alone can not detect all the attacks. Therefore, for some attacks, it is probable that system may trigger false alarms at peak times. The peak time is when the legitimate traffic on the network has been increased for some reasons, such as providing authorized services to too many users. Therefore, the best approach is to combine entropy with some other methods. In some other solutions, researchers have offered graph based methodologies for the detection of DDoS attacks. However, there also lies the possibility of false alarms with the increase of illegitimate traffic [14].

Rojalina et al. [15] developed a defense system and detection methods against DDoS attacks based on deep learning. In this method, the capabilities of software-defined networks have been used to design a prevention algorithm module in the software-defined network controller. Robust infrastructure requirements and high costs are some of the problems associated with this method. The accuracy of the system in detecting attacks is reported to be 98.88%.

Quamar Niyaz et al. [16] propose a multivector system for DDoS attack detection in a SDN environment using deep learning. They implement their system as a network application on top of a SDN controller and for feature reduction they use deep learning to derive a large set of features from headers of the network traffic. For evaluation part, they use various performance metrics by applying it on traffic traces which collected from different scenarios.

G. Dileep Kumar et.al [17] introduced a real-time solution for detecting DDoS attacks based on SDN and Big Data. In their study they implemented SVM algorithm and offered two novel approaches for attack detection. They claimed that the proposed method could further be improved to detect and prevent different types of DDoS attacks.

Zhao et al. [18] developed a neural-network for detecting DDoS attack which has the ability to adapt to new types of DDoS attack. In their proposed system, they used Big Data tools such as HBase and Hadoop for analysing and storing huge amount of unstructured dataset which have been collected from network log.

Saied et al. [19] presented a method for attack detection using ANN algorithm and using various Big Data tools, such as Apache Spark for cluster computing system, HDFS for data storing and Yarn for resource management.

Sufian and Usman [20] presented a system called HADEC which is a live DDoS detection framework based on Hadoop to deal with flooding attack using MapReduce. They implemented an algorithm which only detects the TCP-SYN, HTTP GET, UDP and ICMP attacks.

Dahiya et al. [21] used Apache Spark to develop an intrusion detection system in NetFlow protocol. They used two feature reduction algorithms, Canonical Correlation Analysis (CCA) and Linear Discriminant Analysis (LDA), and then applied supervised classification machine learning algorithms such as Maive Bayes, REP Tree, Random Forest, Bagging using UNSW-NB15 as dataset.

Beluch et al. [22] investigated the performance of various famous machine learning (ML) algorithms such as SVM, Decision Tree, Naïve Bayes and Random Forest using Apache Spark. For the performance evaluation, they used UNSW NB15 as their dataset with 42 features in terms of accuracy, building time and prediction time. They reached to the conclusion that Random Forest algorithm with 97% accuracy has more advantage compared to the other classifiers.

The rest of this article is organized as follows. In the third section, the architecture of software-defined networks and the most common southbound protocol, OpenFlow are described. In the forth section, some Big Data tools that are used in the implementation of data pipeline into the framework are defined. The fifth section describes the proposed methodology

and experimental setup for implementing the BFDD-S framework for detecting distributed denial-of-service attacks. The sixth section discusses the results and evaluates the proposed framework. This article is summarized and concluded in the seventh section.

III. Software-defined Network

A. SDN Architecture

The architecture of software-defined networks is based on separating the control part from the data transmission part of the infrastructure's hardware platform. Figure 1 presents a high level view of the SDN architecture.

In software-defined networks, the switches do not perform any process on the entry packets but refer to the flow table to find a match for the entry packets. If they do not find any match in the table records for the packet field; the packet will be considered as a new packet and sent to the controller for processing. In fact, the controller is an operating system in software-defined networks that process incoming packets and decides on packets based on the defined rules [23].

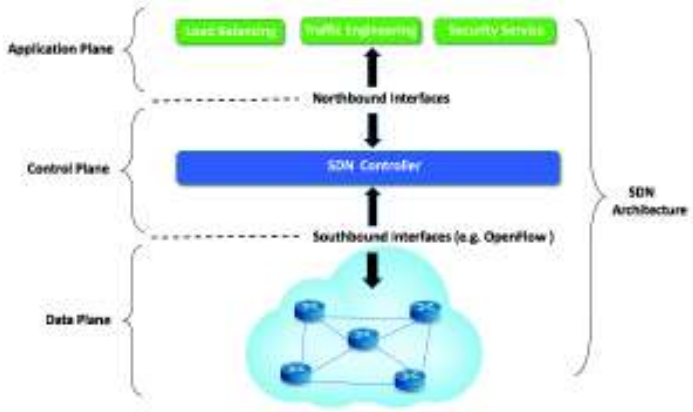

Fig. 1: SDN Architecture.

So the first step towards software-defined networks is defining a messaging protocol responsible for directing information between the central controller and the hardware devices. The development of software-based networks and the relevant standards is the responsibility of the Open Networks Foundation, which is a non-profit organization. One of the most popular standards developed by this foundation is the Open Flow protocol; This protocol defines how data should be communicated between the control plane and the data plane of the network hardware in software-defined networks [24]. Figure 2. shows a sample flow sent to the SDN controller via Openflow channel.

B. OpenFlow

OpenFlow is the first standard defined in software-defined networks as an interface between the control layer and data transmission. The first version of the OpenFlow protocol was initially released and published in December 2009. In general, software-defined networks allow network engineers to

Fig. 2: Sample flow sent to the controller via Openflow.

use high-level programming languages to generate low-level instructions.

The information and instructions are transferred between controller and routers, switches using OpenFlow protocols. In software-defined networks, the central controller retains all network rules and sends out the commands when needed through the OpenFlow protocol [25]. This protocol first specifies the central controller and how this controller can securely connect and control the network devices; Figure 3. shows an overall functioning of this protocol.

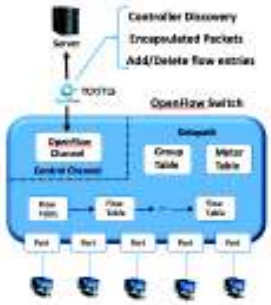

Fig. 3: OpenFlow Architecture.

Today, there is a strong interest in OpenFlow among large-scale data centers. Large companies design switches based on this protocol, and many of them announced their support for this protocol. Google has used this protocol in its data centers [26-27].Therefore, in this research, for the southbound interface, we consider OpenFlow protocol for the SDN networks.

IV. Big Data Tools

A. Apache Spark

Spark [28] is one of the quickest growing and most widely accepted Big Data tools today. It represents a great opportunity for organizations to gain the benefits of large-scale data analytics. Apache Spark has lately emerged to participate in the area of the large-scale data analysis.

This fast processing engine was produced in 2009 at Berkeley University. And then, as its name suggests, it has been developed within the framework of the Apache project , which guarantees its Open Source license. Apache Spark is a distributed processing engine which is responsible for orchestrating, distributing and monitoring applications that consist of multiple data processing tasks by several worker machines, which form a cluster. [29]

Spark is a rather fresh set of tools in the Hadoop ecosystem designed to simplify data analysis. Spark is designed to consider the presence of a large-scale volume of gigantic data (Big Data), distributed storage and data processing using commodity hardware.

Spark is flexible, and it offers a series of APIs which allow users with different backgrounds to use it. It includes Python, Java, Scala, SQL and R APIs, with built-in functions and in general a realistically good performance using all of them. It also includes different libraries to handle structured data (Spark SQL) , streaming capabilities data (Spark Streaming), machine learning (MLib) and computation on graphs (GraphX) [29]. Figure 4. shows the architecture of the Spark.

B. Apache Spark Streaming

Apache Spark Streaming [30] is one of the Spark ecosystem components used for this project. It is an extension of the Spark core designed for processing data streams in real-time. This data stream can come from different sources like Apache Kafka, Apache Flume, RabbitMQ, Twitter, or Facebook and receive data collected from sensors or devices connected via TCP sockets. The Spark Streaming data processing component is one of the components of Spark that provides data stream processing, which can achieve scalability, high performance, and fault tolerance.

By using the Spark streaming for streaming data processing, data can be obtained from many sources, such as Kafka, Flume, Kinesis or TCP sockets, and then complex algorithms developed by advanced functions (such as Hadoop MapReduced) can be used. The processed data can be sent to the file system, the database and the dashboard in real time. Also the Spark-provided machine learning (Using Spark MLib Library) and graphics processing algorithms (Using Spark Graph Library) can be applied on the data streams.

Fig. 4: Operation of the Apache Spark and Spark Streaming.

C. Apache Kafka

Apache Kafka [31] is a fault-tolerant, horizontally scalable, distributed data transmission system. It allows users to transfer data in real time using the publish / subscribe messaging technique. Kafka was created by LinkedIn and currently is an open source project supported by Confluent, a company that is managed by Apache. Its principal features are as follows:

Kafka provides a Publish-subscribe based messaging system for the data streams, performing similar to other message queuing technologies but with excessive performance and gaining very low latencies in the transmission of the messages. For scaling up the processing, it offers to the users the capability of distributing the data processing into various consumer instances. In addition, it allows to store streams and replicate them to provide the fault tolerance. Kafka allows producers to wait for recognition so that a deed is not considered complete until it is fully replicated and guaranteed to persist. Figure 5. presents the architecture of the Apache Kafka.

The Apache community recommends to use of Kafka generally in two types of applications: In systems/applications that require a reliable transmission of streams between them and in real-time processing systems that transform or react to streams.

Fig. 5: Apache Kafka Architecture.

D. Elasticsearch

Elasticsearch [32] is a full-featured open-source search engine developed in Java. It takes unstructured data from various sources and stores it in a complex format that is highly optimized for text search. By using Elasticsearch, large volumes of data can be stored and analyzed quickly and efficiently. Elasticsearch uses Lucene Apache at its core for indexing and searching.

There are many benefits for using Elasticsearch; These benefits include the following:

Scalability: This means that as the volume of data increases, the performance remains reasonable, and the results are reliable. This is a significant feature that helps simplify complex architectures and save time during project execution. Speed: Elasticsearch uses invert indexing.Invert indexing is a word-based method used to search for documents containing a particular word quickly. As a result, it is very fast, even when searching in huge datasets.

V. Proposed Methodology

This section describes the proposed Framework as well as the techniques, experimental setup and datasets used.

A. Implementation

Figure 6. shows the processing of the BFDD-S Framework. The framework consists of two main modules, one for gathering and formatting statistical information developed as an API to the ONOS core using Java programming language and another for detecting attacks. The attack detection module is located in a server and uses data pipeline infrastructure and machine learning for detecting DDoS attacks. The prevention action will be done by the controller (We used ONOS as a controller for this experience).

In this framework, the following tools are used to create a data pipeline infrastructure: Kafka for message queuing, Apache Spark for data processing, and Elasticserach for storing data.

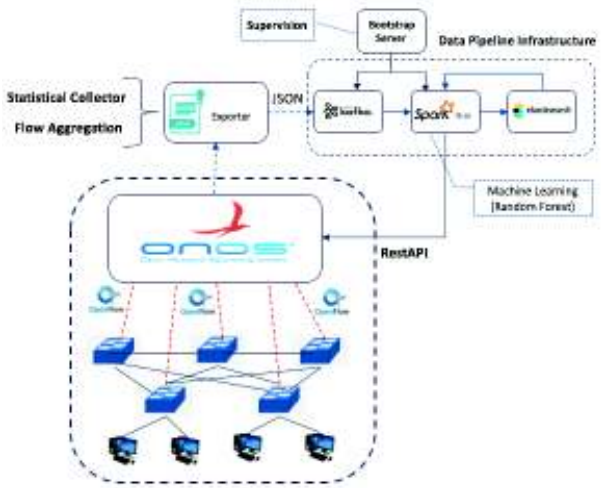

Fig. 6: The BFDD-S Framework Architecture.

In this particular case, we are going to use Kafka as the system data source for Spark Streaming. Typically a Spark Streaming system processes a data flow, stores them in databases, file systems, or reflects them in a graph to give a better view to the user.

The operation of data processing in Spark Streaming works as follows. Spark Streaming receives the data and splits it into small batches, and these batches are processed by the Spark kernel to generate a data stream of results. Figure 7. presents the output of proposed framework.

In the proposed method, every incoming packet should go through 5 different phases from the moment it reaches to the switch and then transferred to the controller and validates. Figure 8. demonstrates these phases in more details. These phases are:

Preliminary Phase, request for communication

The Preliminary phase is a request for communication. It is the phase when the packet for the first time enters to the OpenFlow switch. Upon arrival, the switch checks its current flow tables. If the switch finds a forwarding rule defined for this packet in the flow tables, the flow is allowed to pass to the destination. Otherwise, it will be considered as a new flow, which is sent to the controller to make the decision.

Fig. 7: Output of the BFDD-S Framework.

Phase 2: Information Gathering and Formatting

After entering the controller, initial checks such as destination address, protocol type, etc., are performed. If the packet is detected within the current network rules, the controller allows several packets of the corresponding flow to pass to the server. As a matter of fact, the attack detection systems are usually not able to detect abnormal activities from only one packet. For this reason, the controller requests the entry of several packets of the same flows into the attack detection system. For this phase, we developed a Java API into the ONOS core, called Extractor, for gathering statistical information, flow aggregation, and converting the aggregated data to the suitable format (JSON, for instance) for sending to the data pipeline infrastructure.

Phase 3: Packet analysis and decision Making

After the second phase, it is time for the analysis and decision phase. In this phase, packets are evaluated by a detection module located in the attack server.

The formatted aggregated flows from the Extractor module in JSON format will be passed to Apache Kafka for buffering. Then the Spark as a consumer reads information from Kafka message queuing. In this module, Apache Spark is responsible for data processing and anomaly detection. This phase consists of three steps: the feature engineering process, Machine Learning process, and decision-making step.

We use Spark Streaming as one of the components from Apache Spark Ecosystem to enable processing of live streams of data and to read the buffered information from Kafka. After performing Feature Engineering, the features will be stored in the index using Elasticsearch for rapid retrieval.

For the Machine Learning process, the MLib library is used, which is also one of the Apache Spark Ecosystem components. It is built on top of Spark core and has the facility to provide various machine learning algorithms.

For this experience, we implemented the Random Forest algorithm to detect anomaly patterns in stored data. Then it is used for detecting any anomaly in the new messages received from Kafka.

Phase 4: Reporting phase

After analyzing the packet by the attack detection module,

if no anomaly is detected, a non-attack message will be sent to the controller. The controller then commands the switch by installing the proper rule in the switch's flow table to allow the corresponding flow to pass through the switch. And the controller enters to the decision and action phase.

All these communications in both cases between the detection module and controller will be done via a REST interface . If an anomaly is detected by the detection module, the attack detection module sends an incident report via the REST API, providing the necessary information for decision making by the controller, such as the source IP address of the sender.

Final Phase: The action phase

After receiving the incident report by the controller, and, by updating the log file and analyzing the source and destination of the flow, the controller commands the switch to block the IP address of the attacker.

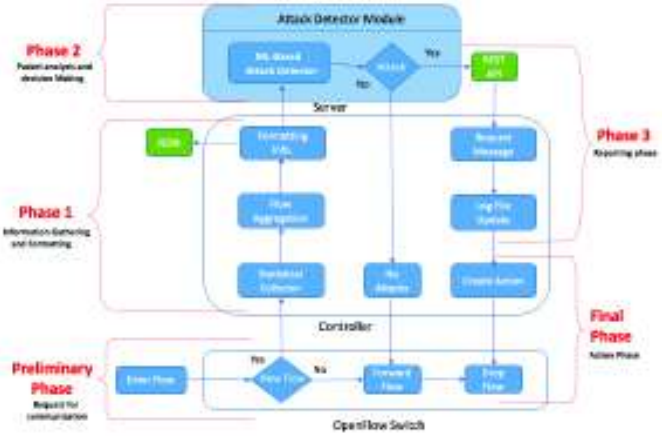

Fig. 8: Five Phase of the BFDD-S Framework's packet processing.

B. Dataset description

In this section, we briefly present two common datasets for network intrusion detection, including NSL-KDD dataset and UNSW-NB15 dataset, which we use in this research for evaluating different classified Machine learning algorithms.

1) NSL-KDD DATASET: NSL-KDD dataset is an authoritative benchmark for evaluating network intrusion detection techniques. It is derived from the KDDCUP99 dataset, which has a significant disadvantage of a large quantity of unusable duplicate records existed in it. This may produce a wrong result and prediction specifically for machine learning algorithms as a detection algorithm. Therefore, NSLKDD eliminates repeated records from the KDDCUP99.

Specifically, NSLKDD includes two training sets ('KDDTrain' and 'KDDTrain_20percent') and two test sets ('KDDTest+' and 'KDDTest-21'), among expresses 41 features defining the basic content and statistical information of the network [33].

2) UNSW-NB15 Dataset: The UNSW-NB15 dataset was generated in 2015 at the Cyber Range Lab of the Australian Centre for Cyber Security (ACCS) using the AXIA Perfect Storm tool to provide a combination of the realistic modern normal and abnormal network traffic.

The UNSW-NB15 dataset was decomposed into two partitions, one is the training data set and the other is the testing data sets, including 175,341 and 82,332 records respectively. The two partitions are available online [34] for research purposes including 49 features and nine different type of attacks such as Fuzzers, Analysis, Backdoors, DoS, Exploits, Generic, Reconnaissance, Shellcode, and Worms [35].

C. Experimental Setup

In order to evaluate the performance of the BDDF-S framework, we implement a testbed which is depicted in figure 9. We design a simple leaf-spine network architecture by using four Dell Power Edge R430 servers and four bare metal EdgeCore AS 4610 switches which support OpenFlow protocol and one HP2530-8G as a management switch.

The emulated SDN network runs within one Linux machine server and is controlled by a remote ONOS SDN controller which is installed and running on another physical server and implement the Big Data pipeline in another physical machine. To emulate the SDN based network, we use Mininet[36] to define the topology on one server, consisting of one Web servers and 15 hosts (h1-h15) which are all connected to a SDN switch.

For the experimentation, we launch DDoS flooding attack to evaluate the performance of the BFDD-S framework. To generate DDos flooding attack we use hping3 to generate ICMP ping flood, the sample command which we use as follow:

sudo hping3 -V -c 100000 -d 9000 -S -w 64 –flood [IP-address]

Alos, the Python scapy library is used to perform UDP port scan. For analysing and measuring the rate of packets passing through the controller we used wireshark. Moreover, for resource consumption measurements we used psutil and htop.

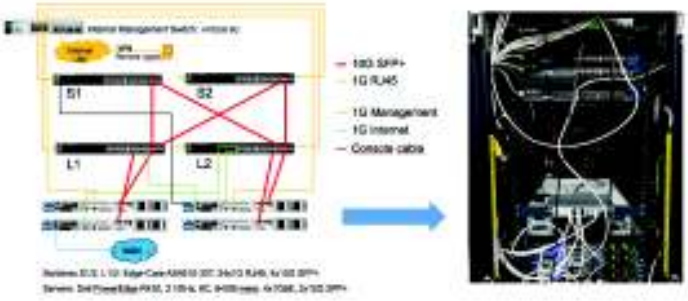

Fig. 9: Experimental Testbed Architecture.

VI. Results and Discussion

A. Comparison of the Classification Algorithms

In this research, for DDoS detection phase, we evaluated the performance of different classification algorithms in order

to find the suitable classifier model to implement using Spark-Mlib Library. The mission of the detection phase is to classify whether the incoming network traffic is normal or consider it as an attack, based on the features of the incoming traffic.

To evaluate the efficiency of the different Spark Machine learning-based algorithms, we compared various classic Machine Learning algorithms, such as Logistic Regression, Naïve Bayes, Support Vector Machine (SVM), and Decision Tree and Random Forest using two datasets i.e., NSL-KDD and UNSW-NB15 as public datasets for Network Intrusion Detection Systems.

Based on the evaluation results, we concluded that Random Forest classifier offered the best performance in terms of accuracy. The results for the NSL-KDD dataset are indicated in Figure 10. The figure depicts that the Random Forest algorithm with accuracy of 99.94% performs better compared to the other algorithms. The results for the UNSW-NB15 dataset are shown in Figure 11. Clearly, Random Forest has better performance compared to the other classification algorithms, followed by Decision Tree, SVM, Linear Regression, and Naïve Bayes.

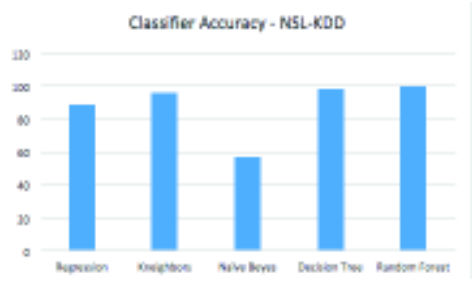

Fig. 10: Comparison of ML Algorithms using NSL-KDD dataset.

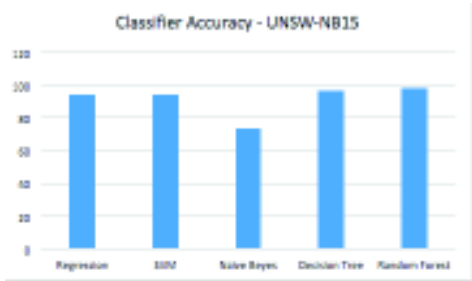

Fig. 11: Comparison of ML Algorithms using UNSW-NB15 dataset.

B. Performance Evaluation of the BFDD-S Framework

In order to evaluate the performance of the framework, we choose the following metrics: CPU and memory consumption of the ONOS controller, average response to the legitimate traffic during the attack, and average time to detect and mitigate a DDoS attack. We use psutil python libarary and htop tool to measure the above mentioned metrics.

The figures 12, 13 and 14 depict the performance metrics under the DDoS attack. The evaluation results clearly show that increasing the number of packet has not so much affect on the performance of the ONOS Controller.

Analysing the CPU and memory consumption, figures 12 and 13 indicate that in the moment that the number of attacking packets are increased under launching flooding attack, in both cases the consumption fluctuation does not increases drastically and it shows that the DDoS attack could not saturate drastically the controller's CPU and memory capacity of the ONOS controller. The controller at the highest number of attacking packets, reaches to less than 20% of average CPU consumption and in addition the average Memeory consumption reaches to less than 35%.

On the other hand, the figure 14 illustrates the average response time by the controller to the legitimate traffic during the attack. It shows by using the BFDD-S framework, there is not so much response delay to the legitimate traffic and the average latency value is not significant and the flooding attack does not considerably affect on the processing of the normal traffic.

Fig. 12: Average Controller CPU Consumption.

Fig. 13: Average Controller Memory Consumption.

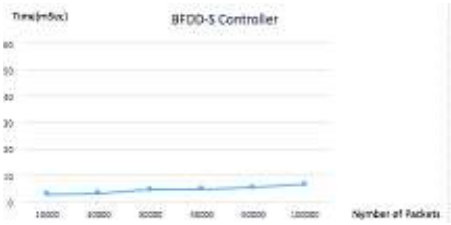

Fig. 14: Average Controller Response time to Legitimate Traffic.

VII. Conclusion and Future work

In this paper, we present an intrusion detection system using distributed processing technologies based on the combination of Machine learning algorithm and Big Data pipeline infrastructure in SDN based networks for proactively preventing the performance degradation of the SDN controller. For implementing machine learning algorithm using Spark, we assessed the performance of different classification algorithms in order to find the classifier model with the superlative classification accuracy.

For evaluating the performance of different detection algorithms using Apache Spark the two common intrusion detection dataset, NSL-KDD and UNSW-NB15 was employed to evaluate the performance of different detection algorithms using Apache Spark. We determined that Random Forest classifier provided the best performance in terms of accuracy, followed by the Decision Tree and Naïve Bayes offered the poorest detection accuracy.

For the proposed system, we use Apache Kafka for message queuing, Apache Spark for real-time data streaming and machine learning processing, and Elasticsearch for storing data. By creating data pipeline with these tools with the following features such as high scalability, and ability to process fast streams of events of Kafka together with Real-Time Stream Processing, scalability of Apache Spark and horizontally scalability and speed of Elasticsearch, the evaluation results of the BFDD-S framework shows that under the attack the SDN controller will not be exhausted and can handle the legitimate traffic with a reasonable delay time.

The aim of this work is to provide a robust and resilient intrusion detection system which can offer a fast, real-time detection system in order to increase scalability and reliability of the DDoS attack detection and mitigation.

Finally, for our future work, since using the console as an output is not adequate in the production environments, we intend to adding a graphical dashboard for the stream processing monitoring to provide an enhanced view of system processing.

Also, we plan to implement other Machine learning algorithms such as deep learning(DL) based on Apache Spark into the proposed system and provide a performance evaluation with the existing system.

Furthermore, the proposed system has been developed on a single computer, not in cluster mode. Spark and Kafka applications are designed to work in cluster mode. Therefore we assume that by working in cluster mode in parallel with several machines, the final result would be more accurate.

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Plant Leaf Recognition Using Deep Learning

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Abstract: Our environment comprises of a wide variety of plants that are similar to each other and sometimes the similarity between the plants makes the identification process tedious thus increasing the workload of the botanist all over the world. Now all the botanists cannot be accessible all the time for such laborious plant identification; therefore, there is a need for a quick classification model. Also, along with the identification of the plants, it is also necessary to classify the plant as healthy or not, since for a healthy lifestyle, humans require good food and this food comes from healthy plants. A large number of techniques have been applied to classify the plants as healthy or diseased in order to provide the solution. This paper proposes one such method known as anomaly detection using autoencoders using a set of collections of leaves. In this method, an autoencoder model is built using Keras and then the reconstruction of the original images of the leaves is done and the threshold loss is found in order to classify the plant leaves as healthy or diseased. A dataset of plant leaves is considered to judge the reconstructed performance by convolutional autoencoders and the average accuracy obtained is 71.55% for the purpose.

Keywords: Convolutional Autoencoder, Anomaly Detection, Web Application

1. INTRODUCTION

One factor which is crucial for the human existence is agriculture, and it has remained a key driver of many economies worldwide especially in developing and underdeveloped economies. As the population of the world is increasing, the demand for food is also increasing and thus there is an urgent need to increase the production of plants along with reducing the costs. With the increase in the production of plants, plant diseases are also increasing rapidly due to various climatic and other conditions, the number of healthy plants produced are becoming less and are thus affecting the global crop production. This leads to the fact that the agricultural manufacturing is required to be more optimized and a variety of techniques have been proposed to deal with the growing problem. Behind every positive approach there are some negative outcomes too, to protect the plants from diseases, extensive use of strong chemicals such as insecticides and fungicides have been used but these chemicals on the other hand are adversely attacking the agricultural ecosystem. There are various factors which lead to the occurrence of diseases in plants and early diagnosis of these diseases can save the agricultural produce and control the threat in future. Despite the growth in technology, farmers mainly rely on traditional methods of observing and measuring to detect of illnesses in plants. However, this process of manual detection can lead to incorrect recognition of whether the plant is diseased or nor. Thus, this situation has lead many scientists to believe that apart from manual recognition, a proper system needs to be proposed for the detection of diseased plants autonomously.

The few technologies that have emerged in the recent years have helped to overcome such problems, and one such technology that has been widely used in recent years in various fields is image recognition [1]. In this technique, the computer can detect and identify the plant, as we know for a fact that leaves are the crucial part of the plant and can strongly express whether the plant is diseased or healthy. Computer vision is a technique which is used to detect the diseased leaves, a task that was earlier done by the human eye.

To work on large datasets using image recognition, efficient techniques are required and with the rapid development of deep learning techniques, the task has become quite easy and is also able to meet the requirements of large datasets for the purpose of classification. The deep learning technique is used for classification in large number of occasions with strong

generalization. One deep learning technique which is quite often used on image datasets for the purpose of classification is convolutional neural networks (CNN) [2]. In agriculture, initially, some related works have been introduced using CNN to classify the leaves of plants and identify whether it is healthy or diseased. In this paper, we have proposed the use of CNNs to make the autoencoder [3] model for the anomaly detection and classify the plant leaf as healthy or diseased by finding out the threshold loss on the reconstructed images of the leaves. Below is the process of anomaly detection using convolutional autoencoders [4].

1.1 Anomaly Detection Using Autoencoders

An unsupervised deep learning algorithm [5] is used for the reconstruction of high dimensional input data with the help of neural network which consists of the latent presentation of the input data. The autoencoders are designed in such a way that these neural networks are used to showcase high dimensional data into lower dimensional data that could be easier to separate. Autoencoders consists of two phases namely, encoder and decoder.

The main work of the encoder is to read the input into a condensed form, while on the other hand the decoder reconstructs the input data as much as possible. An autoencoder design requires only three layers: the input layer, intermediate layer and the output layer. The first layer that is the input layer works in such a way that it extracts the original features from the image and then connects smaller numbers of neurons with the intermediate layer which then reduces the dimensionality. The intermediate layer and the output layer are connected to each other with the same dimensions as that of the input layer. During the process of training, the data used for the output is the same as that used for the input. The main aim behind this is to reduce the value of loss between the original input data and the reconstructed data.

To use autoencoders for the purpose of anomaly detection, the reconstruction error of the autoencoders to detect the outliers is calculated. As we know that normal behaviors can be detected in the autoencoders, therefore for the normal packets, the reconstruction loss should be minimized. Thus, according to the working principle of the autoencoders, the reconstruction error should be greater for the input data that is anomalous. To determine whether the error is large enough to be considered as an anomaly, an adequate threshold is required which sometimes also depends upon the distribution in different datasets. In this paper, the reconstruction error came out to be 0.225 and according to that, if the threshold loss is greater than 0.225 then the plant leaf will be anomalous and otherwise not-anomalous.

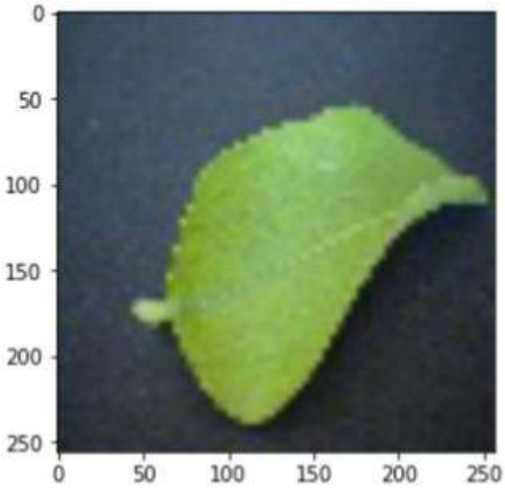

Fig. 1. Original image of Jamun leaf

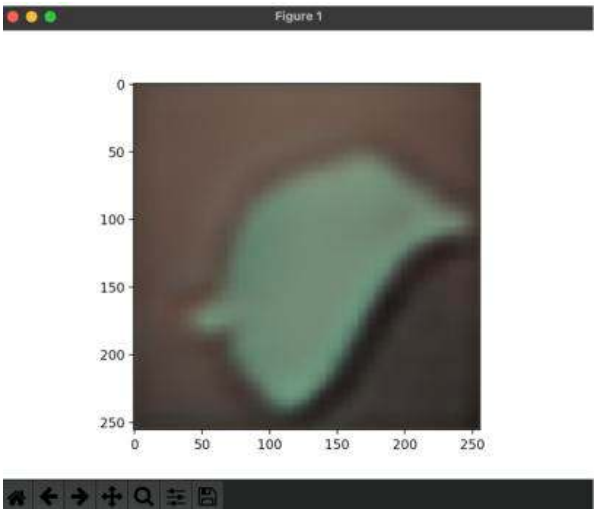

Fig. 2. Reconstructed image of Jamun leaf

2. IMPLEMENTATION

The model presented below is of the plant leaf classification which is mainly divided into three main stages. Firstly, the dataset which is chosen is preprocessed using OpenCV and the images are resized to a lower resolution. After the pre-processing stage, the convolutional autoencoder [6], [7] is trained for the reconstruction of the images with minimum error. The encoder present in the network is used for the purpose of feature extraction. Then, the process of anomaly detection is carried out on the trained data which tell about

the threshold loss in order to distinguish between the diseased and the healthy leaves. Before feeding the data into the classifier, the dataset is divided into two subsets. CNN is employed as the classifier with different kernel functions.

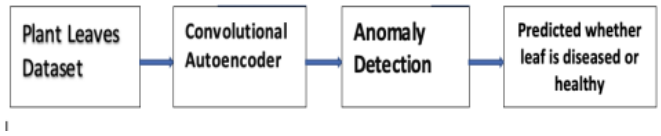

Fig. 3. Flowchart for the plant disease identification

2.1 Plant Leaf Dataset

As we know, plants are one of the most substantial part of the ecosystem and help in regulating climate change and carbon emission. Therefore, a contribution has been made towards the study of plant leaves for their detection, identification and disease diagnosis etc. Eleven environmentally and economically valuable plants named Arjun, Mango, Jamun, Astonia Scholaris, Guava, Bael, Jatropha, Pongamia Pinnata, Basil, Pomegranate, Lemon, and Chinar have been chosen for this purpose. Leaf images of these samples have been taken in healthy and diseased conditions and separated into two different modules.

Mainly, the dataset has been divided into two classes: healthy and diseased. First, the collected images are classified and labeled conferring to the plants. The range in which the plants are named is from P0 to P11. Then, the whole dataset has been bifurcated into 22 categories ranging from 0000 to 0022. The classes which are labeled between 0000 to 0011 are marked as healthy class and on the other hand the classes ranging from 0012 to 0022 are marked as the diseased class. In total, 4502 images have been clicked which constitute 2277 images of healthy plant leaves and 2225 images of diseased plant leaves. The size of the images is adjusted to 256x256. Some images from the dataset are shown in Fig. 4.

Fig. 4. Some images of the plant dataset

2.2 Convolutional Autoencoders

The main purpose of autoencoders is the reconstruction of the data which is inputted as autoencoders is a type of neural network which uses input as the ground truth. The data inputted is firstly condensed into a latent space and then the original data is reconstructed. Using the unsupervised machine learning technique, the neural network could be trained so as to extract some valuable information regarding the original data. Data denoising, dimensionality reduction and expression learning are the three most common applications of autoencoders.

The basic structure of autoencoders contains two parts: Encoder and decoder. Encoder is used to condense the input data into latent space which consists of features with low dimensionality while on the other hand, decoder uses these features for the reconstruction of the original data. A simple representation of autoencoder is shown in Fig. 5, which consists of X as the input data and f, g are the functions of the encoder and decoder, respectively.

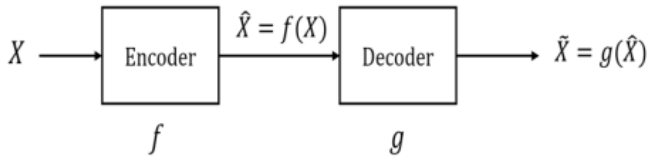

Fig. 5. Structure of autoencoder

The function f converts the input data X into a new latent space called $\hat{\mathbf{X}}$. On the basis of this $\hat{\mathbf{X}}$, the g function coverts to $\tilde{x}$ in the decoder block. To minimize the distance between the output of both functions, the network is trained in a way that it optimizes both f and g functions. Due to this particular operation, the encoder is capable of extracting more salient features from the input data.

The most efficient method in deep learning [8] to work with image dataset is the convolutional neural network. In image classification and computer vision, this network is referred to as the state of art method with high performance. By making various layers in the network, it can extract very important information regarding the dataset such as shape, color, edge etc. and other features which can be used to solve some very complicated problems in classification. Besides this, convolutional autoencoders are basically used to perform feature extraction and reconstruction of the output obtained while training the model. The CNN [10] model is supported by various layers such as pooling, flattening and dropout etc. In general, convolutional autoencoders are trained to give optimal filters with the minimized reconstruction loss.

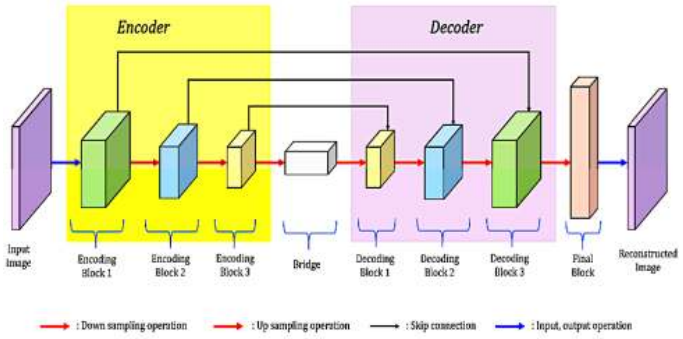

Fig. 6. The proposed autoencoder model

In this paper, we have used the idea of convolutional autoencoder model [11]. The basic architecture of this technique mainly includes the convolutional, ReLU, max polling layer followed by the usage of an appropriate optimizer. In this project, the encoder depth consists of three layers and the decoder part also consists of three layers. The three layers used for both the encoder and decoder parts has the activation function as LeakyReLU and we have also kept the padding as same so as to keep the size of input and the output image exactly the same. Instead of using the max pooling layer, we have used Upsampling and also kept the dropout rate as 0.2. To compile the model, the optimizer that has been used is the Adam optimizer and the loss is calculated using mean square error function. At the end of the function, 20 epochs are adjusted so as to calculate the accuracy of the model.

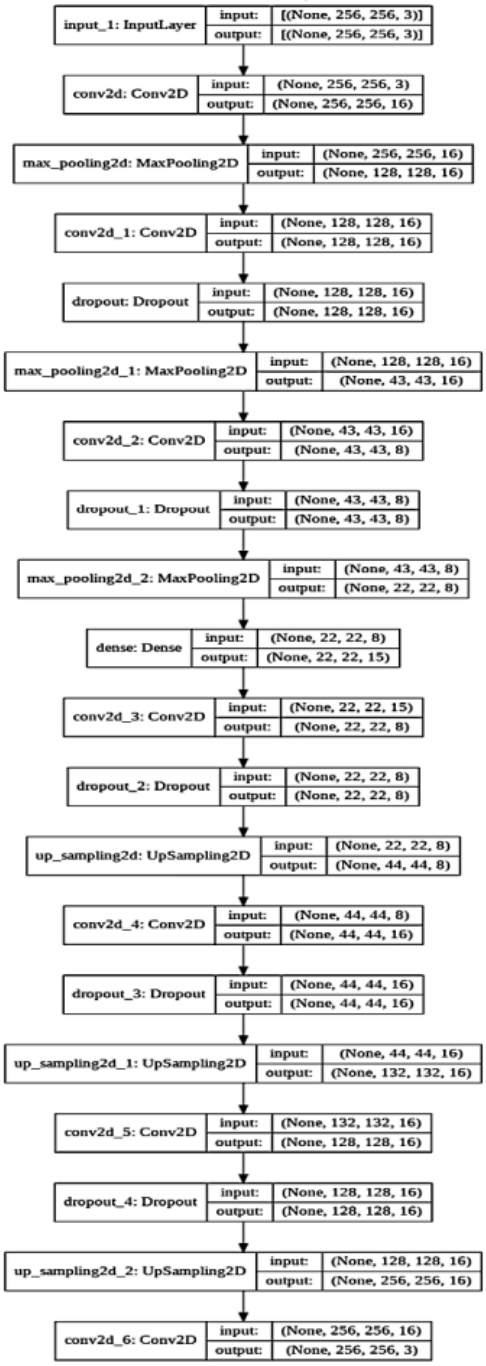

Fig. 7. The model summary of the autoencoder model

The convolutional layer [12] works in such a way that it slides filters to convolve the given input to a feature map formed by the neurons; in this way, it extracts some information from the applied kernels. The model constructed is expected to reconstruct the image, the adequate information about the pixels is important for detailed features. In the process of convolution, the number of pixels is decreased by the increment in the layers and the size of the features are increased during the process of encoding. In the decoding process, a reverse operation is performed in order to reconstruct the original size of the input image provided by the convolutional layer. The activation function called the ReLU is applied in order to improve the training speed of the model. The ReLU layer is also referred to as the computing gradient for increasing efficiency and loss function for the training process. Also, the ReLU function does not affect the previous layer.

2.3 Web Application

To make our Neural Network model readily available to the public and make it easy for people to use it without getting indulged in heavy mathematics, we developed a web application and deployed it on Heroku. The web application [13], [14] was developed using Flask python web framework and HTML to create static webpages. In the working directory, two directories were created named: templates, upload and static. The template's directory is used to store all HTML files, while static was used to store CSS files and upload was used to store images uploaded by user. Using HTML webpage was created with a HTML form; form is used to take user input and send the data to the Heroku server for preprocessing and displaying results. Once the image is sent to server image is resized so that it can be served as input to the model. The classification model outputs one-hot encoding vector, a dictionary was declared to map the one hot encoded vector to names of leaves. From the output of Convolutional Autoencoder network, error is calculated and compared to threshold defined in the training and flag the image as healthy or diseased.

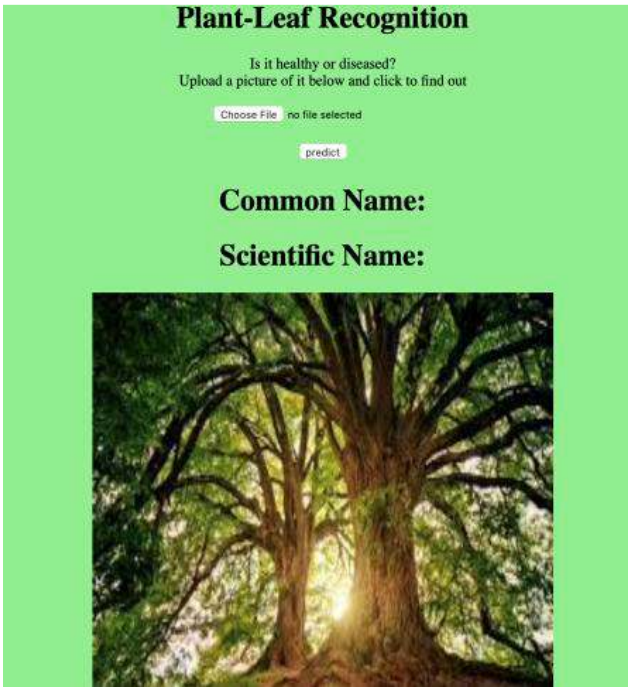

Fig. 8. The web-application

Fig. 9. Image of a healthy Pongamia Pinnata leaf

Fig. 10. Image of a diseased Mango leaf

3.RESULTS

After successfully training the Convolutional Autoencoder, an accuracy of 71.5% was achieved on training data and 79.5% and 89.9% was achieved on the validation and testing dataset, respectively. Threshold of 0.255 was determined by calculating the mean square error between the original images and reconstructed images.

4.CONCLUSION AND FUTURE SCOPE

The proposed Convolution Autoencoders model to classify leaves infected with diseases was successfully trained. An interactive web application was made using this model as the backend in which any user would select the image of a leaf and send it a server where the model was stored and model would return the output as diseased or healthy. The web application was developed so that people could easily use the model.

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Detection of rail surface irregularities using Edge Detection and Image Thresholding: a case study

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Abstract

The purpose of this paper is to conduct a feasibility study to examine rail surface irregularities using edge detection and image thresholding algorithms.

Seven algorithms for measuring the damage are tested. Three Canny Edge versions: (1) OpenCV Canny Edge (2) Canny Edge based on the pixel median (3) Canny Edge based on Otsu's method. Also four Thresholding functions implemented in OpenCV: (4) Simple Thresholding (5) Adaptive Mean Thresholding (6) Adaptive Gaussian Thresholding (7) Otsu's Thresholding.

They are tested on a 28 second video (1280x720 pixels). Their accuracy, precision, recall, and F1 score are compared. The video was recorded on a train moving at 70 km/h. As a sample, 50 above, and 50 below average damaged frames are selected by hand.

Canny Edge detection and the adaptive Thresholding functions reached 72% - 76% accuracy. Best overall performance was reached by AutoCanny (2), with accuracy 76%.

By these means, rail failure forecasting related to surface defects is possible and maintenance planning can be optimised.

1 Introduction

Maintenance costs in 2020 amounted to 20.6 billion, 53% of the total expenditure in the EU railway systems [1]. To keep the costs low, efficient maintenance planning is key. Specifically, [2] estimates 40% of track maintenance cost in Sweden is due to rail surface defects.

2 Related Literature

Traditionally railway track monitoring has been done by hand, which is labour and cost intensive. Through the rise of methods such as computer vision, fault detection has become increasingly automated.

Automatic monitoring consists of (a) data gathering and (b) data processing.

2.1 Data gathering

Ballast geometry defects and thickness reduction have been measured by Laser scanning techniques. [3] [4] [5] [6] [7]. Photogrammetry has also been used [8]. In the last two years, LiDAR (Light Detection And Ranging) has become popular for rail track geometry measurements [4] [9] [10] [11] [12].

Ballast pollution on the surface is usually found by imaging [13]. Substructure defects can be investigated using Ground penetrating radar (GPR) [14] [15] [16] [17].

Laser and imaging scanning are used for detecting surface defects on fish plates. For welding points, acoustic methods [18] [19] and radiography [20] [21] [22] are used.

Sub-surface damage in parts of the rail or switch can be measured by acoustic methods [23] [24] [25] [26] [27]. or Eddy Current testing [28] [29].

There are several methods to detect rail surface defects. For example by 3D laser scans [30] [31] [4].

But most notably, rail surface defects have been investigated using imaging. For one, large part of the track can be easily monitored, since cameras can be mounted onto the train. Also there have been great advancements in digital image processing in other fields.

2.2 Data processing

Machine learning (ML) analysis of images have delivered promising results. This includes traditional machine learning methods, like Support Vector Machines (SVM) and Decision Trees [32]. These are often combined with data pre-processing algorithms like Wave Transform (WT) and Principal Component Analysis (PCA).

In road damage detection, there has been a focus on Convolutional Neural Networks (CNN) [33] [34] [35]. This has inspired similar research in railway damage detection [36] [37] [38] [39].

However, Neural Networks can be computationally expensive. Also for training, they often rely on manually labelled samples. A less computationally expensive approach to analyse images has been Edge detection.

2.2.1 Edge detection in railway

Previous studies used Edge detection algorithms including Sobel, Roberts, and Laplacian of Gaussian. Especially the Canny algorithm has been popular [40]. In other fields, Canny Edge has shown to be computationally more expensive, but less sensitive to noise[41].

Edge detection has been used on rail images in two ways

1. to detect the rail in the image
2. to detect the damage on the rail

Rail detection [42] used Canny Edge and Hough Lines Transform to extract the rail. Damage was measured with a binary threshold. Similarly [43] uses Canny Edge and Hough Transform to find the rail. [44] used Canny Edge and linear fitting. Damage was classified using a CNN. [45] compared Canny Edge, Hough Transform, and the watershed algorithm for separating the rail.

There have been attempts to improve on the standard Canny Edge algorithm. [46] used a genetic algorithm to find the optimal high threshold for Canny Edge. [47] used an edge operator based on fractional order differentiation. [48] used Sobel Edge and line fitting to extract the rail. Damage was measured with a binary threshold.

[49] used Canny Edge, Hough Transform, and morphological matching. They labelled damaged areas using Roberts edge and a Laplacian low pass filter.

Measuring the damage [50] show how Edge detection and threshold can be used to find cracks in the rail. [51] detects rail surface defects by using Canny Edge with different thresholds for differently lit parts of the rail.

[52] used Otsu algorithm to find high and low thresholds for Canny Edge to find damage on the rail. [53] combined 2D Wavelet Transform and Canny Edge. [54] detected defects on a rail in the lab with a custom Sobel operator.

Edge detection has also been applied to other parts of the track [42] [55].

In summary, many variants of Edge Detection and Thresholds have been used to detect damage on rail components. But we found no statistical comparison of Edge Detection techniques in railway in IEEE Xplore from 2000 to 2021. It is unclear which method performs the best.

This paper will test seven techniques on an example video: (1) CannyEdge (2) AutoCanny (3) OtsuCanny (4) SimpleThreshold (5) GaussThreshold (6) MeanThreshold (7) OtsuThreshold. We will compare the (1) Accuracy (2) Precision (3) Recall (4) F1 score of each technique. As samples we select 50 low damage frames, and 50 high damage frames, from a 725 frame video.

3 Case Study

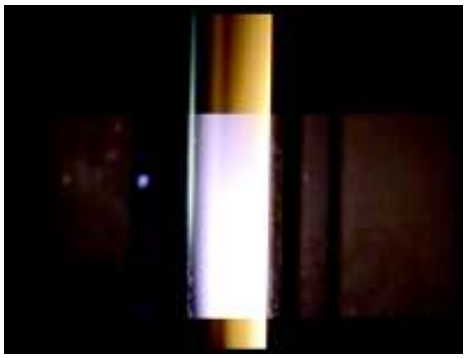
The video is 28 seconds long, containing 725 frames (1280x720 pixels). It was recorded in the Tehran Metro line 2. The camera was mounted on the train, approximately at 1 meter distance to the rails. The train was moving at around 70 km/h.

The authors had some difficulties with the size and position of the rail varying between frames. In some frames there is strong ghosting and uneven lighting.

Examples for different frames are given in figure 1. The kind of surface damage is rolling contact fatigue [56].

(a) below average damage

(b) above average damage



(c) ghosting

Figure 1: Three examples frames

4 Method

A two step process has been used. First, the rail is separated from the rest of the image using Edge Detection and Hough Line Transform. Then the amount of damage on the rail is measured using Edge Detection and Image Thresholding.

OpenCV for Python is used [57], together with NumPy and Matplotlib.

4.1 Detecting the rail

Detecting the rail consists of four steps.

0. Set approximate rail size
1. Grayscale
2. Center of Mass
3. CannyEdge
4. Hough Line Transform

0 - The approximate rail size is set. This helps to select the right Hough Lines. It is set manually once and fixed for all frames.

1 - The frame is converted to grayscale.

2 - The Center of Mass is computed. It is the average of the pixel intensities of the frame.

3 - Canny Edge is performed. For all frames threshold1=40, threshold2=80 were used.

4 - Finally, the Hough Lines are calculated. The parameters threshold=2, minLineLength=200, maxLineGap=100 were chosen. The Hough Lines selected are the most outward which are still within the approximate rail size around the center of mass. These Hough Lines are used to crop out the rail.

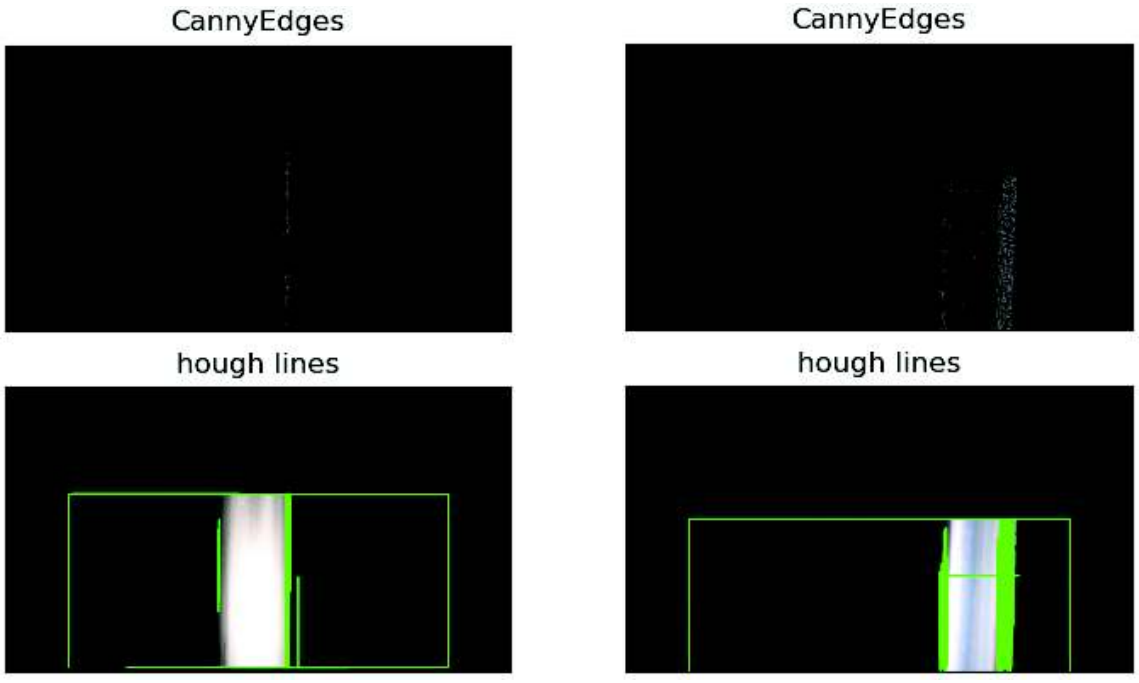
The code is in Appendix A, lines 104 to 161. In pseudocode:

(a) below average damage (b) above average damage

Figure 2: Grayscale

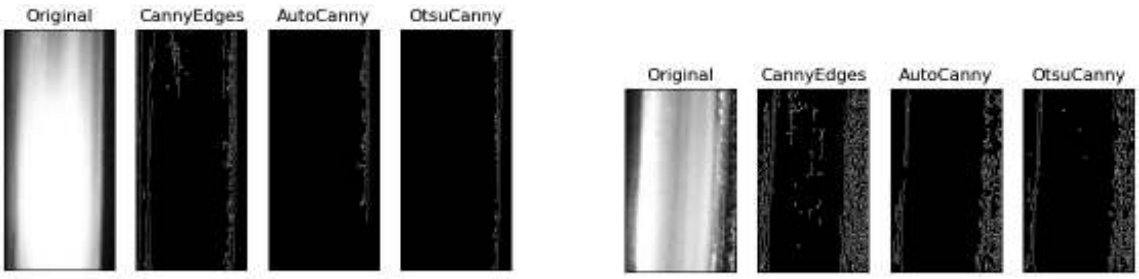
(a) below average damage (b) above average damage

Figure 3: Center of mass and approximate rail size



(a) below average damage (b) above average damage

Figure 4: CannyEdge and Hough Line Transform



(a) below average damage (b) above average damage

Figure 5: CannyEdge, AutoCanny, and OtsuCanny

```
define find_rail:
    for frame in video:
        gray = grayscale(frame)
        edges = CannyEdge(gray)
        hough_lines = ProbabilisticHoughLines(edges)
        com = center_of_mass(frame)

        # for all directions up, down, left, right
        for line in hough_lines:
            if line further away from com than previous line:
                if line not too far far away from com:
                    crop_here = line

        cropped_frame = frame(crop_here)
        return cropped_frame
```

4.2 Detecting the damage

Seven methods have been used to measure the damage, including (1) CannyEdge (2) AutoCanny (3) OtsuCanny (4) SimpleThreshold (5) MeanThreshold (6) GaussThreshold (7) OtsuThreshold

1 - CannyEdge uses the default OpenCV Canny Edge function. The thresholds are set manually to threshold1=10, threshold2=120.

2 - AutoCanny determines the thresholds automatically, as suggested in [58]. The thresholds are calculated as

$$median = median(cropped\ frame) \tag{1}$$

$$threshold1 = max(0, (1.0 - sigma) * median) \tag{2}$$

$$threshold2 = min(255, (1.0 + sigma) * median) \tag{3}$$

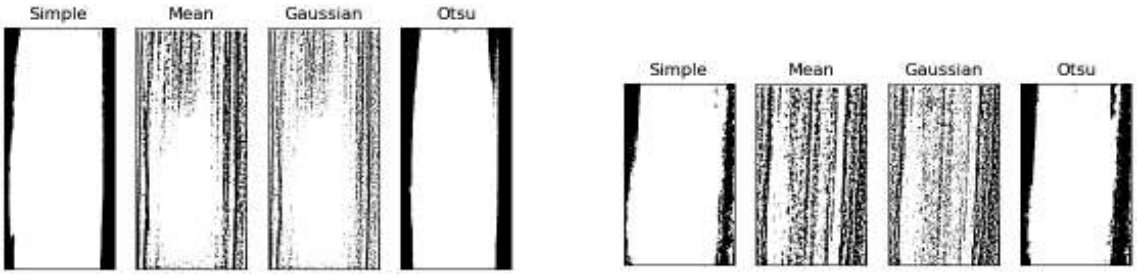
Sigma is chosen as 0.3. Note AutoCanny does not give good results when used to detect the rail. This is because the full frame is dark, leading to small thresholds and noisy edges.

3 - OtsuCanny also determines the thresholds automatically. The threshold from the Otsu algorithm is used as threshold2 for Canny Edge [59]. Threshold1 is chosen as Threshold2/2.

The thresholds 4 - 7 are already ready to use in OpenCV.

4 - SimpleThreshold uses a manually set threshold of 120.

5 - MeanThreshold adaptively changes the threshold for different parts of the frame. It's based on the mean of the pixel's intensity in the neighbourhood.



(a) below average damage (b) above average damage

Figure 6: Simple-, Mean-, Gauss-, and OtsuThreshold

6 - GaussThreshold also adaptively changes the threshold, based on gaussian-weighted sum of the neighbourhood.

7 - OtsuThreshold uses a fixed threshold for the whole image. The threshold is computed using the Otsu algorithm.

4.3 Performance

First 50 frames with above average, and 50 frames with below average damage were chosen by hand. The methods (1) - (7) first measure the damage in each frame. Next the samples are labeled as above or below average.

From that the true positive (tp), true negative (tn), false positive (fp), false negative (fn) assigned labels are counted. The accuracy, precision, recall, and F1 are calculated as follows:

$$accuracy = \frac{tp + tn}{tp + tn + fp + fn} \tag{4}$$

$$precision = \frac{tp}{tp + fp} \tag{5}$$

$$recall = \frac{tp}{tp + fn} \tag{6}$$

$$F1 = 2 * \frac{precision * recall}{precision + recall} \tag{7}$$

The code is in Appendix A. In pseudocode:

```
# frames selected by hand
high_damage = make list
low_damage = make list

for all seven methods:
    for all frames in video:
        cropped = find_rail(frame) # Section 4.1
        norm = normalize(cropped)

        # CannyEdge, AutoCanny, OtsuCanny
        if EdgeDetection:
            edges = CannyEdge(norm)
            white = count_white_pixels(egdes)
            damage = white / amount_pixels

        # SimpleThreshold, MeanThreshold, GaussThreshold, OtsuThreshold
        if ImageThresholding:
            threshold = Threshold(norm)
```

```
            black = count_black_pixels(threshold)
            damage = black / amount_pixels

    mean = calculate_mean_damage

    for frame in high_damage:
        if damage(frame) > mean:
            true_positive += 1
        else:
            false_negative += 1

    for frame in low_damage:
        if damage(frame) < mean:
            true_negative += 1
        else:
            false_positive += 1

    calculate accuracy, precision, recall, f1
```

5 Results

	Accuracy	Precision	Recall	F1 score
CannyEdge	0.72	0.729	0.7	0.714
AutoCanny	0.76	0.842	0.64	0.727
OtsuCanny	0.71	0.8	0.56	0.659
SimpleThreshold	0.62	0.63	0.58	0.604
MeanThreshold	0.76	0.76	0.76	0.76
GaussThreshold	0.73	0.745	0.7	0.722
OtsuThreshold	0.57	0.59	0.46	0.517

Table 1: Accuracy, precision, recall, and F1 score of all methods

The results are show in table 1 and figure 7. CannyEdge, AutoCanny, OtsuCanny, and MeanThreshold, and GaussThreshold perform similarly well. AutoCanny reaches the highest accuracy (76%) and precision (84%). Simple-, and OtsuThreshold perform significantly worse.

The measured damage per frame can be seen in figure 8 and **??**. GaussThreshold and MeanThreshold measure similar amounts of damage for the same frames. Also SimpleThreshold and OtsuThreshold give similar results.

Gauss and Mean show a peak at around the 180th frame. The same peak is visible in the Canny based methods. For AutoCanny, CannyEdge there is a smaller peak around frame 300. This peak around 300 is also found for the Thresholds.

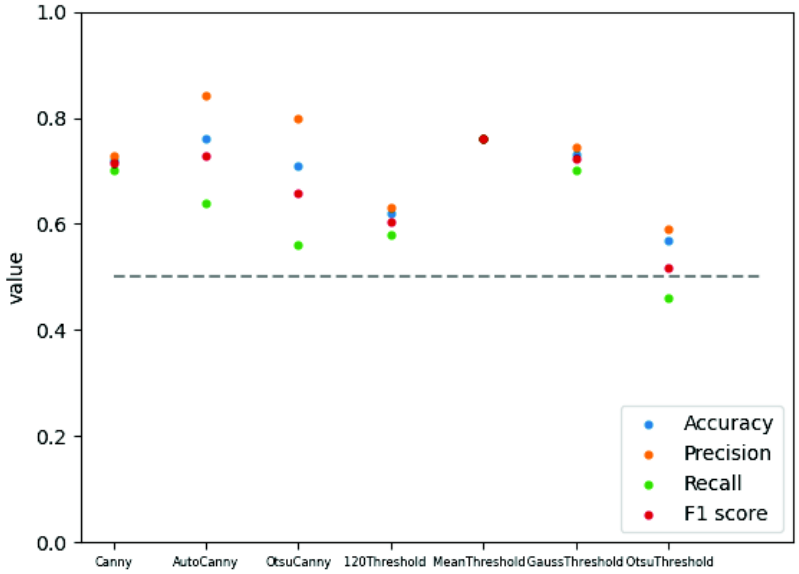


Figure 7: Accuracy, precision, recall, and F1 score of all algorithms

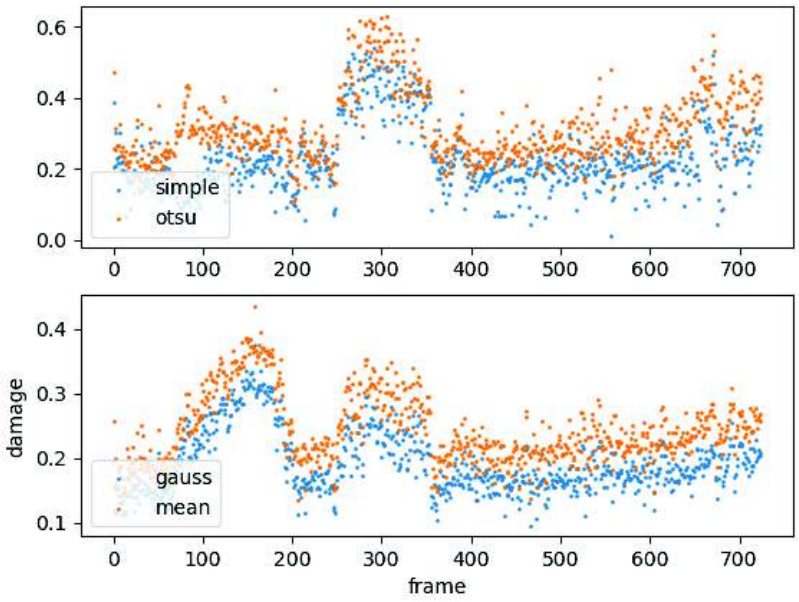
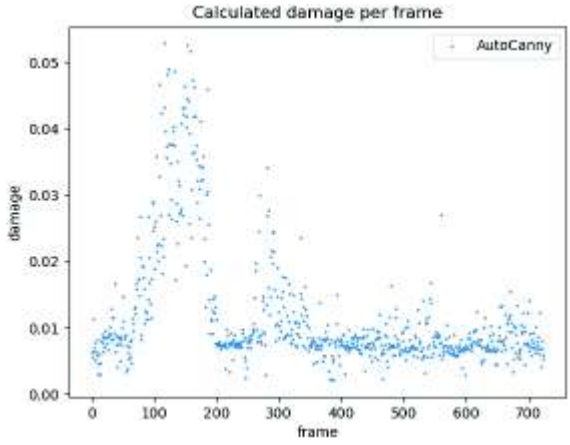
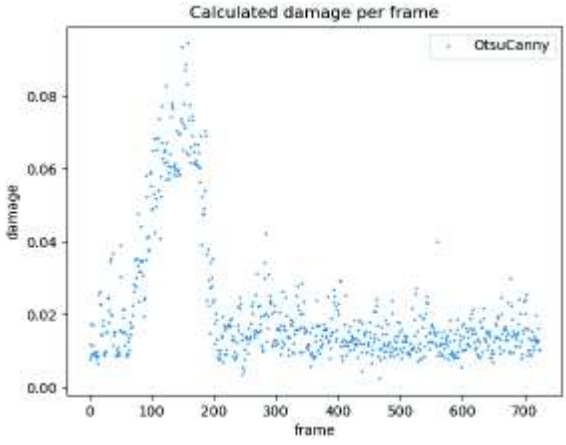


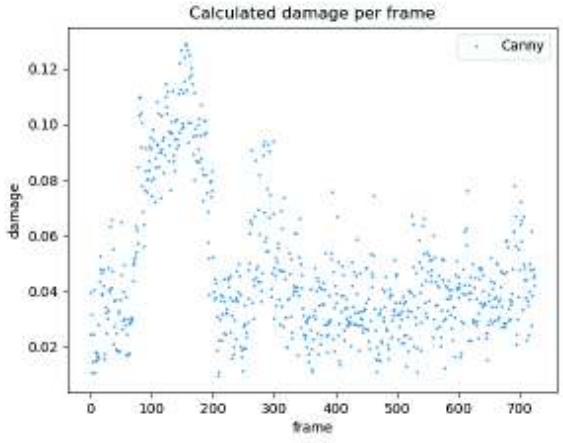
Figure 8: Damage per frame by Image Thresholds



(a) Damage per frame by AutoCanny



(b) Damage per frame by OtsuCanny



(c) Damage per frame by CannyEdge

6 Conclusion

A two step process is used to measure rolling contact fatigue on rails. Canny Edge and adaptive Threshold methods deliver similarly good results, with accuracies up to 76%. Globally fixed Thresholds performed significantly worse.

By these means, rail surface defects can be automatically detected with limited confidence. To improve maintenance planing, these algorithms could be used in combination with human workers validating the results.

However, the sample size of 100 frames is limited. It is unclear how these methods perform in different settings, like daylight. More research is also needed for other kind of defects.

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A Code

```
import matplotlib.pyplot as plt
import numpy as np
import cv2

# all seven methods
flags = ["Canny", "AutoCanny", "OtsuCanny", "simple", "mean", "gauss", "otsu"]

# crop the rail, measure the damage, and test samples for above / below average damage for the whole video
def find_damage_video(video_path, flag="Canny", hsamples=None, lsamples=None):
    cap = cv2.VideoCapture(video_path)
    if not cap.isOpened():
        print("Cannot open video")
        exit()
    # do stuff with video
    damage = []
    damage1d = []
    frame_cnt = 0
    while True:
        status, frame = cap.read()
        if not status:  # end of video
            # print("end of video,", flag)
            break
        # do stuff with frame
        # gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
        try:
            crop = find_rail(frame, plot_sliced=False, frame_num=str(frame_cnt))
            if flag == "gauss" or flag == "mean" or flag == "otsu" or flag == "simple":
                # gauss, mean, otsu, simple
                measure = find_damage_thresholds(crop, flag, frame_num=str(frame_cnt))
            else:
                # Canny, AutoCanny, OtsuCanny
                measure, vis = find_damage_edge(crop, flag, False, frame_num=str(frame_cnt))
            damage.append((frame_cnt, measure))
            damage1d.append(measure)
            frame_cnt += 1
        except:
            print("Error with cropping or measuring the damage. Is this flag right?", flag)
    cap.release()
    h_above_mean = []
    l_above_mean = []
    if hsamples is not None and lsamples is not None:
        mean_dmg = sum(damage1d) / len(damage1d)
        for sample in hsamples:
            if damage1d[sample] > mean_dmg:
                h_above_mean.append(1)
                # print(flag, sample)
            else:
                h_above_mean.append(0)
        for sample in lsamples:
            if damage1d[sample] > mean_dmg:
                l_above_mean.append(1)
                # print(flag, sample)
            else:
                l_above_mean.append(0)
    # plot damage per frame
    x, y = zip(*damage)
```

```
    # plt.figure()
    plt.scatter(x, y, s=1, marker='o', label=flag, linewidths=None)
    # plt.plot(x, y, linewidth=1)
    plt.title("Calculated damage per frame")
    plt.legend(loc="upper right")
    plt.ylabel("damage")
    plt.xlabel("frame")
    plt.show()
    return h_above_mean, l_above_mean


# Center of mass of the image
def center_of_mass(col_image, show=False, with_box=False, frame_num=""):
    gray_image = cv2.cvtColor(col_image, cv2.COLOR_BGR2GRAY)
    gray_image = cv2.normalize(gray_image, None, alpha=0, beta=255, norm_type=cv2.NORM_MINMAX)  # ,
    ↪  dtype=cv2.CV_32F
    ret, thresh = cv2.threshold(gray_image, 127, 255, 0)
    # img1 = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
    # moments
    M = cv2.moments(thresh)
    # coordinates center
    cX = int(M["m10"] / M["m00"])
    cY = int(M["m01"] / M["m00"])
    if show:
        copy = col_image.copy()
        if with_box:
            cv2.rectangle(copy, (cX - 150, cY + 300), (cX + 150, cY - 300), (0, 255, 0), 2)
        # circle
        cv2.circle(copy, (cX, cY), 5, (0, 255, 0), -1)
        cv2.putText(copy, "COM", (cX - 25, cY - 25), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 3)
        # cv2.imshow("Image", gray_image)
        # cv2.waitKey(0)
        plt.imshow(copy, cmap="gray"), plt.xticks([]), plt.yticks([])
        plt.show()
        # plt.savefig('./plots/com' + str(frame_num) + '.png', bbox_inches='tight')
    return cX, cY


# probabilistic houghlines on all sides
def find_rail(col_img, plot_sliced=False, plot_hough=False, frame_num=""):
    img = col_img.copy()
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    gray = cv2.normalize(gray, None, alpha=0, beta=255, norm_type=cv2.NORM_MINMAX)  # , dtype=cv2.CV_32F
    edges = cv2.Canny(gray, threshold1=50, threshold2=100, edges=None, apertureSize=3)  # 30, 80
    # find lines
    hough_lines = cv2.HoughLinesP(edges, rho=1, theta=np.pi / 2, threshold=2, lines=None,
    ↪  minLineLength=200,
                                  maxLineGap=100)  # 2, 200, 100
    # print("amount of lines ", np.size(hough_lines) / 4)
    if plot_hough:
        for line in hough_lines:
            x1, y1, x2, y2 = line[0]  # y is vertical. Same y -> horizontal line
            cv2.line(col_img, (x1, y1), (x2, y2), (0, 255, 0), 3)

        # plt.imshow(col_img, cmap="gray")
        plt.subplot(211), plt.imshow(edges, cmap='gray')
        plt.title('CannyEdges'), plt.xticks([]), plt.yticks([])
        plt.subplot(212), plt.imshow(col_img, cmap='gray')
        plt.title('hough lines'), plt.xticks([]), plt.yticks([])  # x is vertical
```

```
123             plt.show()
124             # plt.savefig('./plots/hough' + str(frame_num) + '.png', bbox_inches='tight')
125         cX, cY = center_of_mass(col_image=col_img, show=False, with_box=False, frame_num=frame_num)  # x is
            ↪ horizontal
126         # cv2.circle(gray, (cX, cY), 5, (0,255,0), 5)
127         # cv2.line(gray, (cX-100, cY), (cX+100, cY), color=(0,255,0), thickness=1)
128         # set default values
129         bot = 640  # bottom of frame
130         top = cY
131         right = cX
132         left = cX
133         # y is vertical. Same y -> horizontal line
134         for line in hough_lines:
135             x1, y1, x2, y2 = line[0]  # y is vertical. Same y -> horizontal line
136             if x1 == x2:  # vertical
137                 if x1 < left:  # further left
138                     if x1 > (cX - 150):  # not too far left
139                         left = x1
140                 if x1 > right:  # further right
141                     if x1 < (cX + 150):  # not too far right
142                         right = x1
143             if y1 == y2:  # horizontal # np.abs(y1 - y2) < 20
144                 if y1 > cY:  # below middle
145                     if y1 < (cY + 300):  # not too far down
146                         bot = y1
147                 if y1 < top:  # higher
148                     if y1 > (cY - 300):  # not too far up
149                         top = y1
150         # crop picture
151         sliced = gray[top:bot, left:right]
152         if plot_sliced:
153             plt.subplot(211), plt.imshow(gray, cmap='gray')
154             plt.title('Original')  # , plt.xticks([]), plt.yticks([])
155             plt.subplot(212), plt.imshow(sliced, cmap='gray')
156             plt.title('Cropped')  # , plt.xticks([]), plt.yticks([])
157             plt.show()
158             # plt.savefig('./plots/cropped' + str(frame_num) + '.png', bbox_inches='tight')
159             print("com", cX, cY)
160             print(" size sliced", top, bot, left, right)
161         return sliced
162
163
164 # measure the damage on the rail using Thresholding. Only for one, cutout image of a rail
165 def find_damage_thresholds(gray_img, flag="simple", show=False, frame_num=""):
166     gray_img = cv2.normalize(gray_img, None, alpha=0, beta=255, norm_type=cv2.NORM_MINMAX)
167     if flag == "simple":
168         ret, thresh = cv2.threshold(gray_img, thresh=120, maxval=255, type=cv2.THRESH_BINARY)
169     elif flag == "mean":
170         thresh = cv2.adaptiveThreshold(gray_img, 255, cv2.ADAPTIVE_THRESH_MEAN_C, cv2.THRESH_BINARY,
            ↪ blockSize=11, C=2)
171     elif flag == "gauss":
172         thresh = cv2.adaptiveThreshold(gray_img, 255, cv2.ADAPTIVE_THRESH_GAUSSIAN_C, cv2.THRESH_BINARY,
            ↪ blockSize=11,
173                                        C=2)
174     elif flag == "otsu":
175         ret, thresh = cv2.threshold(gray_img, 0, 255, cv2.THRESH_BINARY + cv2.THRESH_OTSU)
176     # counting the number of pixels
177     white = np.sum(thresh == 255)
178     black = np.sum(thresh == 0)
```

```
179     result = black / (white + black)
180     # print(' Number of white pixels:', white)
181     # print(' Number of black pixels:', black)
182     # print(' Relative number of black pixels:', result)
183     return result
184 
185 
186 # Canny Edge Detection with automatic threshold. Threshold calculated from Otsu's algorithm
187 # http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.402.5899&rep=rep1&type=pdf
188 def auto_otsu_canny(gray_img):
189     high, thresh = cv2.threshold(gray_img, 0, 255, cv2.THRESH_BINARY + cv2.THRESH_OTSU)
190     low = 0.5 * high
191     canny = cv2.Canny(gray_img, low, high)
192     return canny, low, high
193 
194 
195 # Canny Edge Detection with automatic threshold. Threshold calculated from pixel median
196 #
    ↪ https://www.pyimagesearch.com/2015/04/06/zero-parameter-automatic-canny-edge-detection-with-python-and-opencv/
197 def auto_canny(image, sigma=0.33):
198     # compute the median of the single channel pixel intensities
199     v = np.median(image)
200     # apply automatic Canny edge detection using the computed median
201     lower = int(max(0, (1.0 - sigma) * v))
202     upper = int(min(255, (1.0 + sigma) * v))
203     edged = cv2.Canny(image, lower, upper)
204     # return the edged image
205     return edged, lower, upper
206 
207 
208 # measure the damage on the rail using Edge Detection. Only for one, cutout image of a rail
209 def find_damage_edge(gray_img, flag="Canny", show=False, frame_num=""):
210     gray_img = cv2.normalize(gray_img, None, alpha=0, beta=255, norm_type=cv2.NORM_MINMAX)
211     if flag == "Canny":
212         edges = cv2.Canny(gray_img, threshold1=10, threshold2=120, edges=None)
213     elif flag == "AutoCanny":
214         edges, l, h = auto_canny(gray_img)
215     elif flag == "OtsuCanny":
216         edges, l, h = auto_otsu_canny(gray_img)
217     else:
218         edges = cv2.Canny(gray_img, threshold1=10, threshold2=120, edges=None)
219     if show:
220         plt.imshow(edges, cmap="gray"), plt.title("CannyEdge")
221         plt.show()
222         plt.imshow(gray_img, cmap="gray"), plt.title("Cropped")
223         plt.show()
224     # counting the number of pixels
225     white = np.sum(edges == 255)
226     black = np.sum(edges == 0)
227     result = white / (white + black)
228     return result, edges
229 
230 
231 """
232 Calculate statistical performance
233 """
234 
235 # calculate accuracy, precision, recall, f1 for entire video for one method
236 def statistics(high_dmg_samples, low_dmg_samples, path="./test.mpg", flag="Canny"):
```

```
237     pos_samples, neg_samples = find_damage_video("./test.mpg", flag, hsamples=high_dmg_samples,
238                                                  lsamples=low_dmg_samples)
239     tp = sum(pos_samples)
240     fp = sum(neg_samples)
241     fn = len(pos_samples) - tp
242     tn = len(neg_samples) - fp
243     accuracy = (tp + tn) / (tp + fp + fn + tn)
244     precision = tp / (tp + fp)  # how valid
245     recall = tp / (tp + fn)  # how complete, sensitivity
246     f1 = 2 * (recall * precision) / (recall + precision)
247     return accuracy, precision, recall, f1
248
249
250 # calculate accuracy, precicison, recall, f1 for entire video for all methods
251 def statistics_all_methods(high_dmg_samples, low_dmg_samples):
252     accl, prl, rel, f1l = [], [], [], []
253     for num, flag in enumerate(flags):
254         acc, pr, re, f1 = statistics(high_dmg_samples=high_dmg_samples,
255                                      low_dmg_samples=low_dmg_samples, path="./test.mpg", flag=flag)
256         print(flag, "accuracy, precision, recall, f1 score:\n\t",
257               np.round(acc, 3), np.round(pr, 3), np.round(re, 3), np.round(f1, 3))
258         accl.append((num, acc))
259         prl.append((num, pr))
260         rel.append((num, re))
261         f1l.append((num, f1))
262     # plot
263     s, m = 12, "o"
264     x, y = zip(*accl)
265     plt.scatter(x, y, label="Accuracy", marker=m, s=s, linewidth=None)
266     x, y = zip(*prl)
267     plt.scatter(x, y, label="Precision", marker=m, s=s, linewidth=None)
268     x, y = zip(*rel)
269     plt.scatter(x, y, label="Recall", marker=m, s=s, linewidth=None)
270     x, y = zip(*f1l)
271     plt.scatter(x, y, label="F1 score", marker=m, s=s, linewidth=None)
272     plt.legend(loc="lower right")  # , plt.title("Calculated damage per frame")
273     plt.ylabel("value")
274     plt.ylim([0, 1])
275     plt.xticks(ticks=[0, 1, 2, 3, 4, 5, 6],
276                labels=('Canny', 'AutoCanny', 'OtsuCanny',
277                        '120Threshold   ', "MeanThreshold  ", " GaussThreshold ", " OtsuThreshold"),
278                fontsize=6)
279     plt.hlines(0.5, 0, 7, colors="gray", linestyles='dashed')
280     plt.show()
281
```

Exergoeconomic Analysis and Optimization of Dual Pressure Organic Rankine Cycle for Geothermal Heat Source Utilization

Dodeye Igbong, James Enyia, Oku Nyong, Mafel Obhua

Abstract- In the present study, a dual-pressure organic Rankine cycle (DORC) driven by geothermal hot water for electricity production is developed, investigated and optimized from the energy, exergy and exergoeconomic viewpoint. A parametric study is conducted to determine the effect of high-stage pressure P_{HP} and low-stage pressure P_{LP} variation on the system thermodynamic and exergoeconomic performance. The DORC is further optimized to obtain maximum exergy efficiency optimized design (EEOD case) and minimum product cost optimized design (MCOD case). The exergy efficiency and unit cost of power produced for the optimization of EEOD case and MCOD case are 33.03% and 3.059 cent/kWh, which are 0.3% and 17.4% improvement over base case, respectively. The MCOD case proved to be the best, with respect to minimum unit cost of power produced and net power output over the base case and EEOD case.

Keywords: Geothermal water**,** Dual pressure organic Rankine cycle, Exergoeconomic factor, Optimization

I. INTRODUCTION

In recent years, the utilization of low-grade heat sources such as geothermal, biomass, solar and power and industrial process waste heat, are becoming more and more attractive as a sustainable approach towards ameliorating environmental issues, such as air pollution, acid rain, global warming and ozone layer depletion caused be greenhouse gas emission from fossil fuel combustion. It is also considered a potential solution to reducing the energy shortage being experienced due to the rapid growth in population and economic activities around the world. Organic Rankine cycle (ORC) is widely used and considered a promising heat-to-power conversion technology that uses lower boiling temperature working fluids, which makes it suitable, flexible and efficient for converting a wide range of heat source temperature to useful power output [1][2][3][4]. It has the advantage of small plant size and modularity, easy construction and low cost of operation [4]. It also has capability for better temperature matching characteristics between working fluids and the low-grade heat source fluid, especially for advance ORC configuration, thus minimizing exergy loss in the evaporators while increasing cycle exergy efficiency [3][5].

Geothermal energy is a low-medium grade heat source, that is attracting growing attention for power generation due to concern about environmental pollution problems from fossil fuel consumption. The advantage of geothermal energy over other renewable energy like wind and solar energies, is that it's availability is all year round and independent of time of day or seasons. The utilization of geothermal energy is increasing worldwide, in 2016 the total install generating capacity was 12.7 GW with annual electricity generation of 80.9 terawatt-hour (TWh) in 2015, accounting for 3% global electricity production [6]. Although it represents a small percentage of electricity production worldwide, in some countries geothermal accounts for more than 10% of the national electricity generation capacity [7]. At present, electricity generation from geothermal resources uses three major type of power plants: the dry-steam plants, flash plants (single, double or triple), or binary plants, depending on the state of the fluid and its temperature [7]. For geothermal wells producing high temperature steam (> 235^0C), dry-steam plants are used. When the steam temperature is > 180^0C and < 235^0C, the flash plants are more suitable, and lastly the binary plants are used for hydrothermal well that produces water temperature < 180^0C. In binary cycle, the working fluid other than the geothermal water undergoes a closed cycle, where its evaporates at the heat exchanger, expands in the turbine, condenses in the condenser and it is pumped back to the heat exchanger. Binary plants are often based on ORC or Kalina cycles, whereas the Kalina cycle uses working fluid mixture of water and ammonia (NH_3) which produces two vapour-components at variable temperature, the ORC uses pure organic working fluids with specific evaporation temperature and better matching characteristic with the geothermal fluid, therefore resulting in higher thermodynamic and exergy efficiencies.

Several Scholars have conducted studies on suitable technology options for low-grade heat source utilization such as geothermal, in which ORC is considered the best technology for heat recovery, with cycle modification capable of achieving higher performance [2][8][5][9]. The dual-pressure organic Rankine cycle (DORC) consist of two evaporation processes with different pressure values and a condensation process. This can reduce the heat transfer temperature difference between the working fluids and the heat source fluid, significantly decreasing the exergy destruction in the evaporator [2][3]. Several studies have reported on the performance advantage of the DORC system to the conventional single organic Rankine cycle (SORC). Li et at [10] investigated the thermodynamic performance of series two-stage ORC (STORC), parallel two-stage ORC (PTORC) and single-pressure ORC (SORC) systems using 90-120^0C geothermal water and R245fa. Results showed an increase in the net power output for the STORC and PTORC compared with the SORC system. Shokati et al [11]

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conducted an energy, exergy and exergoeconomic comparative investigation on the SORC, DORC, dual-loop ORC and the Kalina cycle based on heat source temperature of 175^0C. Results showed that the net power output of DORC was 15.2% higher than the SORC, 35.1% higher than dual-loop ORC, and 43.5% higher than the Kalina cycle system. Thierry et al. [12] investigated the performance of DOC using working fluid mixture for heat source temperature range of 90-110^0C. Results indicate that DORC efficiency increased by 12.4% relative to the SORC system. Manente et al. [13] investigated and compared the thermodynamic performance of the SORC and DORC systems driven by geothermal heat source of 100-200^0C temperature range. Results showed DORC gave better performance than SORC, with performance gain of DORC diminishing as heat source temperature increased. Sadeghi et al. [14] evaluated and compared the performance of SORC, STORC and PTORC using zeotropic working fluids and driven by geothermal heat source temperature of 100^0C. Results showed a 34.3% net power output increase for STORC relative to the SORC system. Li et al. [15] studied the thermoeconomic performance of ORC with separate and induction turbine layouts, and analyzed the effect of the low-stage and high-stage pressures on the thermoeconomic performance of the system. Results showed that the induction turbine produced better net power output, with significant decrease in the specific investment cost.

There exist in public domain several researches comparing performance of different ORC layouts and system optimization of the DORC. However, a few studies have investigated the exergoeconomic performance of the DORC system with optimization towards optimal system exergy efficiency and minimum product total cost design. Even though DORC systems produces better performance compared with the conventional SORC, their much higher specific investment cost due to their complex configurations consisting of two evaporation processes, two turbine expansion processes and two pumping processes, might be a drawback. Therefore, it is essential to investigate the thermoeconomic and exergoeconomic performance of DORC applications.

The present study, investigates the exergoeconomic optimization of dual-pressure ORC using geothermal heat source. Thermodynamic and thermoeconomic analysis was performed to determine the system first and second law efficiencies, as well as the exergy unit cost rate for each stream. Parametric analysis was also conducted to determine the influence of the high-stage and low-stage pressures, working fluids mass flow and heat source temperature on the system overall exergy efficiency and product unit cost. In addition, optimization was performed to obtain optimal decision parameters to attain maximum exergy efficiency (EEOS case) and minimum product unit cost (MCOD case). Finally, to design a cost-efficient system the exergoeconomic parameters like the exergoeconomic factor and cost of exergy destruction were determined for each component in order to identify potential opportunities for system improvement.

II. SYSTEM DESCRIPTION

Fig. 1 shows the schematic diagram of the dual-pressure organic Rankine cycle (DORC) driven by geothermal hot water. The ORC system consist of a superheater, the HP and LP evaporators, HP and LP preheaters, HP and LP turbines, an isobaric condenser and the PH and LP pumps. The LP pump compresses the organic working fluid (state 1) exiting the condenser, the pressurize fluid (state 2) then flows through the preheater 1 where heat from the LP evaporator exit stream is used to increase the fluid enthalpy. The working fluid leaving the preheater is divided into two streams. One part of the organic working fluid flows to the LP evaporator (state 3a) and the other part moves to the HP pump (state 3b) where it is further compressed to high-stage pressure. The compressed fluid from the HP pump (stage 5) flows through the preheater 2, absorbing heat before entering the HP evaporator (stage 6). The vaporized fluid is then superheated before exiting the superheater (stage 8) to undergo expansion in the HP turbine. The working fluid leaving the HP turbine (state 9) mixes with the fluid stream from the LP evaporator (state 4) and then flows to the LP turbine inlet (state 10) where it undergoes second turbine expansion. The LP turbine exhaust vapour (state 11) is condensed in the condenser by the cooling water (state 12) into liquid (state 1). The liquid working fluid is then pumped to the preheater 1 and the entire cycle is completed.

The geothermal hot water is the heat source that have been used to drive the ORC system. It is a medium-temperature heat source with maximum temperature of 150^0C at 2525kPa pressure. The geothermal hot water stream (state 14) drives both the HP and LP evaporators and preheaters. It is worth noting that, the working fluid pressure leaving the LP evaporator (state 4) is equal to the HP turbine exhaust vapour pressure (state 9).

III THERMODYNAMIC ANALYSIS

For the purpose of system analysis, each component of the DORC is considered a control volume in which mass and energy conservation principles, as well as the second law of thermodynamics are applied. The EES software developed by Ibrahim and Klein [16] have been employed to model all processes in the ORC system.

The following simplified assumptions are further employed in modelling of the ORC:

- The ORC system operates at steady-state condition
- Pressure drops in all heat exchangers and pipes are negligible
- Dry and isentropic working fluid at the turbine inlets are superheated vapor.
- Pinch point temperature difference at the heat exchanger is 10^0C
- Changes in potential and kinetic are negligible.

The mass and energy conservation, as well as exergy balance relations for each system component are represented as [17]:

$$\sum \dot{m}_{in} = \sum \dot{m}_{out} \quad (1)$$

$$\sum \dot{m}_{in} h_{in} + \dot{Q}_{cv} - \sum \dot{m}_{out} h_{out} - \dot{W}_{cv} = 0 \quad (2)$$

$$\sum \dot{E}_{in} - \sum \dot{E}_{out} + \sum \dot{E}_{heat} + \sum \dot{W}_{J} - \dot{E}_{D,J} = 0 \quad (3)$$

Neglecting the potential and kinetic exergies, the total exergy is considered as the sum of the physical and chemical components expressed as [17]:

$$\dot{E} = \dot{E}_{ph} + \dot{E}_{ch} \quad (4)$$

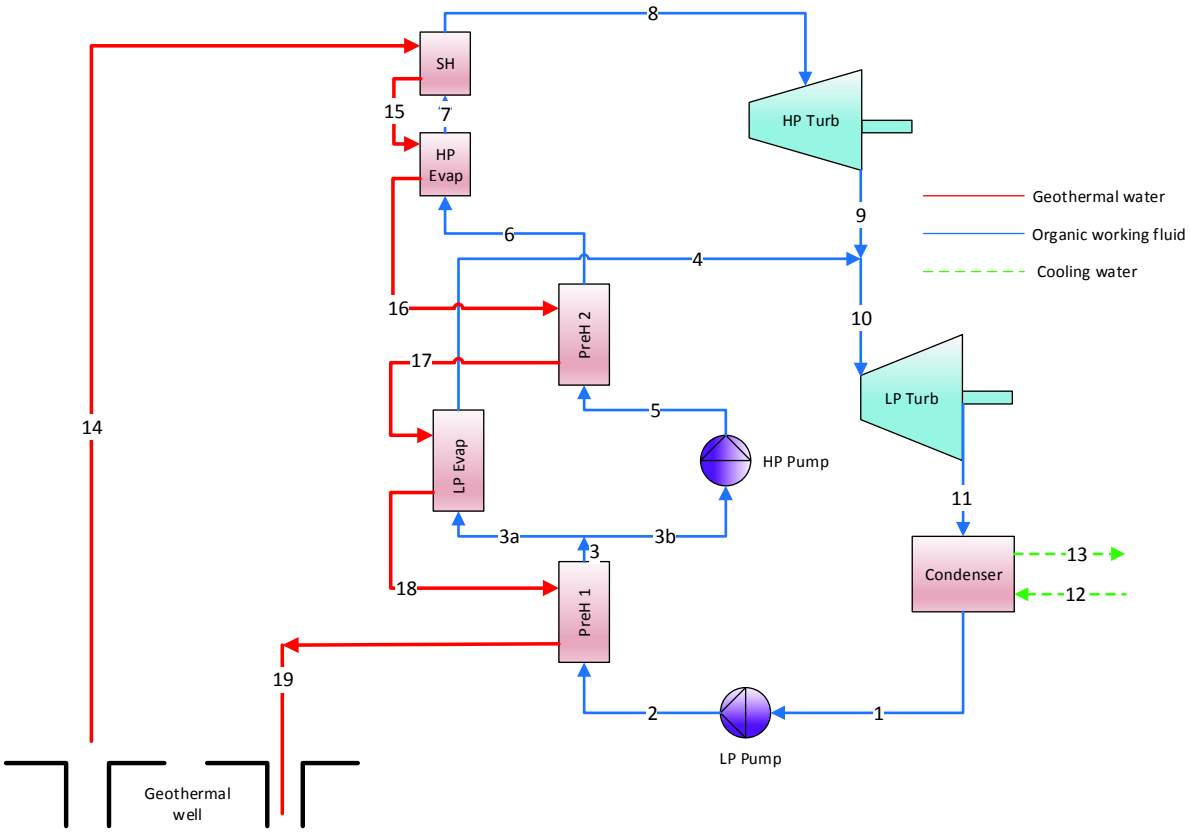


Fig.1. Schematic diagram of dual-pressure ORC driven by geothermal heat source.

The physical exergy quantifies the maximum obtainable useful work when the system state changes due to variation in pressure and temperature from the specific state (T, P) to reference state (T_0, P_0). The specific physical and chemical exergies are expressed as follow:

$$\dot{E}_{ph} = \dot{m}[(h - h_0) - T_0(s - s_0)] \quad (5)$$

$$\dot{E}_{ch} = \dot{m}\left[\sum_{i=1}^{n} X_i\, ex_{ch,i} + RT_0 \sum_{i=1}^{n} X_i Ln(X_i)\right] \quad (6)$$

In the exergy analysis of a system, the product exergy ($\dot{E}_p$) and fuel exergy ($\dot{E}_f$) of both the system components and the entire system are calculated separately. For each system component the exergy destruction is defined as the difference between the product and fuel exergies:

$$\dot{E}_{D,J} = \dot{E}_{f,J} + \dot{E}_{p,J} \quad (7)$$

The ORC performance evaluates the system energy utilization factor, defined in terms of the thermal efficiency and exergy efficiency.

Thermal efficiency is the ratio of the net power output to the input energy from the geothermal heat source [2]:

$$\eta_{thermal} = \frac{\dot{W}_{net}}{\dot{Q}_{in}} \quad (8)$$

Where,

$$\dot{W}_{net} = \dot{W}_{HP\_turb} + \dot{W}_{LP\_turb} - \dot{W}_{pump1} - \dot{W}_{pump2} \quad (9)$$

$$\dot{Q}_{in} = \dot{m}_{14}(h_{14} - h_{19}) \quad (10)$$

The exergy efficiency is expressed as follows

$$\eta_{exergy} = \frac{\dot{W}_{net} + E_{ref}}{\dot{E}_{in}} \quad (11)$$

Where,

$$\dot{E}_{in} = \dot{E}_{14} - \dot{E}_{19} \quad (12)$$

The overall system efficiency, η_{sys}, and the heat recovery effectiveness, ϕ, of the ORC are calculated as follows:

$$\eta_{sys} = \frac{Q_{in}}{\dot{m}_{14}(h_{14} - h_0)} \quad (13)$$

$$\phi = \frac{W_{net}}{\dot{m}_{14}(h_{14} - h_0)} \quad (14)$$

where h_0 is specific heat enthalpy of heat source water at ambient temperature.

The energy and exergy relations for each component of the ORC system is shown in Table 1.

Table 1. Energy and exergy equation for the ORC.

Components	Energy equations	Exergy equations
	Organic Rankine Cycle	
Pump 1	$\eta_{Pump1} = \frac{w_s}{w_A} = \frac{h_{2s} - h_1}{h_2 - h_1}$ $W_{Pump1} = \dot{m}_1(h_2 - h_1)$	$\dot{E}_1 + \dot{W}_{pump1} - \dot{E}_2 = \dot{E}_{Destruction}$
Pump 2	$\eta_{Pump2} = \frac{w_s}{w_A} = \frac{h_{5s} - h_{3b}}{h_5 - h_{3b}}$ $W_{Pump2} = \dot{m}_5(h_5 - h_{3b})$	$\dot{E}_{3b} + \dot{W}_{pump2} - \dot{E}_5 = \dot{E}_{Destruction}$
Condenser	$\dot{m}_{cooling}(h_{13} - h_{12}) = \dot{m}_{11}(h_{11} - h_1)$ $\dot{Q}_{Econ} = \dot{m}_{11}(h_{11} - h_1)$	$\dot{E}_{11} + \dot{E}_{12} - \dot{E}_1 - \dot{E}_{13} = \dot{E}_{Destruction}$
Superheater	$\dot{m}_{14}(h_{14} - h_{15}) = \dot{m}_8(h_8 - h_7)$ $\dot{Q}_{SuperH} = \dot{m}_8(h_8 - h_7)$	$\dot{E}_{14} + \dot{E}_7 - \dot{E}_{15} - \dot{E}_8 = \dot{E}_{Destruction}$
HP Evaporator	$\dot{m}_{15}(h_{15} - h_{16}) = \dot{m}_6(h_7 - h_6)$ $\dot{Q}_{HP\_Evap} = \dot{m}_6(h_7 - h_6)$	$\dot{E}_{15} + \dot{E}_6 - \dot{E}_7 - \dot{E}_{16} = \dot{E}_{Destruction}$
HP Turbine	$\eta_{HP\_turb} = \frac{w_A}{w_s} = \frac{h_8 - h_9}{h_8 - h_{9s}}$ $W_{HP\_turb} = \dot{m}_8(h_8 - h_9)$	$\dot{E}_8 - \dot{W}_{HP\_turb} - \dot{E}_9 = \dot{E}_{Destruction}$
Preheater 1	$\dot{m}_{18}(h_{18} - h_{19}) = \dot{m}_3(h_3 - h_2)$ $\dot{Q}_{preH1} = \dot{m}_3(h_3 - h_2)$	$\dot{E}_{18} + \dot{E}_2 - \dot{E}_{19} - \dot{E}_3 = \dot{E}_{Destruction}$
LP Evaporator	$\dot{m}_{17}(h_{17} - h_{18}) = \dot{m}_4(h_4 - h_{3a})$ $\dot{Q}_{LP\_Evap} = \dot{m}_4(h_4 - h_{3a})$	$\dot{E}_{17} + \dot{E}_{3a} - \dot{E}_{18} - \dot{E}_4 = \dot{E}_{Destruction}$
LP Turbine	$\eta_{LP\_turb} = \frac{w_A}{w_s} = \frac{h_{10} - h_{11}}{h_{10} - h_{11s}}$ $W_{LP\_turb} = \dot{m}_{10}(h_{10} - h_{11})$	$\dot{E}_{10} - \dot{W}_{LP\_turb} - \dot{E}_{11} = \dot{E}_{Destruction}$
Preheater 2	$\dot{m}_{16}(h_{16} - h_{17}) = \dot{m}_5(h_6 - h_5)$ $\dot{Q}_{preH2} = \dot{m}_5(h_6 - h_5)$	$\dot{E}_{16} + \dot{E}_5 - \dot{E}_{17} - \dot{E}_6 = \dot{E}_{Destruction}$

IV. THERMOECONOMIC ANALYSIS

Thermoeconomic analysis is an approach that combines exergy and economic analyses in order to facilitate better design and more cost-efficient systems. The analysis provides information about the cost formation process and cost of unit exergy of each stream. This analysis is conducted through the formation of cost balance equations and auxiliary equations for each component expressed in the form:

$$\sum \dot{C}_{i,J} + \dot{C}_{q,J} + \dot{Z}_J = \sum \dot{C}_{e,J} + \dot{C}_{w,J} \quad (15)$$

Where,

$$\dot{C} = c\dot{E} \quad (16)$$

In the equations above, $\dot{C}$ is the cost rate of exergy $\left(\frac{\$}{hr}\right)$ and c is the cost of unit exergy of each stream $\left(\frac{\$}{GJ}\right)$. Also, C_q and C_w represent the heat transfer rate of each component and the work associated costs, respectively

The cost balance equation for the entire system is usually formulated as follow [17]:

$$\dot{C}_{P,total} = \dot{C}_{f,total} + \dot{Z}_{total} \quad (17)$$

Where, $\dot{C}_P$ denotes total product related costs, $\dot{C}_f$ is the fuel cost rate and $\dot{Z}$ is the total costs related to capital investment and operation and maintenance.

The Investment cost rate ($\dot{Z}_J$) of J^{th} component is defined as the sum of the capital investment $\left(\dot{Z}_J^{CI}\right)$ and operation and maintenance costs $\left(\dot{Z}_J^{OM}\right)$.

$$\dot{Z}_J = \dot{Z}_J^{CI} + \dot{Z}_J^{OM} \quad (18)$$

The annual levelized capital investment cost is computed as [17]:

$$\dot{Z}_J = \left(\frac{CRF}{\tau}\right) Z_J + \left(\frac{y_J}{\tau}\right) Z_J + \omega_J \dot{E}_{P,J} + \frac{R_J}{\tau} \quad (19)$$

Where Z_J is the capital cost for J component, and is calculated with relations as expressed in Appendix A. CRF denotes the capital recovery factor given as :

$$CRF = \frac{i_r(1+i_r)^n}{(1+i_r)^n - 1} \quad (20)$$

Where, i_r is the interest rate, and n is the number of useful years the plant is in operation.

In equation (19), τ is the annual hours of plant operation, y_J is the fixed cost and ω_J is the variable cost relating to operation and maintenance.
The term R_J refers to all other costs independent from investment cost and operation and maintenance costs. The first term in equation (19) is much larger than the two last terms, therefore the two last terms can be neglected.
Table 2 shows the cost balance and auxiliary cost equations for each component of the ORC system.

V. EXERGOECONOMIC PARAMETERS

The exergoeconomic factor (f_J), and the cost of exergy destruction are very important exergoeconomic parameters that are used for evaluating the economic performance of the entire system and each component.

- **Exergoeconomic factor (f_J)**:

Exergoeconomic factor (f_J) defines the proportion of capital investment and operation and maintenance costs in the exergy destruction and exergy loss related costs for each component [11][17].

$$f_J = \frac{\dot{Z}_J}{\dot{Z}_J + (\dot{C}_{D,J} + \dot{C}_{L,J})} \quad (21)$$

Table 2. Component cost balance and auxiliary cost equations of the ORC.

Components	Cost equations	Auxiliary equations
	Organic Rankine cycle	
Pump 1	$\dot{C}_1 + \dot{C}_{w,pump1} + \dot{Z}_{pump1} = \dot{C}_2$	-
Condenser	$\dot{C}_{11} + \dot{C}_{12} + \dot{Z}_{cond} = \dot{C}_1 + \dot{C}_{13}$	$c_{11} = c_1; c_{12} = 0$
Preheater-1	$\dot{C}_2 + \dot{C}_{18} + \dot{Z}_{preH1} = \dot{C}_3 + \dot{C}_{19}$	$c_2 = c_3; c_{3a} = c_3$
LP Turbine	$\dot{C}_{10} + \dot{Z}_{LP\_turb} = \dot{C}_{11} + \dot{C}_{w,LP\_turb}$	$c_{11} = c_{10}$; $c_{w,LP\_turb} = c_{w,pump1}$
LP Evaporator	$\dot{C}_{3a} + \dot{C}_{17} + \dot{Z}_{LP\_evap} = \dot{C}_4 + \dot{C}_{18}$	$c_{3a} = c_4;\ c_{3a} = c_{3b}$
Preheater-2	$\dot{C}_5 + \dot{C}_{16} + \dot{Z}_{preH2} = \dot{C}_6 + \dot{C}_{17}$	$c_5 = c_6$
Pump 2	$\dot{C}_{3b} + \dot{C}_{w,pump2} + \dot{Z}_{pump2} = \dot{C}_5$	$\dot{C}_{w,pump2} = \dot{C}_{w,pump2}$
HP Turbine	$\dot{C}_8 + \dot{Z}_{HP\_turb} = \dot{C}_9 + \dot{C}_{w,HP\_turb}$	$c_9 = c_8$; $c_{w,HP\_turb} = c_{w,pump2}$

HP Evaporator	$\dot{C}_6 + \dot{C}_{15} + \dot{Z}_{HP\_evap} = \dot{C}_7 + \dot{C}_{16}$	$c_6 = c_7$
Superheater	$\dot{C}_7 + \dot{C}_{14} + \dot{Z}_{SuperH} = \dot{C}_8 + \dot{C}_{15}$	$c_7 = c_8$
Mixer	$\dot{C}_4 + \dot{C}_9 + \dot{Z}_{mixer} = \dot{C}_{10}$	
Separator	$\dot{C}_3 = \dot{C}_{3a} + \dot{C}_{3b}$	$c_{3a} = c_{3b}$

- **Cost of exergy destruction**:

The cost of exergy destruction is often referred to as a hidden cost, as it does not appear in the cost balance equation of the components. The cost of exergy destruction, cost of product and cost of fuel can be expressed as follows [18]:

$$\dot{C}_{D,J} = c_{f,J}\dot{E}_{D,J} \quad (22)$$

$$\dot{C}_{P,J} = c_{p,J}\dot{E}_{P,J} \quad (23)$$

$$\dot{C}_{F,J} = c_{f,J}\dot{E}_{F,J} \quad (24)$$

Where c_f and c_p denotes average cost per unit fuel and the cost per unit product for each component.

VI MODEL VALIDATION

The thermodynamic model developed for the DORC system being investigated is first validated against available public literature [19]. A comparison of the results obtained in present work with those reported in Manente et al [19] is shown in Table 3. It is observed that there is a good agreement between results obtained from present study and those reported in literature.

The Input data and assumptions made for the parametric study of the DORC system is listed in Table 4.

Table 3. Comparison of the results from present models with those reported by Ref. [19]

Isobutane	Present Paper	Manente et al [19]	Relative error [%]
T_{Sat_HP} [^{0}C]	113.40	113.30	+0.088
T_{Sat_LP} [^{0}C]	76.57	76.60	-0.039
P_{HP} [KPa]	2525	2530	-0.198
P_{LP} [KPa]	1230	1250	0.0
$\dot{m}_{HP}$ [Kg/s]	62.90	62.90	0.0
$\dot{m}_{LP}$ [Kg/s]	32.74	32.80	-0.183
η_{th} [%]	10.59	10.22	+3.493
η_{sys} [%]	7.026	7.066	-0.569
W_{net} [KW]	3859	3871	-0.310

Table 4. The DORC system Input data

Parameters	Values
Ambient Temperature, T_{amb}	20 [^{0}C]
Ambient Pressure, P_{amb}	101 [kPa]
Geothermal Water Temperature, T_{14}	150 [^{0}C]
Geothermal Water Pressure, P_{14}	2525 [kPa]
Geothermal water mass flow rate, $\dot{m}_{14}$	45 [Kg/s]
Pinch point temperature difference in the evaporator, ΔT_{Evap}	10 [^{0}C]
Cooling water entry temperature, T_{12}	25 [^{0}C]
Condensation temperature, T_{cond}	29 [^{0}C]
Pinch point temperature difference in the condenser, ΔT_{cond}	10 [^{0}C]
Turbine efficiency, η_{turb}	85[%]
Pump efficiency, η_{pump}	70[%]
Annual operating hours, τ	8000 [hr./year]
Interest rate, i_r	15 [%]
Plant years of operation, n	20 years

VII RESULTS AND DISCUSSION

The thermodynamic properties, exergy rate, exergy cost rate and cost rate of unit exergy at each stream for the developed model of the DORC system based on the input conditions listed in Table 4 is presented in Table 5. It can be observed that the cost per unit exergy for the superheater, evaporators and preheaters have the highest values. This is due to the high heat losses experienced in these components. Table 6 presents a summary of the exergy of fuel (i.e. input exergy) $\dot{E}_f$, exergy of product $\dot{E}_p$, exergy destruction rate $\dot{E}_D$, and exergetic efficiency ε, of individual components of the DORC base case. The condenser has the highest value of exergy destruction rate compared to other components, and with a corresponding component exergetic efficiency of 99.87%.

After the condenser, the next components with significant contribution to the cycle exergy destruction rate are HP evaporator, LP turbine and preheater 1, with exergy efficiencies of 99.91%, 98.92% and 99.98%, respectively.

The DORC base case exergoeconomic parameters are presented in Table 7. From exergoeconomic analysis viewpoint, components with the highest value of $\dot{Z} + \dot{C}_D$ should be treated with high impotence in terms of implementing component improvement effort. Therefore, the LP turbine is of higher importance from exergoeconomic viewpoint. The high value of f indicates that the HP evaporator cost rates associated with capital investment cost dominates the contribution associated with exergy destruction in the LP turbine. To reduce the value of $\dot{Z} + \dot{C}_D$ for the LP turbine, capital investment cost should be reduce by using cheaper turbine. The next components with the highest $\dot{Z} + \dot{C}_D$ value are the HP turbine, HP evaporator and condenser in descending order, respectively. In the same manner, in HP turbine the capital investment cost $\dot{Z}_{LP\_turb}$ value dominates the contribution associated with exergy destruction $\dot{C}_{D,HP\_turb}$. This implies, lowering the value of $\dot{Z} + \dot{C}_D$ in the HP turbine would come by choosing turbine with lower capital investment cost.

Table 6. Results of exergy analysis of the DORC system components

Components	$\dot{E}_p$ [KW]	$\dot{E}_f$ [KPa]	$\dot{E}_D$ [KW]	ε [%]

HP Turbine	626.1	632.4	6.229	99.02
LP Turbine	1310.0	1325.0	14.270	98.92
Condenser	30809.0	30849.0	39.110	99.87
LP Pump 1	8322.0	8323.0	1.637	99.98
Preheater 1	12371.0	12384.0	12.59	99.90
LP Evaporator	7658.0	7669.0	11.470	99.85
HP Pump 2	8347.0	8349.0	1.884	99.98
Preheater 2	11407.0	11416.0	8.323	99.93
HP Evaporator	16176.0	16191.0	14.640	99.91
Superheater	16278.0	16279.0	0.4564	100.00

Table 5. Thermodynamic flow parameters, exergy flow rates, cost flow rates and unit cost of exergy for Isobutane

State	Fluid	T [^{0}C]	P [KPa]	$\dot{m}$ [Kg/s]	$\dot{E}_{ex}$ [MW]	$\dot{C}$ [$/h]	c [$/GJ]
1	Isobutane	39.00	517	43.34	8.238	154.40	5.205
2	Isobutane	39.67	1250	43.34	8.322	161.40	5.389
3	Isobutane	76.57	1250	43.34	12.371	188.30	4.229
4	Isobutane	76.57	1250	14.48	7.658	86.42	3.135
5	Isobutane	78.19	2525	28.87	8.347	135.70	4.517
6	Isobutane	113.3	2525	28.87	11.407	158.10	3.850
7	Isobutane	113.3	2525	28.87	16.176	190.00	3.263
8	Isobutane	114.3	2525	28.87	16.278	194.50	3.319
9	Isobutane	82.45	1250	28.87	15.646	186.90	3.319
10	Isobutane	80.48	1250	43.34	23.303	436.70	5.205
11	Isobutane	52.42	517	43.34	21.979	411.90	5.205
12	Water	25.00	101	877.30	17.108	0	0
13	Water	29.00	101	877.30	30.809	264.60	2.386
14	Water	150.00	2525	45.00	23.345	115.40	1.373
15	Water	149.40	2525	45.00	23.243	114.90	1.373
16	Water	123.30	2525	45.00	18.460	91.24	1.373
17	Water	106.30	2525	45.00	15.391	76.07	1.373
18	Water	86.57	2525	45.00	11.854	58.59	1.373
19	Water	63.69	2525	45.00	7.792	38.51	1.373

Table 7. Results of exergoeconomic parameters of the DORC system components

Components	c_p [$/GJ]	c_f [$/GJ]	$\dot{C}_D$ [$/hr]	$\dot{Z}_J$ [$/hr]	$\dot{Z}_J + \dot{C}_{D,J}$ [$/hr]	f [%]
HP Turbine	9.979	3.319	0.07441	14.940	15.010	99.50
LP Turbine	9.979	5.205	0.26730	22.250	22.520	98.81
Condenser	2.386	2.319	0.32640	7.139	7.465	95.63
LP Pump 1	5.389	5.254	0.03096	4.003	4.034	99.23
Preheater 1	4.229	4.072	0.18450	6.831	7.016	97.37
LP Evaporator	3.135	2.912	0.12020	6.024	6.144	98.04
HP Pump 2	4.517	4.305	0.02919	6.349	6.378	99.54
Preheater 2	3.850	3.672	0.11000	7.208	7.318	98.50
HP Evaporator	3.263	3.118	0.16440	8.240	8.404	98.04
Superheater	3.319	3.251	0.00534	3.968	3.968	99.87

Other components are observed to follow similar trend. The high value of *f* for these components indicates that the capital investment cost $\dot{Z}$, is larger than the cost rate associated with exergy destruction $\dot{C}_D$. Therefore, any further reduction in the value of $\dot{Z} + \dot{C}_D$ parameter can be achieved by lowering the capital investment cost of the components.

Comparing the processes involving compression in the pump, expansion in the turbines and heat transfer in the superheater, evaporators and preheaters, the LP pump1 and superheater are observed to have lower value of rate of exergy destruction $\dot{E}_D$ than other components in the DORC. The superheater and LP pump1 also appears to have lower value of $\dot{Z} + \dot{C}_D$ compare to other components of the cycle, in which superheater has the lowest value of $\dot{Z} + \dot{C}_D$, which is understandable considering the degree (1^0C) of superheating in the base case. Therefore, the LP pump1 and superheater are considered the cheapest components in the cycle with minimum values of $\dot{Z} + \dot{C}_D$ and having no significant effect on the exergoeconomic performance of the cycle given any changes in the component. It is also observed that all the components where heat transfer process occur except in the superheater, have high rate of exergy destruction $\dot{E}_D$ with corresponding high cost associated with exergy destruction $\dot{C}_D$.

VIII PARAMETRIC STUDY

In this section, an investigation on the effect of operating parameters on the cycle thermodynamic and exergoeconomic performance is undertaken. Fig. 2 shows the influence of HP and LP pressures variation on the DORC thermal efficiency and cycle power outputs. Analysis indicates that, as HP pressure increases while LP pressure is held constant, the power output of the HP turbine decreases.

Thermal efficiency: Fig. 2a. shows the variation of thermal efficiency (η_{th}) with respect to changes in P_{HP} and P_{LP} pressures. The η_{th} trend terns to gradually decrease as the value of P_{HP} rises and sharply increases with P_{LP} rise. This is because the increase in P_{LP} leads to a decrease in heat source utilization rate. That is, as P_{LP} increases heat absorbed in the HP evaporator $\dot{Q}_{HPE}$ decreases, heat absorbed in the LP evaporator $\dot{Q}_{LPE}$ decreases and heat absorbed in the LP preheater 1 $\dot{Q}_{preH1}$ increases at first and then decrease. Since the total amount of heat $\dot{Q}_{Total}$ absorbed by the cycle is determined by $\dot{Q}_{HPE}$ and $\dot{Q}_{preH1}$, in which the value of $\dot{Q}_{HPE}$ dominants the value of $\dot{Q}_{Total}$, which decreases at first and then increases afterwards. Therefore, causing thermal efficiency η_{th} to increase as the value of P_{LP} increases.

Net power output: Fig. 2b. illustrates the effect of P_{HP} and P_{LP} pressure variation on the DORC system net power output. It can be observed, that when P_{HP} increases the value of $\dot{W}_{net}$ decreases, whereas the rise in P_{LP} causes $\dot{W}_{net}$ to increase at first and then declined afterward. This trend is due to the different responses of $\dot{W}_{HP\_turb}$ and $\dot{W}_{LP\_turb}$ to changes in P_{HP} and P_{LP}.

As P_{LP} increases while P_{HP} is held constant, the value of $\dot{W}_{HP\_turb}$ decreases (Fig. 2c) while $\dot{W}_{LP\_turb}$ increases steadily (Fig.2d). Similarly, as P_{HP} increases while P_{LP} is constant, the value of $\dot{W}_{HP\_turb}$ decreases gradually while $\dot{W}_{LP\_turb}$ is reasonably unchanged. These effects lead to an initial increase in the value of $\dot{W}_{net}$ and a decline afterward as P_{LP} increases and a steady decline in $\dot{W}_{net}$ as P_{HP} increases. The higher value of $\dot{W}_{net}$ can be observed in the range of 1000KPa < P_{LP} < 1500KPa and 2300KPa < P_{LP} < 2500KPa as indicated in Fig. 2b.

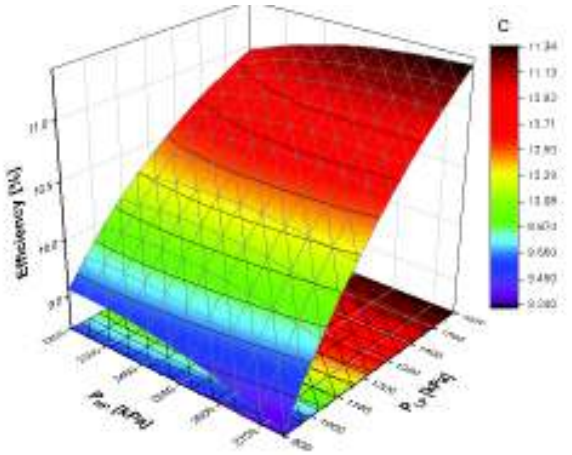


Fig. 2a: Thermal efficiency (η_{th}) over P_{HP} and P_{LP} variation

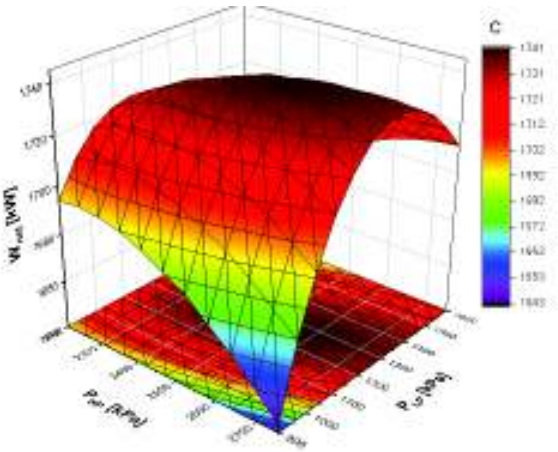
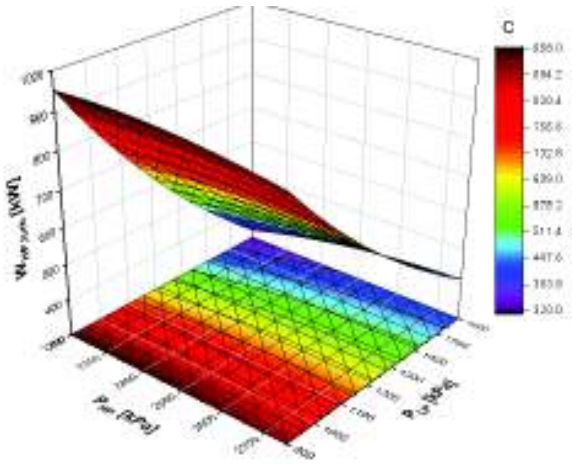


Fig. 2b: Net power output ($\dot{W}_{net}$) over P_{HP} and P_{LP} variation



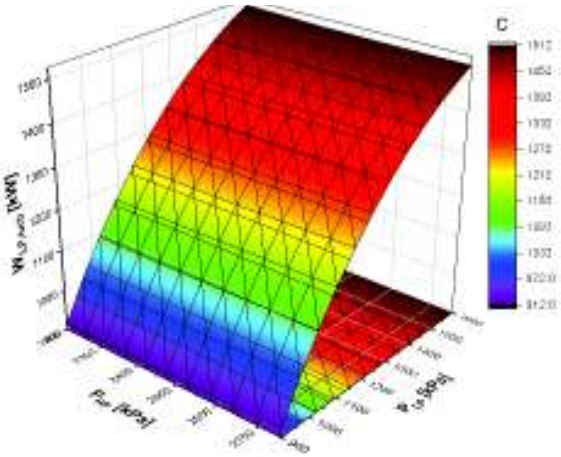


Fig. 2c: $\dot{W}_{HP\_turb}$ over P_{HP} and P_{LP} variation

Fig. 2d: $\dot{W}_{LP\_turb}$ over P_{HP} and P_{LP} variation

Fig.2. Thermodynamic parameters variation with respect to changes in HP and LP pressure

Fig.3 shows variation in exergoeconomic parameters such as $\dot{C}_{D,overall}$, $\dot{Z}_{overall}$, $\dot{C}_{D,overall} + \dot{Z}_{overall}$, $f_{overall}$ and $c_{w,turb}$ over changes in the high-stage pressure (P_{HP}) and low-stage pressure (P_{LP}) of the cycle. Table 7 indicates that the $\dot{Z} + \dot{C}_D$ value of the LP turbine, HP turbine and HP evaporator have the largest influence on the exergoeconomic performance of the cycle. If the value of P_{HP} is increased while P_{LP} is held constant, the values of $\dot{C}_{10}$, $\dot{C}_{11}$ and $\dot{C}_{D,LP\_turb}$ will have a slight decreasing trend while the LP turbine capital investment cost $\dot{Z}_{LP\_turb}$ remaining fairly constant. The values of $\dot{C}_8$ and $\dot{Z}_{HP\_turb}$ takes a descending trend and the value of $\dot{C}_{D,HP\_turb}$ is observed to slightly increase. The values of $\dot{C}_6$, $\dot{C}_7$, $\dot{Z}_{HP\_evap}$ and $\dot{C}_{D,HP\_evap}$ all takes a descending trend.

If the P_{LP} is increased while P_{HP} is kept constant, the values of $\dot{C}_{10}$, $\dot{C}_{11}$, $\dot{Z}_{LP\_turb}$ and $\dot{C}_{D,LP\_turb}$ showing similar trend, increasing steadily as P_{LP} increases. The value of $\dot{C}_8$ increases, the $\dot{Z}_{HP\_turb}$ show a declining trend, while the parameter $\dot{C}_{D,HP\_turb}$ ascend at first and then descend afterward. The $\dot{C}_6$, $\dot{C}_7$ and HP evaporator cost rate associate with exergy destruction $\dot{C}_{D,HP\_Evap}$ show slight increase and the parameter $\dot{Z}_{HP\_Evap}$ remains unchanged. It is obvious that changes in these component parameters can significantly influences the overall exergoeconomic performance of the DORC system.

In the case of P_{HP} increasing and P_{LP} constant, the $\dot{C}_D$ shows a descending trend for the LP turbine and HP evaporator and an increasing trend for HP turbine. These components account for up to half of the value of the overall cost rate associated with exergy destruction, $\dot{C}_{D,overall}$, therefore affecting the behavior of $\dot{C}_{D,overall}$. Fig. 3a show that the value of $\dot{C}_{D,overall}$ decreases as P_{HP} is increased and P_{LP} is constant. This indicate that $\dot{C}_{D,LP\_turb}$, $\dot{C}_{D,HP\_evap}$ and other components with descending trend have stronger influence on the behavior of $\dot{C}_{D,overall}$. The $\dot{Z}_{overall}$ trend is observed to first increase and then decrease as P_{HP} is increased and P_{LP} held constant (Fig. 3b). The trend of $\dot{Z}_{overall}$ can be attributed to the behavior of $\dot{Z}_{HP\_turb}$ and $\dot{Z}_{HP\_evap}$. Since the value $\dot{Z}_{overall}$ is greater than that of $\dot{C}_{D,overall}$, the $\dot{C}_{D,overall} + \dot{Z}_{overall}$ parameter have similar trend as the $\dot{Z}_{overall}$ parameter, ascending at first and then descending as P_{HP} increases (Fig.3c). The value of $f_{overall}$ parameter, which is the ratio of $\dot{Z}_{overall}$ and $\dot{C}_{D,overall} + \dot{Z}_{overall}$ show decreasing trend as P_{HP} increases. The unit cost of power produced $c_{w,turb}$ show slight decrease as P_{HP} increases.

If P_{LP} is increased and P_{HP} is held constant, the value of $\dot{C}_D$ for components with significant influence on the behavior of $\dot{C}_{D,overall}$ such as the LP turbine and HP evaporator show an increasing trend. This results in the ascending trend of $\dot{C}_{D,overall}$ as P_{LP} increases. In the other hand, the $\dot{Z}_{overall}$ parameter have similar behavior as previous, increasing at first and then decreasing. $\dot{C}_{D,overall} + \dot{Z}_{overall}$ also takes a similar trend due to the dominant influence of $\dot{Z}$. The $f_{overall}$ parameter show increasing trend with increase in P_{LP}, reflecting the dominance of $\dot{Z}_{overall}$ in the $\dot{C}_{D,overall} + \dot{Z}_{overall}$ parameter.

IX. OPTIMIZATION

The DORC system optimization is considered in this section to determine the optimal design (working conditions) from the viewpoint of the exergy efficiency optimal design (EEOD), and the minimum unit cost of product optimal design (MCOD) using the direct search method in EES software. Six decision parameters with the range of variation shown below were considered to optimize the system:

$$2200\ \text{KPa} \leq P_{HP} \leq 2750\ \text{KPa}$$

$$900\ \text{KPa} \leq P_{LP} \leq 1600\ \text{KPa}$$

$$1^0\text{C} \leq \Delta T_{SH} \leq 10\ ^0\text{C}$$

$$25^0\text{C} \leq T_{cond,out} \leq 29\ ^0\text{C}$$

$$1^0\text{C} \leq \Delta T_{cond,pp} \leq 10\ ^0\text{C}$$

$$5^0\text{C} \leq \Delta T_{Evap,pp} \leq 15\ ^0\text{C}$$

The results of the optimization presented in Table 8, compares the performance of the base case, EEOD and MCOD cases. The exergy efficiency in the EEOD case is 33.03% which is 0.3% and 0.1% higher than the values obtained from the base cases and the MCOD case, respectively. The thermal efficiency in the EEOD case is 11.3%, which is 6.19% and 4.24% higher than the base case and MCOD, respectively. The net power produced in the EEOD case is 1939kW, which is 10.2% higher than the base case and 2.24% lower than the MCOD case, respectively. With regards to the minimum unit cost product/power optimal design (MCOD) case, the $\mathbf{c_{w,turb}}$ parameter is 3.059 cent/kWh, which is 17.4% and 14.64% lower than the base case and EEOD case, respectively. The net power output in the MCOD case is 1991kW, which is 12.55% and 2.6% higher than base case and the EEOD case, respectively. It is apparent from Table 8, that in MCOD case both unit cost of product and net power produced are higher compared to the base case and EEOD case.

In Table 9, comparative assessment of the base case, EEOD and MCOD cases from a thermoeconomic viewpoint is presented. The analysis identifies the optimal design and components with the highest exergy destruction rate and exergoeconomic factors for component optimization and

system improvement. The base case is observed to have the highest value of $\dot{E}_{D,overall}$ (110.609kW), which is 7.36% and 6.53% higher than the EEOD and MCOD cases, respectively. The condenser has the highest contribution to the cycle total rate of exergy destruction and the superheater having the minimum contribution for all three cases.

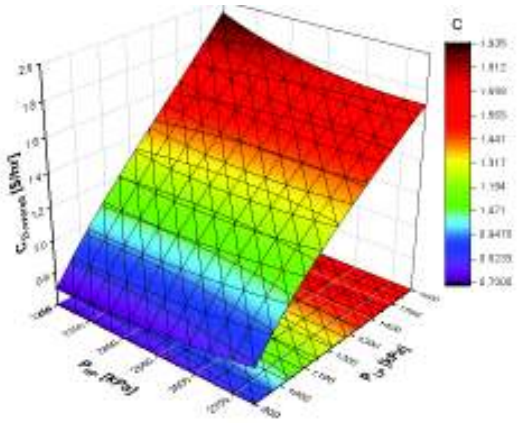


Fig. 3a: $\dot{C}_{D,overall}$ over P_{HP} and P_{LP} variation

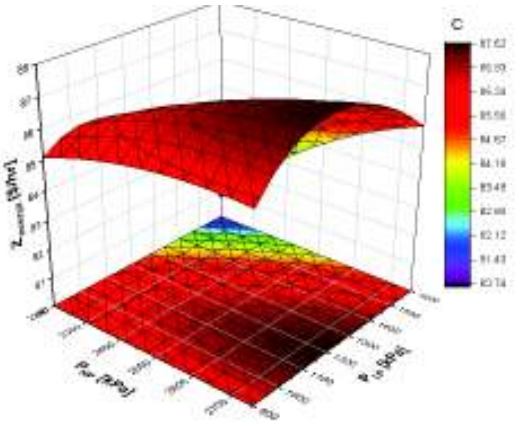


Fig. 3b: $\dot{Z}_{overall}$ over P_{HP} and P_{LP} variation

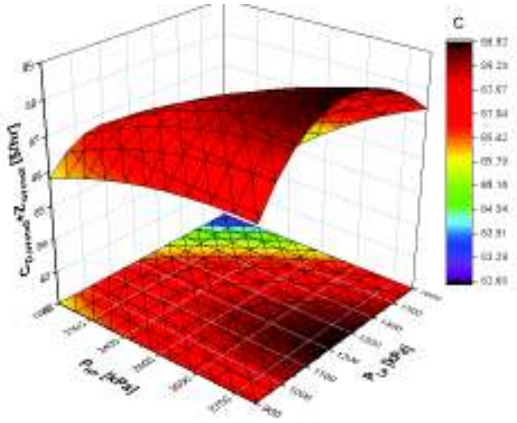


Fig. 3c: $\dot{C}_{D,overall} + \dot{Z}_{overall}$ over P_{HP} and P_{LP} variation

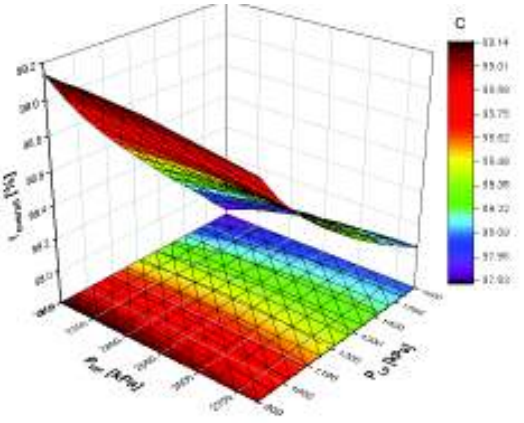


Fig. 3d: $f_{overall}$ over P_{HP} and P_{LP} variation

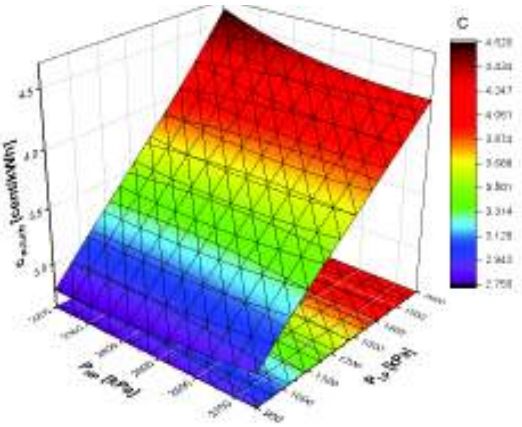


Fig. 3e: $c_{w,turb}$ over P_{HP} and P_{LP} variation

Fig.3. Exergoeconomic parameters variation with respect to changes in HP and LP pressures

Table 8. Results of optimization

Parameters	Base case	Optimization	
		EEOD	MCOD
P_{HP}	2525	2481	2590
P_{LP}	1250	1200	1059
ΔT_{SH}	1	1	1
ΔT_{Evap_pp}	10	10	5
ΔT_{cond_pp}	10	5	6.66
η_{ex}	32.93	33.03	33
η_{th}	10.6	11.3	10.82
W_{net}	1741	1939	1991
$c_{w,turb}$	3.592	3.507	3.059
θ	66.39	69.38	74.39
η_{sys}	7.039	7.841	8.05
$\dot{m}_{cooling}$	877.3	909.7	692.9
$\dot{m}_{HP}$	28.87	29.43	33.56
$\dot{m}_{LP}$	14.48	14.5	14.58

Table 9. Results of exergoeconomic analysis for base case, EEOD and MCOD

Component	Rate of exergy destruction $\dot{E}_{D,J}$ (KW)			Cost rate of exergy destruction $\dot{C}_{D,J}$ ($/hr)			Cost rate of Investment $\dot{Z}_J$ ($/hr)			$\dot{C}_{D,J} + \dot{Z}_J$ ($/hr)			Exergoeconomic factors f (%)		
	Base case	EEOD	MCOD	Base case	EEOD	MCOD	Base case	EEOD	MCOD	Base case	EEOD	MCOD	Base case	EEOD	MCOD
HP Evaporator	14.640	15.580	14.200	0.16440	0.17080	0.13400	8.240	8.273	10.230	8.404	8.444	10.360	98.04	97.98	98.71
LP Turbine	14.270	16.250	14.320	0.26730	0.30710	0.19280	22.250	23.550	22.250	22.520	23.860	22.440	98.81	98.71	99.14
Preheater 2	8.323	8.780	8.836	0.11000	0.11340	0.09258	7.208	7.260	10.270	7.318	7.373	10.360	98.50	98.46	99.11
HP Pump 2	1.884	1.928	2.567	0.02919	0.02927	0.03147	6.349	6.338	7.437	6.378	6.367	7.469	99.54	99.54	99.58
Preheater 1	12.590	14.370	7.501	0.18450	0.20600	0.08467	6.831	6.946	8.588	7.016	7.152	8.673	97.37	97.12	99.02
LP Evaporator	11.470	11.840	9.752	0.12020	0.12120	0.08335	6.024	5.976	7.036	6.144	6.098	7.120	98.04	98.01	98.83
HP Turbine	6.229	6.636	9.138	0.07441	0.07745	0.09285	14.940	15.470	18.400	15.010	15.540	18.500	99.50	99.50	99.50
LP Pump 1	1.637	1.700	1.478	0.03096	0.03242	0.02011	4.003	3.888	3.683	4.034	3.920	3.703	99.23	99.17	99.46
Superheater	0.456	0.469	0.520	0.00534	0.00536	0.00518	3.963	3.956	3.881	3.968	3.962	3.886	99.87	99.86	99.87
Condenser	39.110	24.910	35.070	0.32640	0.20960	0.25110	7.139	8.880	8.392	7.465	9.090	8.643	95.63	97.69	97.09
Total:	**110.609**	**102.463**	**103.382**	**1.313**	**1.273**	**0.988**	**86.950**	**90.530**	**100.20**	**88.260**	**91.810**	**101.20**	**98.45**	**98.61**	**99.03**

The HP evaporator, LP turbine and condenser are observed to have the highest value of cost rate associated with exergy destruction $\dot{C}_D$, and the HP turbine and superheater having the lowest value. The components in Table 9 are being arranged in descending order of their $\dot{Z} + \dot{C}_D$ value. Results indicate that the HP evaporator and LP turbine have the highest values, this means that focus will be place on these components in terms of optimization and modification for component improvement and cost effectiveness. The high value for exergoeconomic factor f observed, indicates that the capital investment costs $\dot{Z}$ for these components are larger than the contribution of the cost rate associated with exergy destruction in the $\dot{Z} + \dot{C}_D$ parameter. Therefore, to lower value of $\dot{Z} + \dot{C}_D$, effort to select components with low capital investment cost and operating and maintenance cost might be employed.

X. CONCLUSION

In the present study, the thermodynamic, exergoeconomic analysis and optimization is performed on the dual-pressure organic Rankine cycle (DORC) for the utilization of medium temperature geothermal source for power production. The main conclusions obtained from the model simulation, parametric analysis and optimization of the DORC are listed as follows:

- Two optimization cases were performed on the DORC with regards to maximum exergy efficiency optimized design (EEOD) and minimum product cost optimized design (MCOD). The MCOD case proved to be the best with respect to both units cost of power produced and net power produced, with product unit cost of 17.4% and 14.64% lower than base case and EEOD case, respectively, and a net power produced of 12.55% and 2.6% higher than the base case and EEOD, respectively.
- The LP turbine, HP turbine and HP evaporator have the highest value of $\dot{Z} + \dot{C}_D$ and from exergoeconomic viewpoint these components should receive more attention to achieve system improvement.
- The high values of the exergoeconomic factor, *f*, for these components indicate that the capital investment cost $\dot{Z}$ dominate the contribution of cost rate due to exergy destruction in the $\dot{Z} + \dot{C}_D$ parameter. Therefore, the use of cheaper components like HP evaporator, LP turbine and HP turbine will have remarkable improvement on the system cost effectiveness.

Appendix A: Equipment cost $(\dot{Z}_I)$ calculation

The equations for calculating the equipment purchase cost for the turbine, pumps and heat exchangers are expressed as follows [1][20]:

$$Z_{turb} = C_{P,turb}(F_{M,turb}F_{P,turb}) \quad (A.1)$$

$$Z_{pump} = C_{P,pump}(B_{1,pump} + B_{2,pump}F_{M,pump}F_{P,pump}) \quad (A.2)$$

$$Z_{HX} = C_{P,HX}(B_{1,HX} + B_{2,HX}F_{M,HX}F_{P,HX}) \quad (A.3)$$

Where C_P refers to component bare module cost and can be calculated as follows :

$$\log C_{P,x} = K_{1,x} + K_{2,x}\log Y + K_{3,x}(\log Y^2) \quad (A.4)$$

where Y in equation (A.4) indicates the capacity of the turbine and pump, or the area in the case of the heat exchanger. K_1, K_2 and K_3 are coefficients of equipment cost given in Table A.1. F_M is the material factor, and B_1 and B_2 are constants given in Table A.1. F_P is the pressure factor and can be obtained as follows:

$$\log F_{P,x} = C_{1,x} + C_{2,x}\log(10P - 1) + C_{3,x}(\log(10P - 1))^2 \quad (A.5)$$

C_1, C_2 and C_3 are constants given in Table A.1. The Marshall and Swift equipment cost indices [20] is utilized to convert equation A.1 – A.3 from reference year to present year (2021).

$$C^*_{2021} = C_{\text{original cost}} \frac{CI^{2021}_{M.S}}{CI^{\text{reference year}}_{M.S}} \quad (A.6)$$

The LMTD method have been adopted in the present study to calculate the heat exchange area. The heat transfer rate in heat exchanger can be expressed as [1]:

$$Q = U_k A_k \Delta T_{mean} \quad (A.7)$$

Where ΔT_{mean} is the logarithmic mean temperature difference between the working fluid and the coolant, and U_k is the overall heat transfer coefficient given in Table A2.

Table A1. Equipment cost parameters [21].

X	Y	K_1	K_2	K_3	B_1	B_2	C_1	C_2	C_3	F_M
Turbine	$\dot{W}_{turb}(KW)$	2.2476	1.4965	-0.1618	0	1	0	0	0	3.4
Pump	$\dot{W}_{pump}(KW)$	3.3892	0.0536	0.1538	1.89	1.35	-0.3935	0.3957	-0.0023	1.6
Heat exchanger	$A_{HX}(m^2)$	4.3247	-0.3030	0.1634	1.63	1.66	0.03881	-0.1127	0.0818	1

Table A2. Approximate values of overall heat transfer coefficient from several heat exchangers.

Components	Overall heat transfer coefficient, U_k $\left(\frac{KW}{m^2K}\right)$
Evaporator	0.9
Condenser	1.1
Heat exchanger	1.0

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Green Synthesis, Characterization and Application of Zinc Oxide and Silver Oxide Nonparticipants

Nassima Khanfri, Ali Boucenna

***Abstract*—** As metallic nanoparticles are increasingly used in many economic sectors, there is interest in the biological and environmental safety of their production. The main methods of synthesizing nanoparticales are chemical and physical approaches that are often expensive and potentially harmful to the environment. The present study is devoted to the possibility of the synthesis of silver nanoparticales and zinc oxide from silver nitrate and zinc acetate using basilica plant extracts. The products obtained are characterized by various analysis techniques, such as UV/V, XRD, MEB-EDX, FTIR, and RAMAN. These analyzes confirm the crystalline nature of AgNps and ZnONps. These crystalline powders having effective biological activities regarding the antioxidant and antibacterial, which could be used in several biological applications.

***Keywords*—** green synthesis, bio-reduction, metals nan Oparticales, Plants extracts.

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Impact of Climate Change on Human Health and The Growing Threat of Climate Change in India

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Abstract -- Extreme weather could be a manifestation of global climate change. Climate change is one of the most important global environmental challenges of the present century. Climate change is projected to increase the threat to human health, particularly in lower-income countries. It will have implications on food production, water supply, air quality, coastal settlements and human health. As two-third of the Indian population depends directly on climate-sensitive sectors like agriculture, fisheries and forests, it is bound to have an adverse impact. The changing climate can affect the basic elements required for maintaining good health: clean air, potable water, adequate food and shelter. Recently, India reported an increase in the incidence of vector-borne diseases, a decrease in crop production, more frequent extreme weather events, which could be attributed to changing climate. Though India has contributed only 2 percent of the total carbon emissions from fossil fuel burning over the last 100 years, still it is likely to experience greater effects from the 'extreme weather' events. Heat-waves in Odisha in 1998 and in Andhra Pradesh in 2003 caused an estimated 2000 and 3000 deaths respectively. The Eastern Indian state of Odisha's capital Bhubaneswar has a record with an unusual mercurial rise in summer in the month of June 2005, as the highest temperature rose to 46.3 degree Celsius which was 10 degrees above normal. Climate change is projected to bring changing rainfall patterns, increased temperatures, evaporation, and salinization of water sources through rising sea levels. Over the years, water supplies stored in glaciers and snow cover are projected to decline. This will reduce water availability to populations supplied by meltwater from major mountain ranges. Addressing climate change will need promoting mitigation and adaptation strategies without hampering economic development, good scientific evidence and coordinated action by multiple stakeholders.

Introduction

Over the last 50 years, the global climate is changing as the Earth becomes warmer. Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. Human activities have released sufficient quantities of carbon dioxide and greenhouse gases to affect global climate. The Gases that trap heat in the atmosphere are called greenhouse gases. Many greenhouse gases occur naturally in the atmosphere, such as carbon dioxide, methane, water vapor, and nitrous oxide, while others are synthetic. Those that are man-made include the chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these gases have risen because of increased use of fossil fuels (such as coal, oil and natural gas).

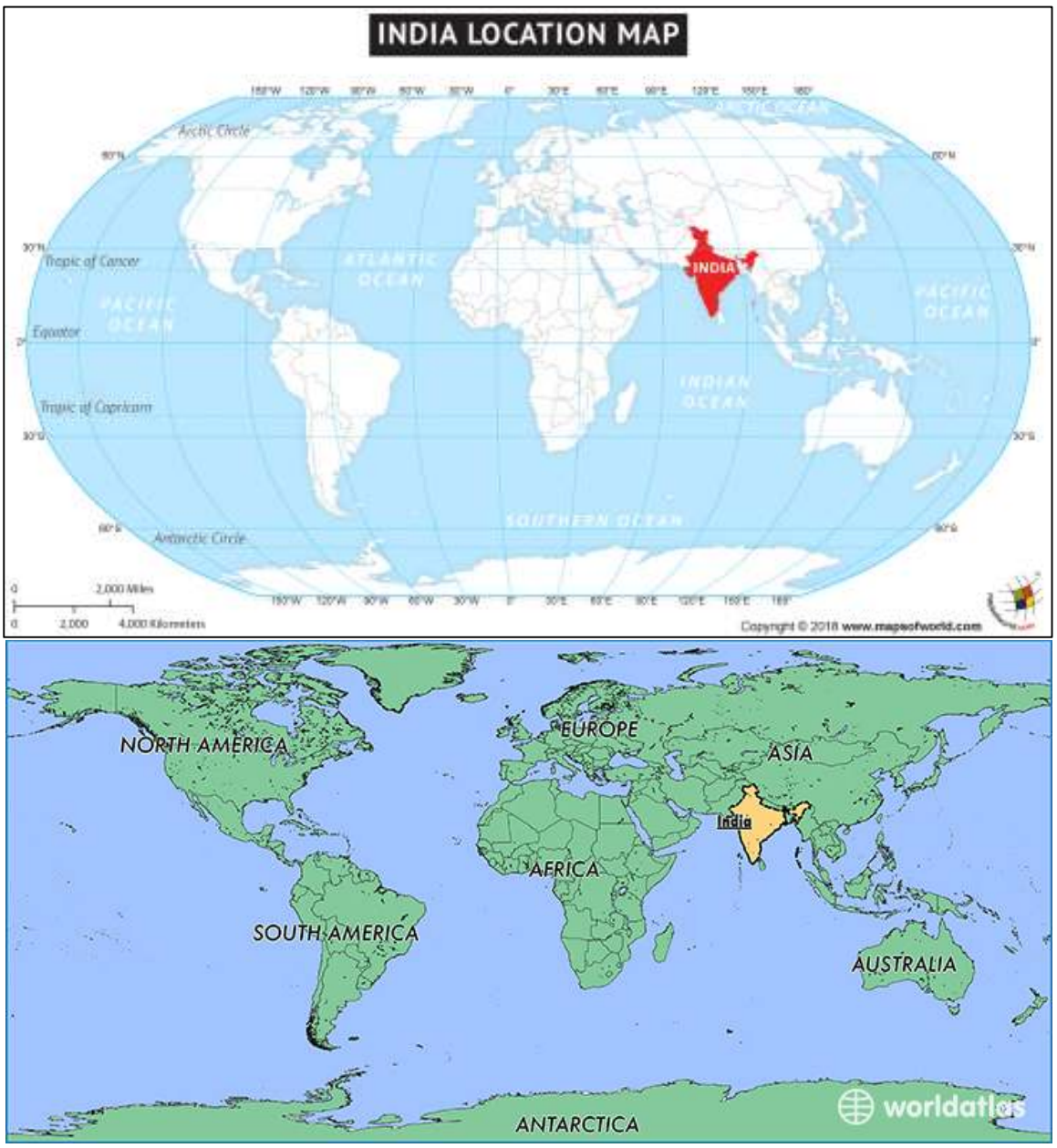
Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods". In the last 130 years, the world has warmed by approximately 0.85^{o}C. Each of the last 3 decades has been successively warmer than any preceding decade since 1850. There are significant impacts of climate change in the form of changing weather pattern, rising sea levels, melting of glaciers, forest fires, changing precipitation patterns and more extreme weather events, such as Kashmir floods (2014), Uttarakhand flash floods (2013), Tsunami (2004) are some vivid examples. Globally an estimated 12.6 million deaths are caused by avoidable environmental risk factors every year.

Study Area

India is positioned on the Indian subcontinent in south-central Asia, and is located in both the eastern and northern hemispheres. It is bordered by the Arabian Sea, Bay of Bengal, Gulf of Mannar, Indian Ocean, and the countries of Pakistan, China, Nepal, Bhutan, Bangladesh and Burma (Myanmar). India lies on the Indian Plate, the northern portion of the Indo-Australian Plate, whose continental crust forms the Indian subcontinent. The country is situated north of the equator between 8°04' to 37°06' north latitude and 68°07' to 97°25' east longitude.

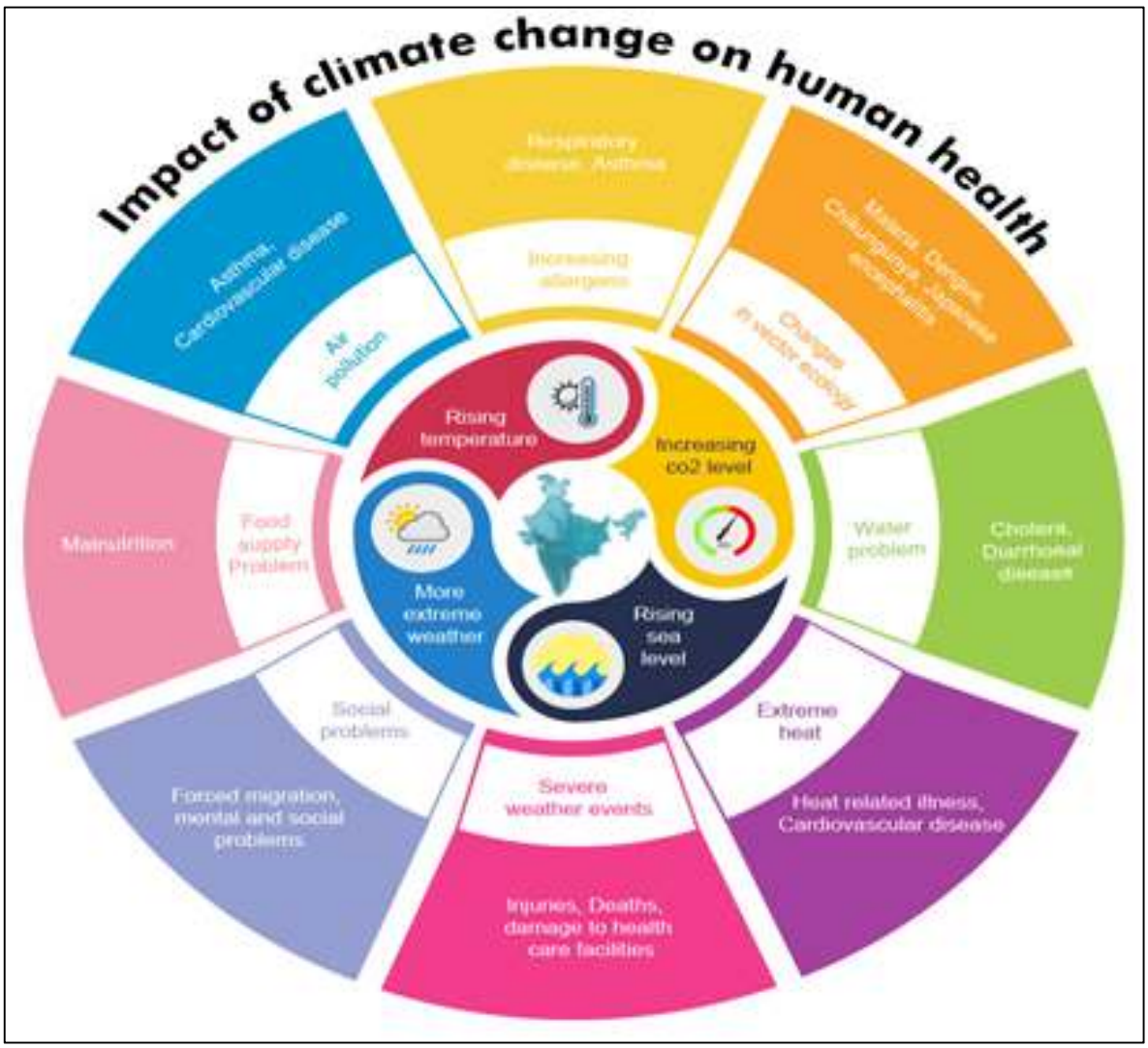
India has the 2nd largest urban system in the world, with 310 million people. Although presently the 5100 urban centers hold less than 30% of the total Indian population, this figure is expected to rise to 40% by 2030 in an estimated 70,000 urban settlements, as urban population is likely to grow by 575 million over the next 50 years. By 2025, 70 Indian cities are expected to have more than 1 million inhabitants.



Impact of Climate change on Human Health

All populations are affected by climate change, but certain regions and groups have higher susceptibility to climate-sensitive health impacts owing to their age (children and elderly), gender (particularly pregnant women), social marginalization (associated in some areas with indigenous populations, poverty or migration status), or pre-existing medical conditions or other health conditions like HIV. The socioeconomic impact of health problems caused by climate change are considerable.

People living in small island developing states (group of small island countries that tend to share similar sustainable development challenges) and other coastal regions, megacities, and mountainous and polar regions are more vulnerable to climate change. In developing countries with weak health infrastructure, damage due to climate change is more and they need assistance to prepare and respond.



Climate Change can affect Human Health in number of ways

Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter- for instance changing the severity and frequency of health problems already exiting in that area, creating unanticipated health problems in places where they have not previously occurred, disturbing food-producing ecosystem and increasing the frequency of extreme weather events. Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.

Water problems and increased risks of water borne diseases

Water borne diseases are sensitive to climate and also show seasonal variation. Diarrheal diseases are more common during rainy season. Increasingly variable rainfall patterns due to climate change are likely to affect the supply of fresh water. Globally, water scarcity already affects 4 out of 10 people. A lack of safe water can compromise hygiene and increases the risk of diarrhoeal diseases (which kills

approximately 2.2 million people every year), trachoma (an eye infection that can lead to blindness) and other illnesses.

People are forced to carry water from long distances and store supplies in their homes. House hold water storage can further increase the risk of contamination of water. In extreme cases, water scarcity leads to drought and famine. By the late 21st century, climate change is likely to increase the frequency and intensity of drought at regional and global scale.

Floods are also increasing in frequency and intensity. Floods contaminate freshwater supplies, and increase the risk of water-borne diseases. Both drought and floods are risk factor for water borne diseases (cholera, and various diarrhoeal diseases). When floodwaters become contaminated with animal waste, outbreaks of leptospirosis may occur. Outbreaks of rotavirus, cholera are also reported in past after floods. Lack of basic sanitation is also a contributory factor for increase in water borne diseases.

Changes in vector ecology and vector borne diseases

India is afflicted with six major vector borne diseases (VBDs) namely malaria, dengue, chikungunya, filariasis, Japanese encephalitis and leishmaniasis. A vector is any organism – such as fleas, ticks, or mosquitoes – that can transmit a pathogen, or infectious agent, from one host to another. Climate change enhances the transmission season and expands the geographical distribution of vector-borne diseases (like dengue, malaria), as warmer temperature and humidity favours the breeding of insect vectors and also alters the geographic distribution of existing vectors. Warmer average temperatures can mean longer warm seasons, earlier spring seasons, shorter and milder winters, and hotter summers, conditions might become more favourable for many carriers of vector-borne diseases. Malaria which is transmitted by Anopheles mosquitoes is strongly influenced by climate, collection of stagnant water provides breeding grounds for mosquitoes. These conditions are potentially aiding in the spread of malaria. The *Aedes* mosquito, vector of dengue and chikungunya fever is also highly sensitive to climate conditions, and studies suggest that climate change is likely to continue to increase exposure to dengue.

Climate change might also affect other vector borne diseases endemic to South Asia. These include parasitic diseases such as leishmaniasis, lymphatic filariasis and onchocerciasis, and tick-borne diseases and the effect is due to the impact of climate on the relevant vector populations. Climatic factors might also influence human plague, a bacterial disease carried by rodents and transmitted by fleas.

Effects of extreme temperatures

Climate change including heat waves, cold spells, and other extreme events will bring new and emerging health issues. Heat stress can make working conditions unfavaroubale and increase the risk of cardiovascular, respiratory and renal diseases and heat related illnesses. With 1.5°C warming, 350 million more people could be exposed to deadly heat stress by 2050.

Air pollution and increasing aeroallergen levels

Air pollution and increasing aeroallergen levels are also high in extreme heat that can trigger asthma and other respiratory diseases. Climate change may affect human health by increasing ground-level ozone and/or particulate matter air pollution. Ground-level ozone (a key component of smog) is associated with many health problems, including diminished lung function, increased hospital admissions and emergency department visits for asthma, and increases in premature deaths.

Fossil fuel combustion (for power, transportation and industry) responsible for climate change is also a major contributor to air pollution, which causes 7 million premature deaths worldwide every year. Black carbon, produced by inefficient combustion in sources such as cook stoves and diesel engines, is the second greatest contributor to global warming. Over 90% of the urban population of the world breathes air that exceeds WHO's (World Health Organization) guideline levels for outdoor air pollution. Flooded materials in homes, schools, and businesses can cause mold to grow and when inhaled, contributing to respiratory problems.

Food supply problems

Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions. This will increase the prevalence of malnutrition and undernutrition. These were highlighted as a concern for a number of developing countries in Africa, Asia and Latin America, with the impacts of climate change on food security, particularly in relation to floods and drought. The meat and dairy industries contribute to approximately 15% of greenhouse gas emissions and diets that are high in meat and dairy increase risks of cancer and cardiovascular disease.

Severe weather events

An increase in frequency of extreme events such as storms, floods, droughts, and cyclone directly affects the human health in terms of loss of life and injury (physical injuries and post-traumatic stress disorders) and affects indirectly through loss of houses; population displacement; contamination of water supplies; loss of food production; increased risk of epidemics of infectious diseases and damage to infrastructure for provision of health services.

Forced migration

It is estimated that 22.5 million people are displaced annually by climate or weather-related disasters, and these figures are expected to increase in the future. Climate-induced human mobility has a socioeconomic cost with mental and social problems to individual and community.

The human cost

Climate and weather have direct and indirect impacts on human life. The most disadvantaged, vulnerable and poor populations are expected to be disproportionately affected by climate change, with rising food and water insecurity, higher food prices, loss of income and livelihood opportunities, negative health effects, and population displacement (including forced migration).

Protecting health from climate change

Climate change is a global challenge that needs the action from all people. In late 2015, to address climate change, more than 190 countries approved Paris Agreement at the 21st session of the

Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris. In the agreement, all countries agreed to work to limit global temperature rise to well below 2 degrees Celsius and to make best efforts to keep it to 1.5 degrees Celsius, for the achievement of the Sustainable Development Goals. Meeting the goals of the Paris Agreement could save about a million lives a year worldwide by 2050 through reductions in air pollution alone.

In 2017 WHO launched a Special Initiative on Climate Change and Health in Small Island Developing States. While these countries contribute very little to causes of climate change, they are among the most vulnerable to climate change impacts.

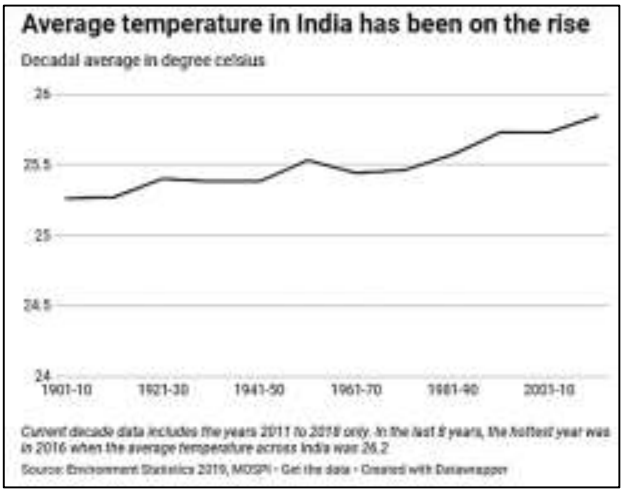
India laid strong foundations for greater global cooperation on climate action through its pledge for Paris Agreement. India has committed to cut its emission intensity of gross domestic product (GDP) by 33-35% of 2005 levels by 2030. Promotion of renewable energy by Indian government is a strong commitment towards climate change. There's a lot we can also do in our daily life to prevent climate change including use of climate friendly transportation, save energy, go solar, harvest rain water, reduce waste and promote urban green spaces.

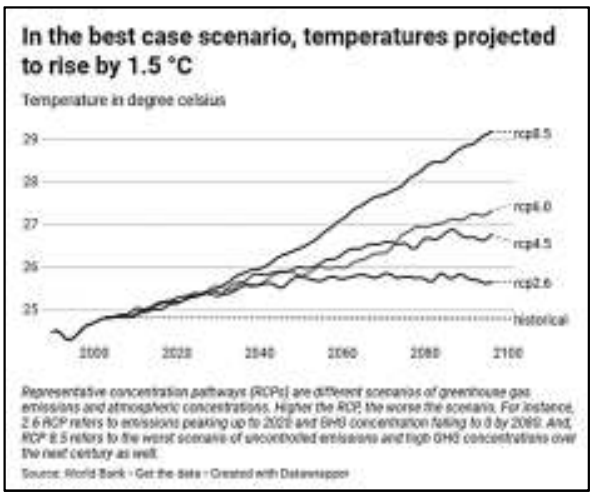
The Growing threat of climate change in India

Extreme events that have an immediate impact and long-term effect of rising temperatures are endangering lives and crippling economic activity. This summer in Chennai, locals were praying for some rain; in Mumbai, people were reeling under a deluge. Long ago, these extreme disparities may have been solely blamed on nature’s vagaries, but now science has established that human-induced climate change is playing a major role. Climate change, caused by emissions from industries and other human activity, is making the world warmer, disrupting rainfall patterns and increasing the frequency of extreme weather events. No country is immune to these forces, but India is particularly vulnerable.

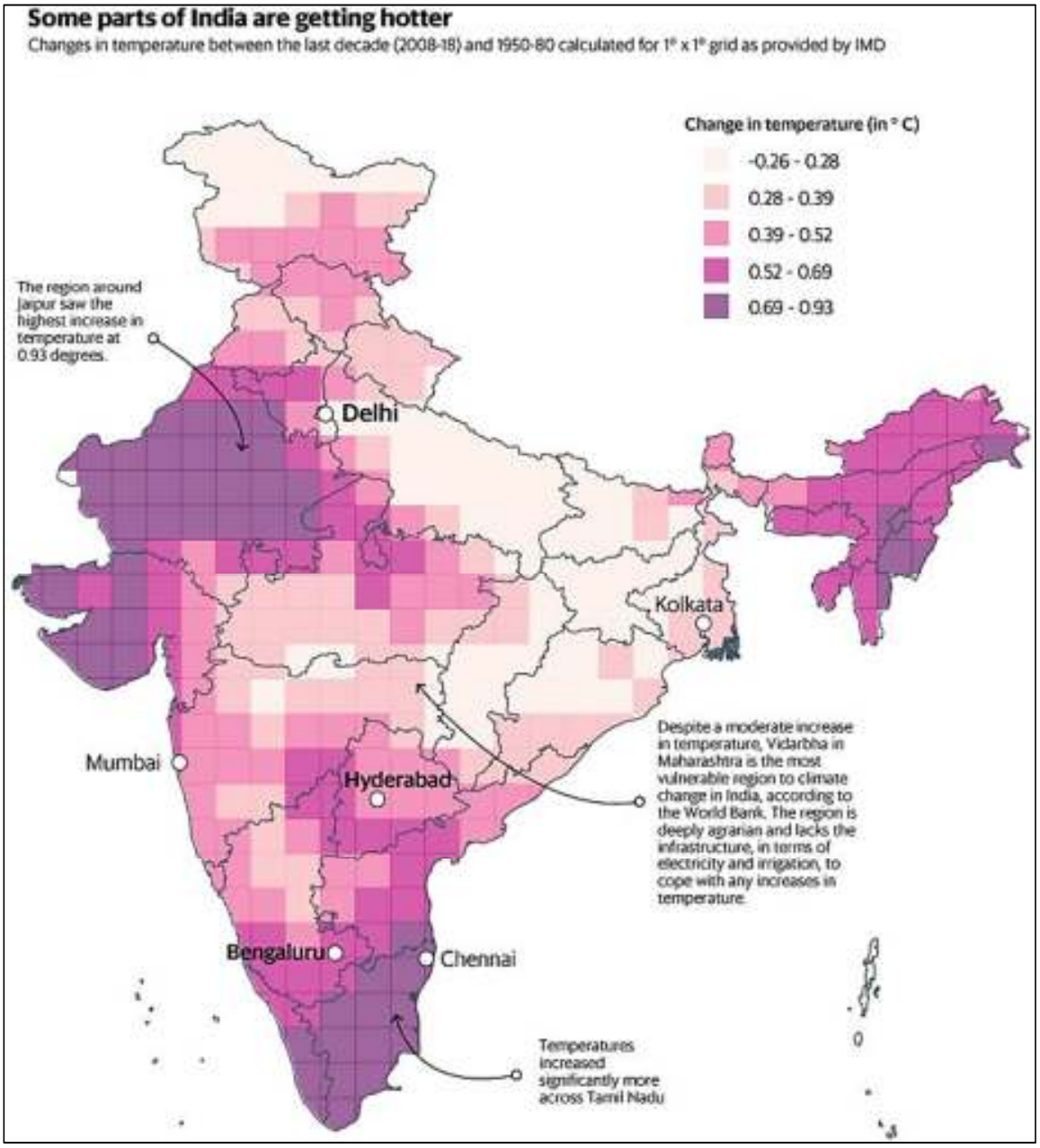
In 2018-19, as many as 2,400 Indians lost their lives to extreme weather events such as floods and cyclones, according to the environment ministry. The India Meteorological Department (IMD) says these events are increasing in both frequency and intensity Extreme events may be the most tangible and immediate impact of climate change, but another more long-term and equally dangerous effect is rising temperatures. In India, according to IMD data released by the statistics ministry, average temperatures have increased by 0.6 degrees Celsius (° C) between 1901-10 and 2009-18. At an annual level, this may seem trivial, but projections deeper into the future paint a more alarming picture. For instance, the World Bank estimates that, if climate change continues unhindered, then average temperatures in India could reach as high as 29.1° C by the end of the century (up from 25.1° C currently).

As climate change becomes more palpable, some parts of India will be more affected. Comparing the average temperature in 2009-18 to the that in 1950-80 reveals that some pockets have already become much hotter. In parts of Rajasthan, Gujarat, Tamil Nadu, Kerala and the North-East, average temperature over the last decade has risen by nearly 1° C compared to the historical average in the 1950-80 period.

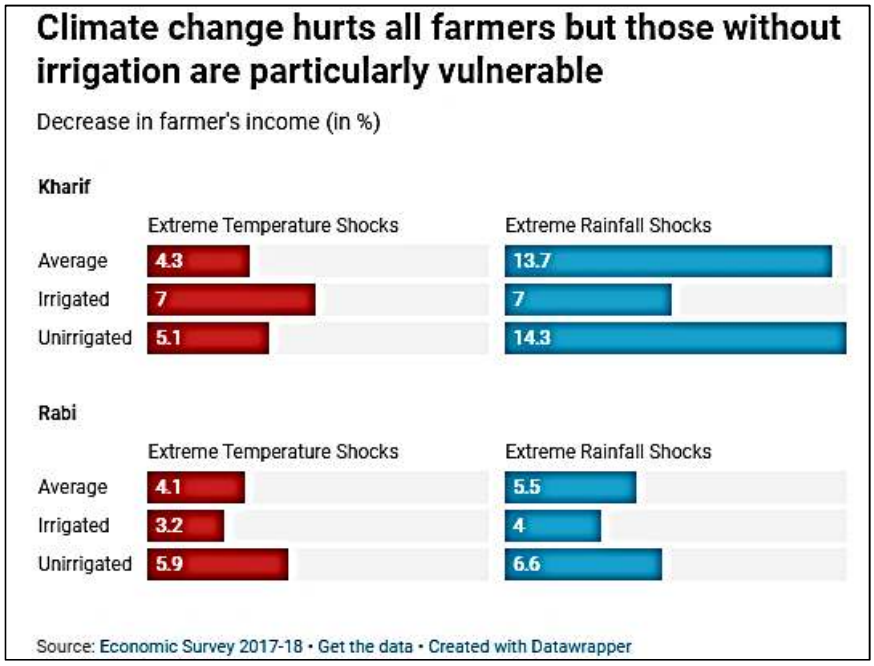




However, these areas won't necessarily be the most affected by the change in temperature. A region's vulnerability to temperature changes depends on several factors such as access to infrastructure (electricity, roads and water connections) and dependence on agriculture. According to the World Bank, central districts in India are the most vulnerable to climate change because they lack the infrastructure and are largely agrarian. Within this region, the districts in Maharasthra's Vidarbha region are particularly susceptible to climate change damage. These are also the districts that are already under severe rural distress, having experienced the greatest number of farmer suicides in recent years. In these districts, the World Bank suggests that GDP per capita could shrink by nearly 10% by 2050 because of climate change.

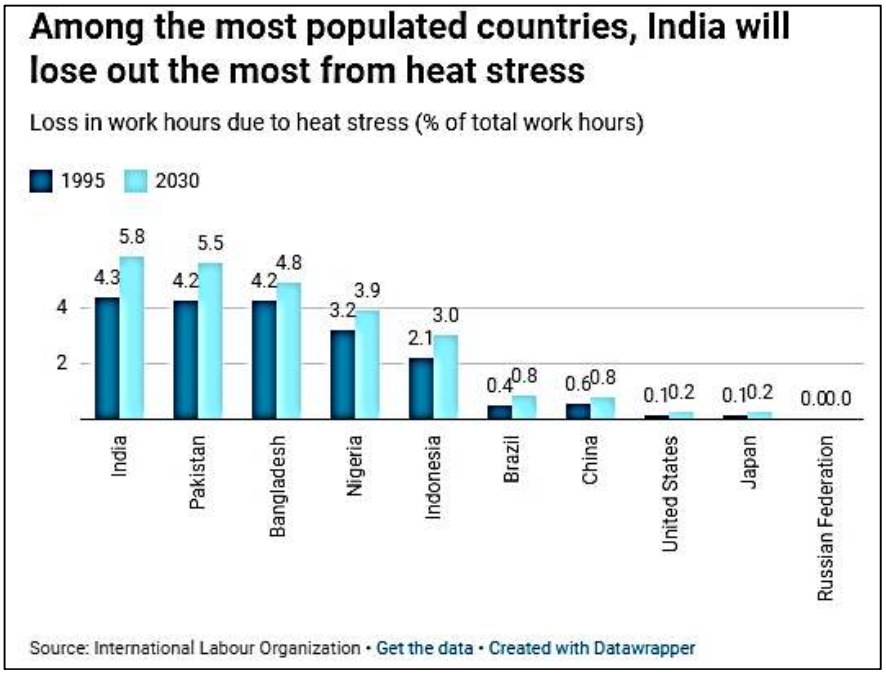


A primary channel for the fall in incomes comes from climate change's effects on farmers. The monsoon and suitable temperatures are critical inputs for farmers. Hotter weather and disrupted rainfall hurt crop yields and, consequently, their incomes. According to the 2017-18 Economic Survey, extreme temperatures and droughts (defined as temperatures or rainfall loss 40% greater than the median) shrink farmer incomes to the tune of 4-14% for key crops. Poorer farmers in regions with weaker infrastructure and less irrigation are most affected.



Farmers may be the most hurt by climate change, but other workers can be affected, too. In industries such as construction, high temperatures can make life miserable for workers and decrease their productivity. According to the International Labour Organization, the loss in productivity by 2030 because of heat stress could be the equivalent of India losing 34 million full-time jobs (up from 15 million in 1995)—the highest among the world's most populous nations.

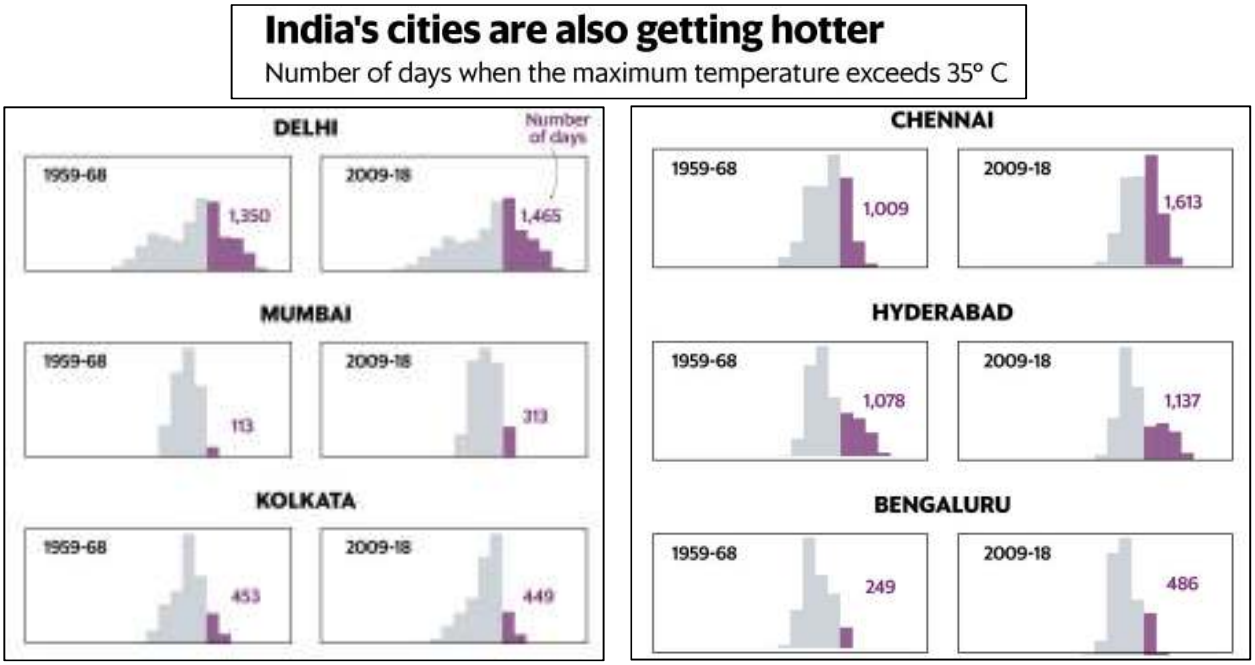
Rising temperatures, especially combined with humidity, can even be fatal. In his new book, Air: Pollution, Climate Change and India's Choice Between Policy and Pretense, Dean Spears suggests that a newborn exposed to a week of hot and humid environment is much less likely to survive compared to one faced with a less hostile condition.

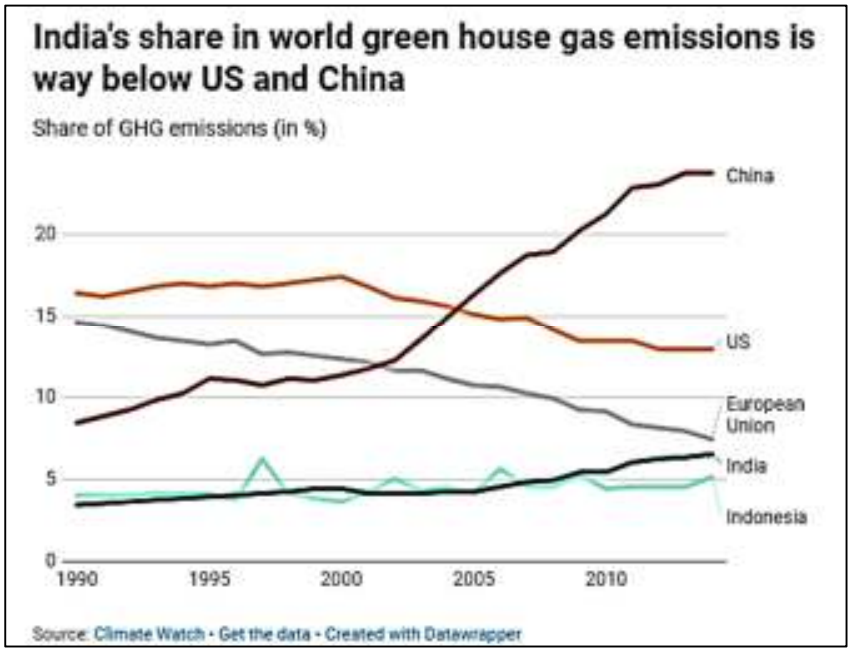


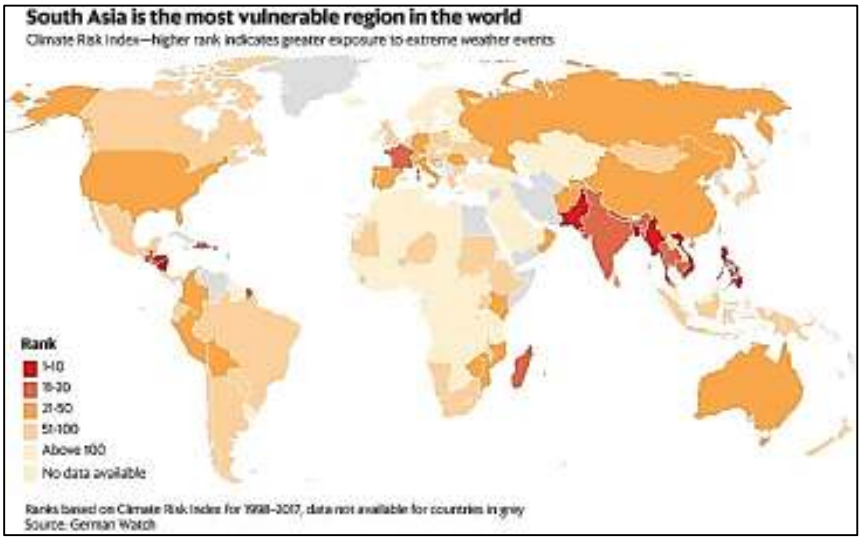
Climate change is also manifesting itself in the rise in extreme hot days (temperatures exceeding 35° C) across Indian cities. For instance, in Delhi, the number of days where temperatures have crossed 35° C has increased to 1,613 in this decade (2009-18) from 1,009 in 1959-68. Other major cities, such as Mumbai, Bengaluru and Hyderabad, have also seen similar increases. In cities, which are epicenters of economic activity, rising temperatures can increase the spread of diseases and hurt productivity. And, in coastal cities, climate change-induced rising sea levels also pose an additional threat through more frequent flooding.

Few countries are likely to suffer from climate change to this extent. According to the Global Climate Risk Index released by Germany-based think tank, German watch, India is the 14th most climate change-affected country in the world. This vulnerability, though, is not India's own doing. In terms of global greenhouse gas emissions, India's share remains significantly lower than those of both the US and China. In many ways, India is paying for the excesses of the developed world.

While much of India's climate change crisis is a result of outside forces, there are domestic drivers as well. For instance, the country still overwhelmingly relies on coal for electricity, the emissions from which contribute significantly to climate change (68% of India's emissions come from generating energy). Not only does this add to climate change, it also aggravates another major environmental problem: Air pollution. Similarly, inefficient agricultural policy encourages excessive water use, which exacerbates any climate change-induced monsoon variations. Thus, climate change is inextricably linked with India's other environmental crises, which makes a case for a comprehensive plan to tackle it critical for our future.







Policy Implications

With close economic ties to natural resources and climate-sensitive sectors, India may face a major threat, and require serious adaptive capacity to combat climate change. With 27.5 per cent of the population still below the poverty line, reducing vulnerability to the impacts of climate change is essential. In response to the predicted changes in public health due to climate change, our policymakers need to work to strengthen the health care systems along with water and wastewater systems. Adaptation will require diverse strategies like inter-sectoral coordination which could include physical modification to the built environment and improved housing and building standards. In order to address some of the predicted changes as well as those are taking place in India in an effective manner, more emphasis is required on the following policies:

- Strengthening health systems and service delivery mechanisms.
- Provision of drinking water and sanitation facility to all.
- Provision of funding for low income communities with poor sheltering and high exposure/risk to heat and cold waves.
- Educating people about climate-related diseases.

Conclusion

Considering the increasing trend of impact of climate change on human health, adoption of mitigation measures like strengthening health systems and service delivery mechanisms through early monitoring, disease surveillance, vector and disease control, and health insurance to counter the same becomes imperative. Investment in research and development, health risk assessment studies, vulnerability mapping studies, establishment of baseline conditions, scenario modeling and adoption of clean development mechanisms, etc. are the need of the hour.

Positive co-benefits

Steps to reduce greenhouse gas (GHG) emissions can have more immediate positive health effects, such as promoting the safe use of public transportation and active movement (biking or walking as alternatives to using private vehicles) reduces carbon dioxide emissions and air pollution; and helps prevent diseases like diabetes, heart disease and cancer. We have a much better future in store for us if we act quickly and make significant changes in our lifestyle.

Some ways to save energy and reduce GHG emissions

- Replace old appliances with energy efficient models and light bulbs.
- Save electricity by turning them off completely when not in use, including your computer.
- Recycling paper, plastic, glass & aluminums keeps landfills from growing. **Reduce, reuse, and recycle waste.**
- Shop local. Supporting neighborhood businesses keeps people employed and helps prevent trucks from driving far distances.
- Green your surroundings.
- Bike, walk or take public transport. Save the car trips for when you've got a big group.
- Use renewal energy. If you have the option, install solar panels in your house.
- Use a refillable water bottle and coffee cup. Cut down on waste.
- Bring your own bag when you shop.
- Compost—composting food scraps can reduce climate impact while also recycling nutrients.

"Rising global temperature, record levels of greenhouse emissions, and increasing impacts of climate change require urgent and measurable action on the part of everyone."

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Structural-Geotechnical Effects of the Foundation of a Medium-Height Structure

V. Rodas, L. Almache

***Abstract*—**The interaction effects between the existing soil and the substructure of a 5-story building with an underground one, were evaluated in such a way that the structural-geotechnical concepts were validated through the method of impedance factors with a program based on the method of the finite elements. The continuous wall-type foundation had a constant thickness and followed inclined and orthogonal directions, while the ground had homogeneous and medium-type characteristics. The soil considered was type C according to the Ecuadorian Construction Standard (NEC) and the corresponding foundation comprised a depth of 4.00 meters and a basement wall thickness of 40 centimeters. This project is part of a mid-rise building in the city of Azogues (Ecuador). The hypotheses raised responded to the objectives in such a way that the model implemented with springs had a variation with respect to the embedded base, obtaining conservative results.

***Keywords*—**Interaction, soil, substructure, springs, effects, modeling, embedment.

I. Introduction

THE structural analysis of the foundation of a structure has been carried out over time, in such a way that the stresses of this study are those that reach the embedded supports for the foundation, without considering the geotechnical-geophysical effect; that, as generally known, this involves a transfer of loads and displacements to the different strata of the present soil [1]. The general disposition of this analysis is to define, using the impedance functions methodology, proposed by the ASCE [2], some springs with displacements and rotations calculated over an optimal area to effectively distribute the areas of ground stress surrounding.

When it is necessary to select a foundation for a mid-rise building in a seismic risk zone, the engineer will choose a combined shoe to support the loads. However, it may be that they have a different behavior, depending on the project and the causes that affect it, as a result of the interaction of the soil with the substructure; since the geotechnical properties, the type of footing, the dynamic characteristics and the damping, have influence on its seismic response [3]. Subsequently, the foundation walls are also built with respect to the base of the structure, which are often used to resist the different lateral loads, imposed by the design earthquakes that are defined in the design. Precisely, this demand requires considering suitable non-linear factors to know and evaluate the behavior of the substructure, the interaction and the movements of the surrounding terrain [4].

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The great limitation of such analysis is the change in the internal stresses and their calculated variation, since generally the soil structure interaction is not considered. Therefore, a modeling is proposed such that the effects of the soil are added to those of the specific substructure by means of the aforementioned supports. These are defined as a set of changes in the response of the flexibility of the terrain, in which the hardness and movements present in it due to the structure are established, and which are presented in such a way that due to the variation of the period, the components and type of foundation; they conclude in other types of results [5].

A. Objective of the Study

The soil structure interaction effect is modeled in a building approved by the competent entity, using the method of impedance functions to establish the performance guidelines of the established foundation [6]. Likewise, the behavior of the stresses resulting from the foundation is evaluated against the ground in which it is located; by means of analysis of infinitesimal elements, to obtain the structural configuration patterns regarding the type of foundation and its affection according to the type of soil.

As a final point, the periods of vibration and drifts of floors are contrasted, by means of the replacement of the embedments by springs, to get to know the capacity of the substructure with regard to its primary characteristics.

B. Theoretical Basis

The soil substructure interaction (SSI) is solved in a practical way, incorporating the coefficients for the stiffness of the ground and its strata. The contributions of science regarding this issue are given for the consideration of the foundation and its adjacent or surrounding terrain. These consider bending and displacement vibrations. The different methodologies for calculating foundations also contribute greatly to the development of this type of study, about structural effects [7]. This SSI effect takes place, through dimensionless parametric analyzes that control gravity, one is the stiffness index of the soil and the other is the relation of the structure in its aspect, both of which are correlated. This effect considers a homogeneous elastic space using different models with the cone methodology in different soil circumstances [8].

The concept of interaction requires a modeling that allows to analyze the total structure, focusing on the combined footing type substructure, considering the soil in the range of linear and non-linear behavior [9].

The aforementioned analysis is based on the equations of

the elastoplastic deformations and the discretization of finite elements by the efforts and pressures produced on the surrounding soil, in which the constitutive laws are evaluated [10]. Due to these pressures and tensions, in a general way, carried out broadly, the structure itself is conceived in such a way that it has certain displacements due to the existing terrain; that is, the weight of the structure settled on it [11]. In this part it refers to the foundation since it is the party of interest in this analysis. After this paragraph is an outline to help understand it better: The stiffness matrices to be obtained from these efforts follow analytical solutions of the displacement of the Soil-Substructure Interaction problem and the modification of its dynamic response; mainly taking into account the effects of the entrance movement in the substructure and its generated vibration waves, demonstrating its effectiveness [12].

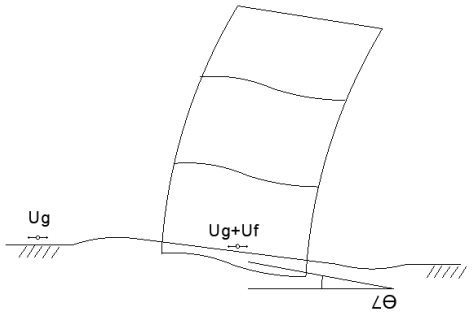

Fig. 1 Displacement scheme

II. Applied Methodology and Case Study

To present this research, there is a structure of medium height type, of 5 levels with one of them underground with a hybrid type construction, in the city of Azogues in the province of Cañar (Fig. 2). The presented system consists of the two major construction materials as a whole, such as reinforced concrete and A36 steel, taking note in particular that its foundation is a combination of continuous and isolated footing throughout its area.

The substructure covers an area of approximately 15 meters x 23.94 meters of land, with the effective width of the footings being 1.50 meters (Fig. 2). It consists of a foundation system that is chosen due to the complexity of the analysis as it is not an isolated footing in general, but rather ones that comprises a basement wall 4 meters below the ground; so, the analysis of its effects on the ground should provide interesting technical insights.

The methodology adopted in the present study is that of the substructure [13], since springs are proposed based on the footings, obtaining their respective stiffnesses to establish comparisons according to the type of soil and its shear modulus as a function of the pseudo-acceleration obtained by geophysical tests. This ISE analysis is based mainly on the modeling of the substructure with its adjacent terrain in a finite element program, which contains capabilities for structural science on par with geotechnics, through which several parameters of great interest are defined for the study [14].

The method of infinitesimal elements is based on the equivalence of rigid bases to bases with spring elements; in this case, it refers to the chosen foundation which is the one that represents this element. This statement corresponds to a virtual work for the subsequent resolution to the approximate way of equilibrium used in a discretized model of the foundation [15]. Similarly, the impedance functions for the comparison of results are of interest and fundamental for the aforementioned equivalence springs, those are the ones in Fig. 4.

A. Description of the Geophysical Test

For geology, a field trip was carried out where the disposition of the structural characteristics and geological units was verified, proceeding to their corroboration through geophysics (Seismic Refraction Lines). It is evidenced that the area is made up of a geological unit, the Azogues formation, whose behavior is rocky, exposing sandstones on its slopes. Susceptibility is moderate to low since it is a heterogeneous solid soil.

The interest of the wave velocity lies in the requirement of the Soil-Structure Interaction, as shown in Table I, generated by the National Earthquake Hazards Reduction Program (NEHRP), since by determining this parameter, Vs30 using the Multichannel analysis of surface waves (MASW methodology) [16] is based on the type of soil and the area are of interest, according to the local regulations.

The Multichannel Surface Wave Analysis (MASW) method evaluates the elastic condition of the soil for geotechnical engineering purposes using the dispersion of Rayleigh waves, which takes two thirds of the total seismic energy generated by the source, obtaining the profile of speeds of the shear waves, Vs [17].

Considering the succession of geophysical tests, the obtaining of the shear modulus G is corroborated, according to the table found in the regulations depending on the speed parameters and periods.

TABLE I
Classification of Soils According to the NEHRP

Soil Type	Soil Classification	Vs 30 (m/s)
A	Hard rock	> 1500
B	Rock	760 - 1500
C	Very dense soil or soft rock	360 - 760
D	Hard ground	180 - 360
E	Soft soil	< 180
F	Special soils that require site-specific evaluation	-

The typification of geophysical and geotechnical characteristics is obtained in terms of values of interest for later development of the impedance functions for springs.

Figs. 7 and 8 describe the curve that depicts the variation of the propagation speed of Rayleigh waves [18] (phase velocity) as a function of frequency (or wavelength).

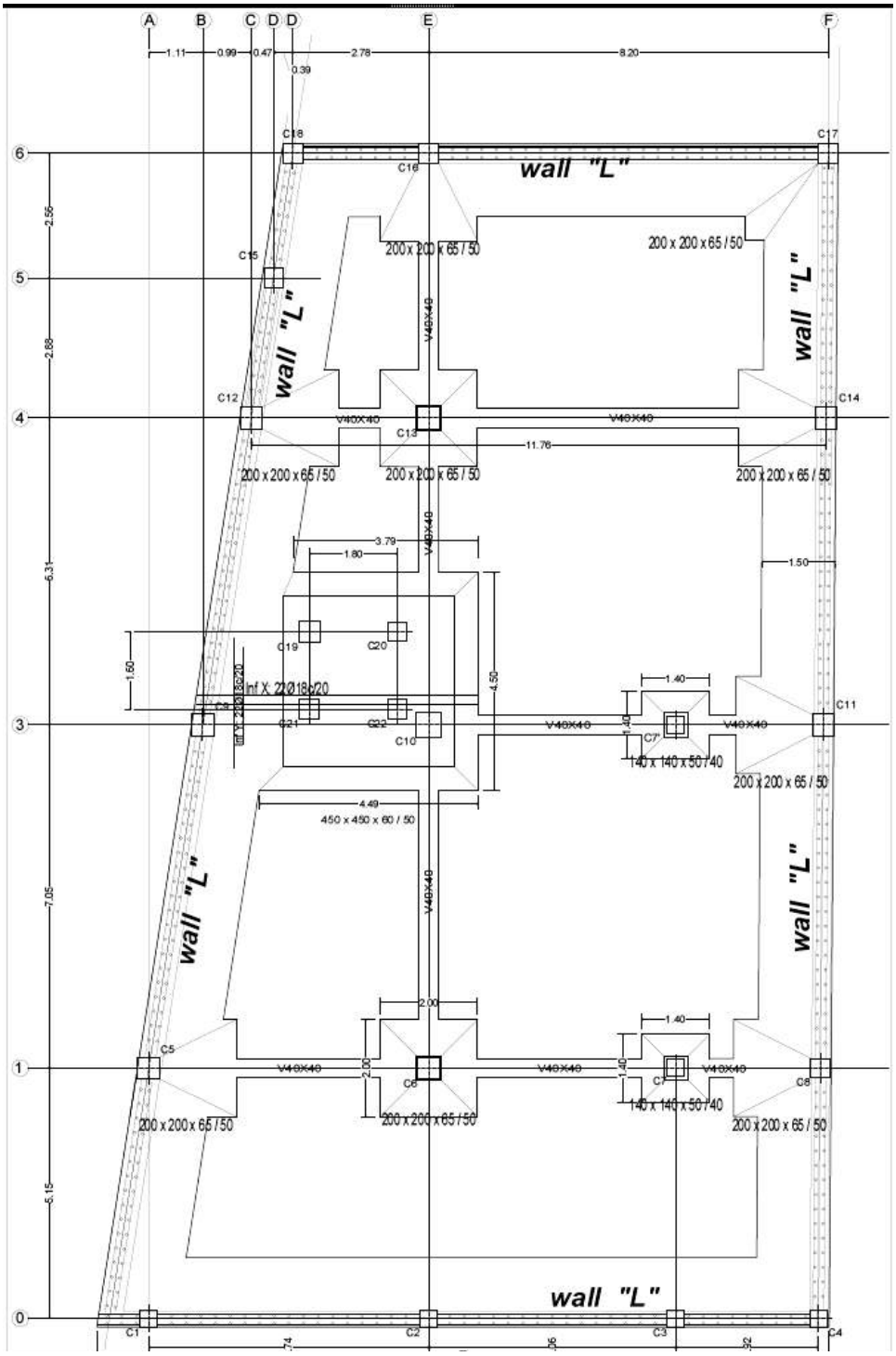

Fig. 2 Foundation plant

B. Method Development

The advanced method of impedance functions that involves the characteristics of the soil and existing basements is used, for which the structure is described in a structural analysis program [19].

Basically, to begin with, there is a foundation plant of approximately 15.00 meters x 23.94 meters with five floors and one underground as an addition, consisting of both isolated and continuous footings; which were modeled in a finite element program, as described in Fig. 9.

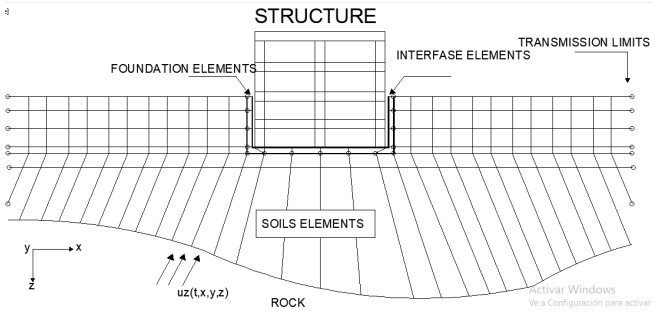

Fig. 3 Discretization method [15]

Structure characteristics: the columns are 300 mm x 300 mm x 10 millimeters and the beams according to plans are mostly made of A36 steel IPE, which vary from # 200 to # 450. The slab has a collaborating plate with a thickness of 25 centimeters and a concrete resistance f'c of 210 kg/cm^2.

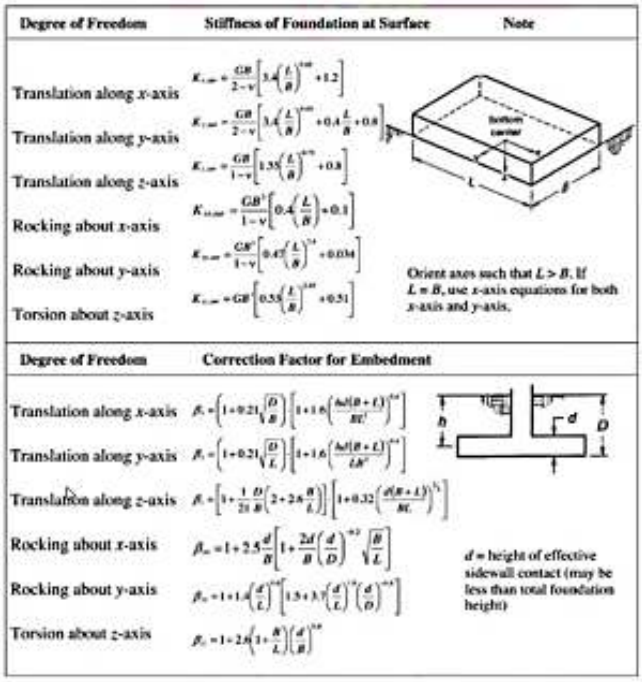

Fig. 4 Impedance functions

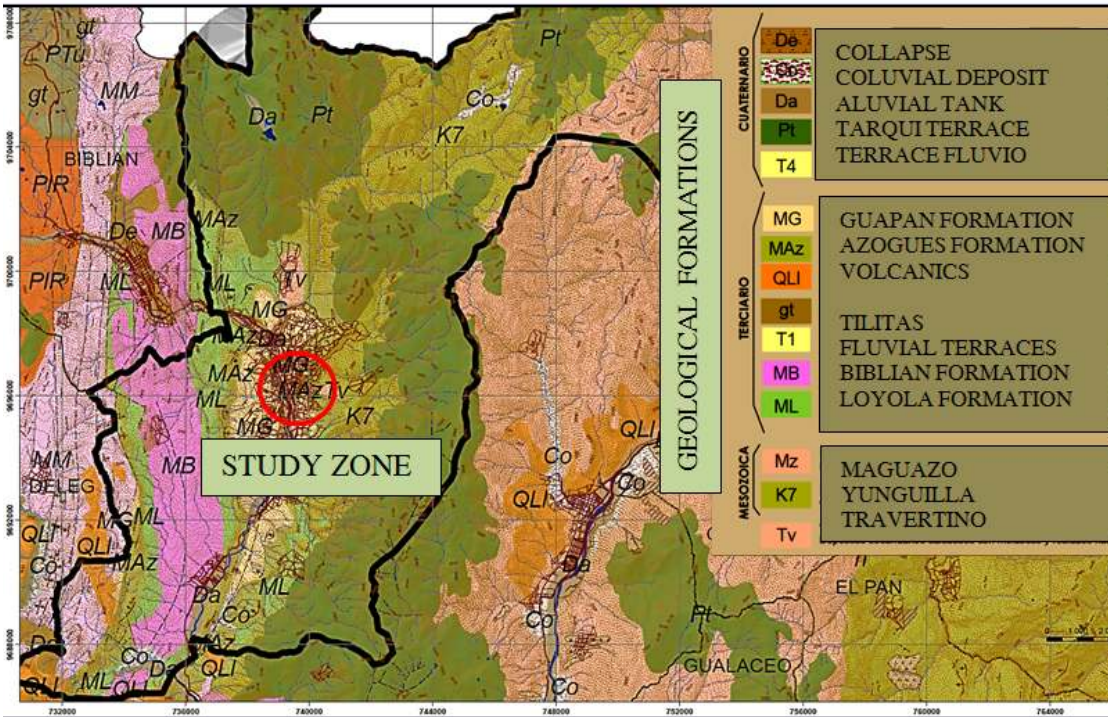

Fig. 5 Classification of soils according to NEHRP [16]

Model 1: Recessed Base

The structure is recessed as a structural modeling is normally carried out in accordance with the NEC [20], in which it is stated that the design spectra must have 85% of the basal stress, that is, they must have modal calibration for that requirement. As such, the vibration periods of the rigid base structure are presented in Fig. 9; in the same way, the drifts obtained are in Table IV.

Model 2: Spring Base

In the first place, the factors of the impedance functions are calculated, which are equations that allow the calculation of stiffnesses and damping in the main directions of the foundation, taking into account the underground foundation and the flexibility of the existing soil.

Site Class	Effective Peak Acceleration, $S_{XS}/2.5^a$			
	$S_{XS}/2.5$ =0	$S_{XS}/2.5$ =0.1	$S_{XS}/2.5$ =0.4	$S_{XS}/2.5$ =0.8
A	1.00	1.00	1.00	1.00
B	1.00	1.00	0.95	0.90
C	1.00	0.95	0.75	0.60
D	1.00	0.90	0.50	0.10
E	1.00	0.60	0.05	[b]
F	[b]	[b]	[b]	[b]

Fig. 6 Shear modulus as a function of effective acceleration

TABLE II A
FINAL CHARACTERISTIC VALUES: WAVE SPEEDS

Seismic line executed	Defined strata			Wave speeds	
	number of layers Spresent	stratum variation (m)	stratum power (H)	Vp (m/s)	Vs (m/s)
LS -1	1	0.0-4.5	4.5	878	510
	2	4.5-30	25.5	1018	620
LS -2	1	0.0-1.0	1	1288	788
	2	1.0-30	29	1560	930
LS -3	1	0.0-12	12	1080	660
	2	12.0-30	18	1145	700

TABLE II B
FINAL CHARACTERISTIC VALUES: CAPACITIES

Specific weight	Allowable capacity	Cutting module	Poisson's ratio	Young module
KN/^{3}	q (kg/cm^2)	G (KN/m^2)	v (-)	E (KN/m^2)
17.42	296.12	461843.62	0.25	1150352.15
18.08	448.27	708273.99	0.21	1707195.81
19.17	604.25	1213423.42	0.2	2914385.87
20.11	935.16	1773078.72	0.22	4341652.31
18.34	403.58	814563.19	0.2	1958161.75
18.61	434.34	929776.19	0.2	2234424.24

TABLE II C
FINAL CHARACTERISTIC VALUES: MODULES

Endometric module	Bulk module	Ballast module	Dominant period
Ec (KN/m^2)	kb (KN/m^2)	k (KN/m^3)	T (s)
348511.17	753019.96	1224031.38	0.16
562950.08	965107.46	1782225.69	
969653.9	1623942.75	3086952.44	0.12
1375331.29	2624869.92	4571710.37	
650045.5	1095060.16	2041436.14	0.1
742340.27	1247971.54	2329076.87	

Initial data: according to the geophysical study and the structural plan, we have the starting data in Fig. 11 for the calculation of stiffnesses.

The procedure for the values of the impedance factors in terms of stiffnesses and rotations is as follows:

- It begins with the calculation of stiffnesses and rotations, taking into account the units according to the geophysical study.
- Depending on the positioning of the shoes, a correction factor "ß" is calculated.

Fig. 7 Equipment used for the Seismic Refraction test

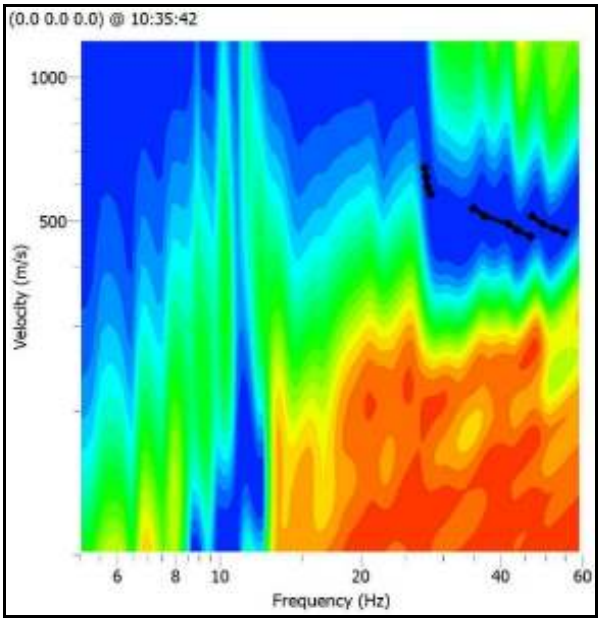

Fig. 8 LS dispersion curve - 1

TABLE III
MODAL PARTICIPATING RATIOS: RECESSED BASE

Case	No.	Period(s)
MODAL	1	0.793096
MODAL	2	0.713611
MODAL	3	0.568602
MODAL	4	0.227405
MODAL	5	0.225566
MODAL	6	0.223137
MODAL	7	0.222386
MODAL	8	0.221274
MODAL	9	0.220606
MODAL	10	0.220222
MODAL	11	0.203456
MODAL	12	0.188807

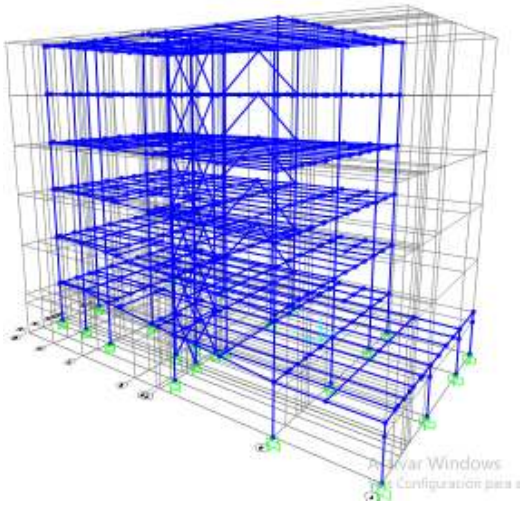

Fig. 9 Recessed base model

The dynamic stiffness components depend on the position of the shoe and also on the existing terrain data. One of the ways to calculate the aforementioned functions is presented, starting with the main "k" rigidities and their corrections. Once all these values have been obtained, the process occurs in each assigned support, by assigning springs with restrictions, depending on whether the footing is isolated or continuous, the initial input data varies, the table of values of one of the columns from the structure.

TABLE IV
DRIFT DUE TO PERMANENT LOAD: RECESSED BASE

UX	UY	UZ	PISO	Δ (m)	H (m)
0.0005	0.0004	0.0006	PO	0.0006	2.7
0.0005	0.0004	0.0006	P1	0.0005	3.24
0.0005	0.0004	0.0006	P2	0.0010	3.24
0.0005	0.0004	0.0006	P3	0.0014	3.06
0.0005	0.0004	0.0006	P4	0.0019	3.06
0.0005	0.0004	0.0006	P5	0.0021	3

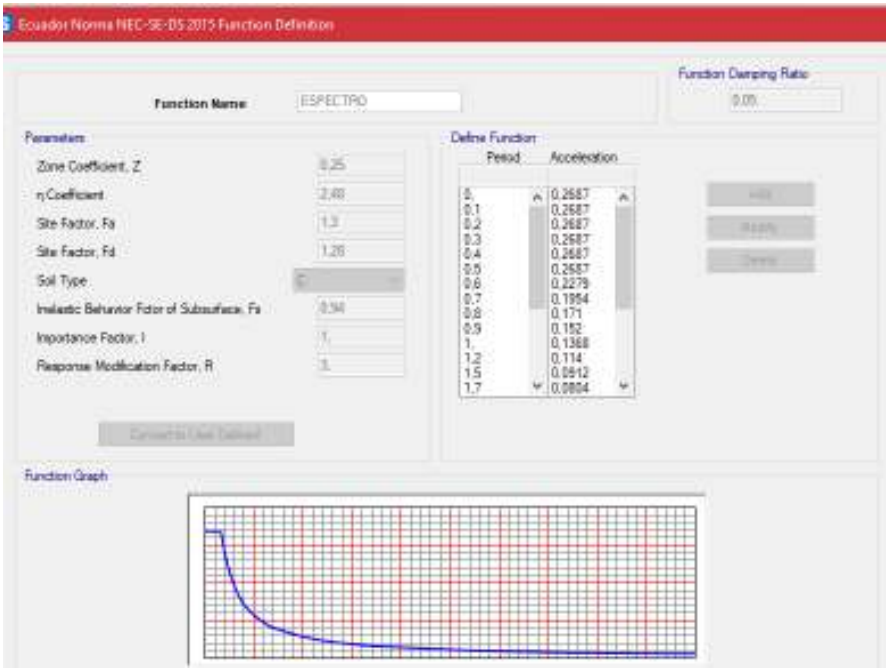

Fig. 10 Spectrum according to NEC

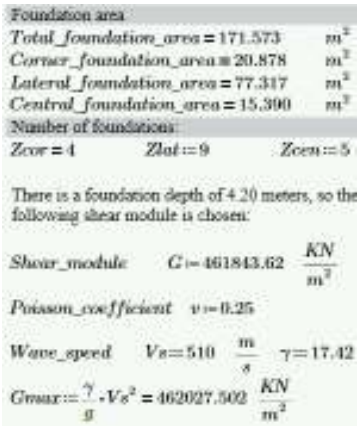

Fig. 11 Foundation area [19]

The model with springs obtained is shown in Fig. 13. Concerning the results in Fig. 13, in regard to the vibration periods, the Summary table, Table VI, is available. The drifts obtained are given in Tables V and VI.

III. COMPARISON BETWEEN A RIGID BASE AND BASE WITH SPRINGS

The characteristic parameter of a structural model is the period of vibration. In view of that, in this research work, the effects of the soil on the substructure or foundation are considered to contrast the performance guidelines in terms of their drifts and periods.

As a general indicator, it is known that the modes of participation of the structure are the three initial ones, since

the participation of the structure is found in those.

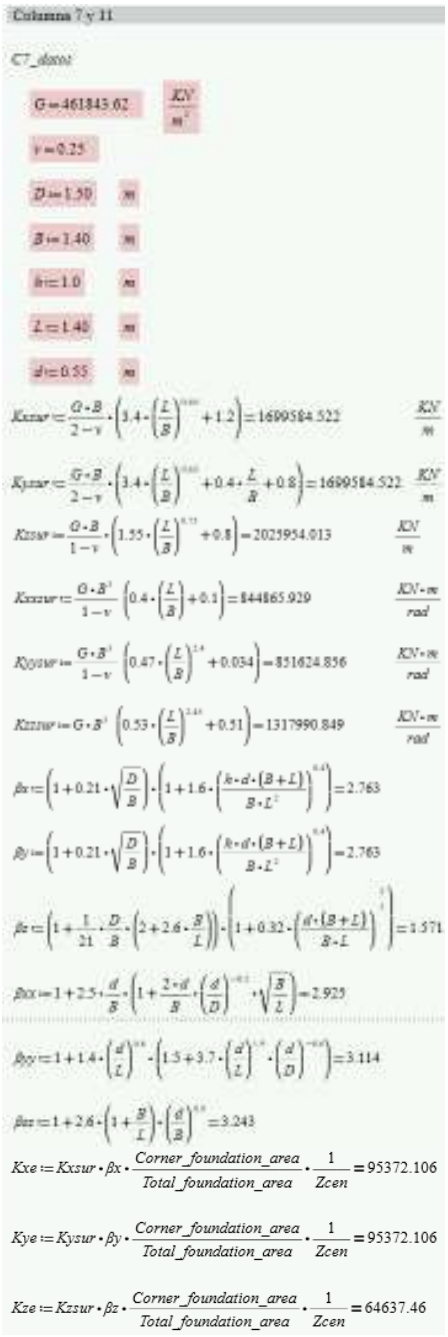

Fig. 12 Stiffnesses and rotations of interest - foundation [19]

When the base is rigid compared to that of springs, a significant difference is obtained in terms of modal share values, so structural and geotechnical effects should be included more often to the foundation.

The indicative of the period of vibration is a very important factor, and the resonance issue of a structure should be evaluated to reach 90% of its behavior [20].

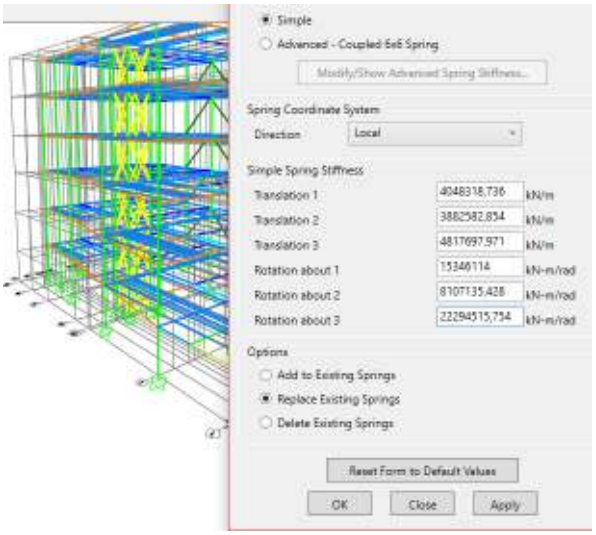

Fig. 13 Introduction of stiffnesses and rotations – foundation

TABLE V
MODAL PARTICIPATING RATIOS: MODEL WITH SPRINGS

Case	No.	Period(s)
MODAL	1	0,8735804
MODAL	2	0,7860325
MODAL	3	0,6311943
MODAL	4	0,2504898
MODAL	5	0,2483756
MODAL	6	0,2456399
MODAL	7	0,2446477
MODAL	8	0,2434421
MODAL	9	0,2426743
MODAL	10	0,2423674
MODAL	11	0,2239666
MODAL	12	0,2082817

TABLE VI
DRIFT DUE TO PERMANENT LOAD: MODEL WITH SPRINGS

UX	UY	UZ	PISO	Δ (m)	H (m)
0.0001	0.0001	0.0001	PO	0.0004	2.7
0.0003	0.0002	0.0001	P1	0.0006	3.24
0.0007	0.0003	0.0002	P2	0.0010	3.24
0.0011	0.0005	0.0002	P3	0.0014	3.06
0.0015	0.0008	0.0002	P4	0.0020	3.06
0.0020	0.0010	0.0002	P5	0.0022	3

TABLE VII
PERIOD COMPARISON

Mode	Embedment Base	Spring Base
First	0.793096	0.8735804
Second	0.713611	0.7860325
Third	0.568602	0.6311943

Regarding drifts, it must be verified according to current regulations in the country which specify that certain amounts are not exceeded according to the structure, in this case we take the value for metallic structure.

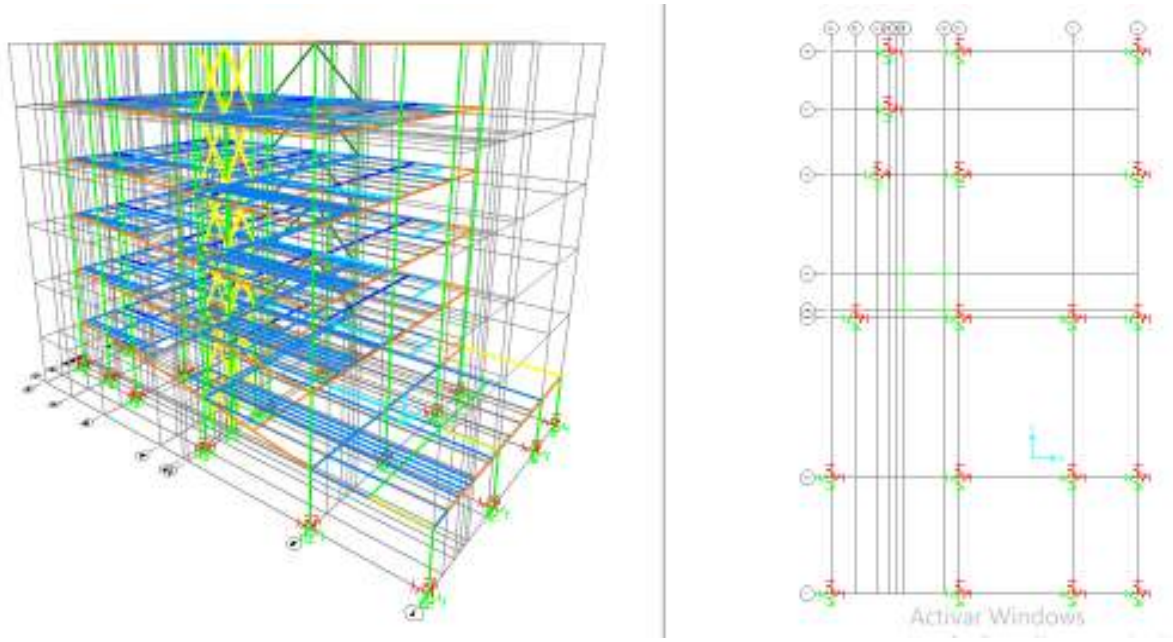

Fig. 14 Model with springs

TABLE VIII
PERMISSIBLE DRIFT ACCORDING TO NEC

Structures	Maximum Drift (-)
Concrete	0.02
Masonry	0.01

MAXIMUM INELASTIC DRIFT LIMIT = 0.75 * R * Δ
0.0022 * 0.75 * 3 = 0.004995

So, it is below the limit. By the same token, there are drifts obtained in both models.

TABLE IX
DRIFT COMPARISON

Model	Embedment Base	Spring Base
Maximum Drift (m)	0.00214	0.00220

It is observed that although the structure was approved by the competent entity, it does not effectively satisfy the vertical displacements of the normed Table IX, however, they are acceptable, but not conservative. The model with springs represents similar values, so the geotechnical effect in this sense was similar in terms of their vertical movements.

IV. CONCLUSIONS

To establish the shear modulus, Poisson's ratio and wave velocity geophysical tests were carried out in the field and also corroborated by the ASCE formulations.

A rigid base represented by embedments assumes that the terrain is not real, therefore it does not represent its different movements demonstrated in the seismic exploration lines. A more realistic result in the analysis of structural-geotechnical effects when modeling a structure is given with the basis in which springs are included through the impedance functions.

The impedance functions include dynamic parameters such as the shear modulus and wave velocity obtained from geophysical tests, which were verified mathematically with the formulations of interest. The wave velocity and its exploration lines were taken at depths of 30 meters according to the regulations; however, for the analysis, the Vs30 is taken at the depth of the study foundation.

When replacing an embedment with springs, different behaviors are obtained in the vibration modes parameters by approximately 8% when it comes to a mid-rise building.

It is concluded that, by not including the structural-geotechnical effect in an infrastructure modeling, several fundamental criteria are omitted that would generate chain errors in the constitutive design.

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Preparation of Papers - Paper Title Exceptionally Glauconite-Rich Strata from the Miocene Bejaoua Facies of Northern Tunisia: Origin, Composition, and Depositional Conditions

Abdelbasset Tounekti, Kamel Boukhalfa, Tathagata Roy Choudhury, Mohamed Soussi, Santanu Banerjee

***Abstract*—** The exceptionally glauconite-rich Miocene strata are superbly exposed throughout the front of the nappes zone of northern Tunisia. Each of the glauconitic fine-grained intervals coincide with the peak rise of third order sea-level cycles during the Burdigalian-Langhiantime. These deposits show coarsening- and thickening-upward glauconitic shale and sandstone, recording a shallowing upward progression across offshore-shoreface settings. Petrographic investigation reveals that the glauconite was originated from the alteration of fecal pellets, and lithoclast including feldspar, volcanic particle, and quartz and infillings with intraparticle pores. Mineralogical analysis of both randomly oriented and air-dried, ethylene-glycolate, and heated glauconite pellets show the low intensity of (002) reflection peaks, indicating high iron substitution for aluminum in octahedral sites. Geochemical characterization of the Miocene glauconite reveals a high K2O and variable Fe2O3 (total) content. A combination of layer lattice and divertissement theories explains the origin of glauconite. The formation of glauconite was facilitated by the abundant supply of Fe through contemporaneous volcanism in Algeria and surrounding areas, which accompanied the African-European plate convergence. Therefore, the occurrence of glauconite in the Miocene succession of Tunisia is influenced by the combination of eustacy and volcanism.

***Keywords*—** glauconite, autogenic, volcanism, geochemistry, chamosite, northern Tunisia, Miocene.

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The Role of People and Data in Complex Spatial-Related Long-Term Decisions: A Case Study of Capital Project Management Groups

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***Abstract*—**Significant long-term investment projects can involve complex decisions. These are often described as capital projects and the factors that contribute to their complexity include budgets, motivating reasons for investment, stakeholder involvement, interdependent projects, and the delivery phases required. The complexity of these projects often requires management groups to be established involving stakeholder representatives, these teams are inherently multidisciplinary. This study uses two university campus capital projects as case studies for this type of management group. Due to the interaction of projects with wider campus infrastructure and users, decisions are made at varying spatial granularity throughout the project lifespan. This spatial-related context brings complexity to the group decisions. Sensemaking is the process used to achieve group situational awareness of a complex situation, enabling the team to arrive at a consensus and make a decision. The purpose of this study is to understand the role of people and data in complex spatial related long-term decision and sensemaking processes. The paper aims to identify and present issues experienced in practical settings of these types of decision. A series of exploratory semi-structured interviews with members of the two projects elicit an understanding of their operation. From two stages of thematic analysis, inductive and deductive, emergent themes are identified around the group structure, the data usage, and the decision making within these groups. When data were made available to the group, there were commonly issues with perception of veracity and validity of the data presented; this impacted the ability of the group to reach consensus and therefore for decision to be made. Similarly, there were different responses to forecasted or modelled data, shaped by the experience and occupation of the individuals within the multidisciplinary management group. This paper provides an understanding of further support required for team sensemaking and decision making in complex capital projects. The paper also discusses the barriers found to effective decision making in this setting and suggests opportunities to develop decision support systems in this team strategic decision-making process. Recommendations are made for further research into the sensemaking and decision-making process of this complex spatial-related setting.

***Keywords*—** Decision making, decisions under uncertainty, real decisions, sensemaking, spatial, team decision making.

I. Introduction

CAPITAL projects are significant long-term investments and can involve complex decisions when combining factors such as: budgets, the reasons for investment, the range of stakeholders, interdependent projects, and the impacts of construction and the product [1], [2]. The complexity of these projects can be measured [3], [4]. For this study, the projects gain complexity from the interconnectedness of their components [2]. Complex strategic decision making often requires management groups to be established involving stakeholder representatives, these teams are inherently multidisciplinary with the expected advantage of an increased knowledge pool [5]. This study uses university campus capital projects as case studies for this type of management group. Project Management Groups (PMGs) are created at the university to deliver the project through to completion, and it is the representative members of two of these PMGs that the study will be conducting semi-structured interviews with. One of the buildings was an expansion to accommodate more collaborative academic work for a multiple-school research institute. The second building was a humanities-oriented teaching and student study space to meet a judged lack of space in the associated schools.

The university campus infrastructure and range of users means that decisions are made at differing levels of spatial granularity over a capital project. Spatial contexts introduce complexity to decision making in groups [6]. Combining this with the range of backgrounds and experience of team members, there is a need for clear focus and goal priority for projects as found with similar projects in the literature [7].

It is suggested in some research on success factors of project management that that the human factors are woven into management factors leading to decisions [8]. This paper explores the people as well as the data and decision making to try and understand how well the human dimensions are connected into the group operation.

Sensemaking is the process to understand complex situations, when carried out successfully it enables the team to arrive at a consensus and make a decision [9]. For a team, it can be the process through which they try to explain the situation and anticipate potential future states [10]. We treat sensemaking as the process of reaching situational awareness as a product, which provides understanding in complex or uncertain situations in order to make decisions. Previous research has used the sensemaking perspective as a way to study the decision-making process and the strategies employed during the process [11].

Of particular interest in understanding complex spatial-related long-term decisions and the sensemaking processes is the trust in data and decisions for collaborating groups [12]. Research has demonstrated that there is a role of the larger

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institutional setting on individual projects and it is also a resource in the team decision making [13]. In multidisciplinary team meetings there is an influence on discussions of the expertise of individual members during discussion, this can direct the mapping of roles and responsibilities of individuals in the team onto the decision making [14].

The paper aims to further identify and present problems experienced in practical settings of these types of team strategic decision making. The research offers a case study of opportunities to support factors such as coordination in projects and consensus reaching in team decision making [15], [16].

This study aims to understand the structure of the sensemaking and decision process for significant development projects on campuses, and the extent to which data are used to achieve this. In an effort to identify opportunities to intervene and support team sensemaking, the study investigates the following research question: "To what extent is data used in the group sensemaking and decision-making process for significant development projects?"

II. Method

A. Data Gathering Process

Participants were recruited from the PMGs of the two most recently completed buildings on the main university campus to take part in semi-structured interviews. The semi-structured format was appropriate for the limited number of participants accessible for the interviews and would provide reliable and comparable data [17]. This would enable interviews to follow a general guide of questions, while allowing for different paths that emerge from interviewees to be pursued in more depth. The goal of the interviews was to gain a qualitative understanding of the team members' experiences and views from the projects.

Six interviewees (3 from one project, 2 from the second project, and 1 who sat on both PMGs) represented a varied set of roles at the university including heads of school, directors within the university senior management, and capital project managers.

Interviews were held virtually using Microsoft Teams meetings, and followed broadly six areas of questioning:

- An introduction to the participant to understand their role at the university outside of the PMG, the extent of their experience with capital projects, what they understood their role in this team to be, and whom/what they saw themselves representing.
- Framing of the project that was being discussed by summarising the purpose of the build as they understood it, this meant the driver(s) for the build, the target users, and some of the impacts and needs considered during the project.
- The wider working processes of the group such as the meeting frequency and format, the nature of discussions and decision-making involved in the project.
- The extent of data use by the team during discussions and the decision-making process, any data generated by the group during the project, and the format of presentation for either of these types of data.
- Further detail on the working method of the group, how they collaborated, and tool use in discussions or presentations.
- A reflection on unforeseen challenges and their resolutions, desires from the participants if the project were repeated, and experience they carried forward to current/future projects.

Sample supporting documents were also sourced from the managing group of the PMGs, the university Estates Office, these included terms of reference, and meeting agendas and reports for both projects represented in the study. These would be combined with written notes and the transcriptions from interviews for analysis.

B. Data Treatment/Pre-Processing

Written notes were collated from interviews that managed references in interviews to extra material such as PMG reports and the terms of reference. Interview transcriptions were anonymised, and unrelated sections were removed such as disruption from the interview during the call. These were then exported to Nvivo as the data corpus for thematic analysis.

Thematic analysis was carried out following a reflexive approach [18]. The first stage was in vivo coding, this was driven by the theoretical interest in the areas explored by the interview questioning, and by the initial research questions on how PMGs operate and how they could be supported. A list of initial codes was generated by a series of read throughs of the interviews, familiarisation with the data, and emerging patterns were documented to begin developing themes for the second stage. The level of theme identification reflected the areas of questioning in the interviews, with overlap appearing in responses being grouped into themes such as the discussion of data available and in the reflection of participant desires. These preliminary codes and themes then became subthemes to three emergent main themes relevant to the research questions. A second stage of coding was then carried out, this time deductive coding using these emergent themes and subthemes from the inductive process. Allocating data to these defined themes generated a list of codes, and produced relevant data extracts that were able to be presented to demonstrate the emerging themes.

III. Extracted Themes

The three themes and the 12 subthemes generated by the analysis were:

People:

- Representation
- Future occupants
- Decision makers
- Subgroups and related group
- Gatekeepers and experts.

Data

- Data types
- Presentation and visualisation

- Data flow
- Trust/validity/veracity.

Decision

- Decision flow
- Granularity
- Tools.

Broadly these cover the makeup of the PMGs and their degree of multidisciplinarity, the extent of and opportunity for data use, and the nature of the discussion and decision making for these projects.

IV. Theme 1 - People

Theme 1 explores the makeup of the management groups, whom/what these people represent, who is attached to the group, and what the role of members are.

A. Representation

The university capital project management teams are designed to be representative of the stakeholders for the capital project, and so the groups are inherently multidisciplinary. The degree of representation is determined through the managing group of university PMGs, the Estates Office, and the Chair of the group. This method using the experience of the Estates Office should capture most stakeholders, particularly the target end users of the building, but there is potential to miss representation of more removed or indirect stakeholders, such as campus visitors.

Some team members have a firm understanding from their own perspective of why they are part of the group:

> "…it has my staff in it, and it's connected to one of our other buildings." and "…my role was definitely to represent the school…bring forth any particular issues, of which there are quite a few that relate specifically to [us]."

For one participant it was about what they were there to represent too:

> "I represent the students and the academics, and the university financially…I know how many academics need wheelchair space, I know how many have got childcare so have to work until 7 o'clock at night that sort of thing…So it's the data really, maybe I represent the data."

Many members identified what they believe was a primary reason for their membership of the team, commonly that related to their job title at the university, though they also saw themselves as fulfilling an additional role alongside this:

> "I was there for two reasons, one to provide continuity…the idea was that there'd be a permanent member of staff to support the [Student Union] officer view, and the officer view would be the view of students or would be the representation of students…My view was more of a critical, operational, you know how are we going to do this, what are the impacts of this going to be."

> "My involvement in the BDI project was twofold really, one was representing the IS (Information Services) infrastructure side of it, but also to look at okay that building came from having a really big ambition, and to make sure whatever that ambition was, it was translated into decision making around what was in the building."

B. Future Occupants

The most directly involved groups can be very clearly seen for a project, often driving the lists used to pulled together the management team members, these are the groups that all participants in the previous section identified themselves as representing. However, the concept of future occupants or users, and the expectations of involvement can be disjointed within team, or between the group and the stakeholders. One of the buildings was going to require a physical interface between the new build and an existing building. When considering the impact on those that would not be occupying the new build, participants often drew attention to awareness of how the building would fit into its place on the campus:

Neighbours of one of the new sites could also have had their deliveries impacted "…there's some big limitations now on turning circles of trucks, so it's limited the size of trucks that can get to certain parts of that bit of the campus. …what does that mean for people, does that mean they have to have more deliveries…"

A notable issue for both occupants and non-occupants was amenities. These buildings do not operate in isolation, they will either provide a service and will therefore draw non-occupants, or they do not and the end-users will need to seek out amenities and services elsewhere, usually in nearby buildings:

> "…there needed to be greater consideration around what are these people going to do to eat when you suddenly parachute another 300, 400 people in."

A particular issue highlighted in one of the projects was around cost implications for the new build and impacts for the future users. In one case the make-up of the future occupants and their activities could have large implications for VAT. For those not moving into that building there were cost implications for reconfiguring the old space that was being vacated to ensure it was suitable for them. Achieving this understanding of future occupancy and use can be difficult but significant in decision making:

> "…probably the biggest work in terms of the Project Management Group which then fed into the actual implementation group really is what the loading of people was going to look like, what the distribution was going to be between schools."

> "…that would generate income through obviously having undergraduates there, so that was clearly teaching but what they hadn't realised that was undergraduate research projects from other schools would also take place in the building."

C. Decision Makers

The flow of decision making and way the teams work is explored in more detail in Theme 3, but here the extent to which the group are the decision makers in the project is considered.

In some instances, the group clearly acts as the decision makers for the project, such as choosing the specification of the IT systems going into the buildings. As seen in the representation subtheme and in formation of the group membership, the managers of the team, the Estates Office, can act as the decision maker as opposed to the group. In discussing the decision on room sizes for one of the buildings, the Head of Estates at the time chose to increase the sizes to give some leeway for future class sizes.

There were several decisions highlighted that related to the running of the project, the building as a process, rather than the end product. The team was able to act with autonomy to shape this building process. For example, on choosing where to make space for contractors:

> "…there was an idea I had right at the very beginning which was to stick the builders into the underground car park because they were going to put lots of huts in front of the Boots building."

There were examples of decision influencers emerging in the group for topics that related to their role of representation or expertise, where the rest of the group may be non-experts and ratified a decision rather than making it. This will be explored further in the next subsection, but Information Services presented an instance that they took on a role of decision influencers:

> "…that was one of the important decisions because that had knock on impacts to the trunking, you know whether its optical fibre, copper, whatever these are kind of very technical things but the decisions that were being made about the research led to impacts on the building…"

PMG members could be upskilled though to be able to act as decision makers alongside the experts:

> "…[there is a] complexity of the university and the regulatory environment that we need to operate in, so I've learned a lot more about the sort of specific building regulations, environmental impacts statements and policies, and how that drives some very significant decision making."

In one of the projects, future occupants were made decision makers having had their choice narrowed by contractors and the management group. The stakeholders had more direct involvement but through a curated list of colour schemes and branding options for the new building.

D. Subgroups and Related Groups

As seen in the previous subtheme, there are instances when decisions can be made or influenced by a stakeholder rather than by the group. This stakeholder was often part of a subgroup associated with the main representative team and would take on roles including fact-finding/justification projects, or were part of the wider planning structure of the university. The capital projects operated within a network of management teams at the university, meaning the group operated within meeting cycles of major university committees. The subgroups had a degree of autonomy when feeding into the main project group:

> "The biggest work in terms of the project management group which then fed into the actual implementation group really is what the loading of people was going to look like."

Participants acknowledged that these related subgroups were often used for decision making and then feeding back into the central group for ratifying decisions and discussions throughout the project:

> "I think that particular decision was probably done offline."
>
> "I think that was done slightly outside of the PMG but it certainly was brought back to the PMG to be kind of discussed and noted."

This overlapping of subgroups can cause some participants to struggle to separate the roles and the activity, and the purpose of the management group:

> "What you found was there were a lot of meetings outside of meetings…certainly there were separate meetings about specific topics but all the big items were discussed in PMG."
>
> "I've got to be sure it definitely happened at PMG and didn't take place somewhere else."

In the instances that these offline decisions are made by subgroups it is unclear to what extent the team could then scrutinise the decisions in their role of ratifying them.

E. Gatekeepers and Experts

In their roles as representatives of a stakeholder group many of the participants were to an extent an expert in an area of discussion for the project. Some of the team members acted in the capacity of a gatekeeper to data or to access a user group. The group managers, the Estates Office, were one of two notable groups whose representative was a significant expert and gatekeeper for discussions. Sitting between the university, contractors, and consultants the Estates Office recognise themselves as the conduit, experts and gatekeepers:

> "…arguably we're the ones who have more knowledge across the whole project if you like."
>
> "…not an overseeing role but a sort of making sure the right information is getting at the right times to the group."

The other notable related group was the university finance committee:

> "All these PMGs have a representative from Finance…they'll basically say look you can't do that, or you won't be able to do that or this will need approval, that's their job."

Participants recognised that experts were also involved from future occupant groups for reasons such as understanding of health and safety zones. In some cases, the members recognised themselves as the experts or gatekeepers to help the team understand detail of how much teaching would take place in a building or space on campus, or evidencing the need for single occupancy offices:

> "I lead the team who build all the timetables for the university and who run all the exams for the university…I know and I can get the data for what areas

of campus are going to be busy with what sized groups."

F. Theme Summary

This theme highlights the varied makeup of the teams, multidisciplined representatives of many stakeholders in these two projects. The exact membership of this group is determined through appointment of a Chair by the university Estates Office and generation of a list of representatives by the Terms of Reference. This process generates only an initial list of stakeholders, and it is clear as projects develop and are modified the list changes as true stakeholders that were unaccounted for emerge. The interviews revealed a strong connectedness of campus user groups and interdependencies between the future occupants of new building projects and the extended list of other stakeholders. It was common for participants to describe how different groups would be interested in not just the new space that was coming but also the space being vacated, and the space vacated by those that take that space up, and so on. This created significant interdependencies when considering ramifications of decisions about the new space.

The collaborative setting demonstrates well the connectedness of a population in space and its use. There is a spatial relationship between these campus users, their buildings, and users beyond just occupants such as campus visitors and deliveries. They interact with each other either intentionally or not. This is highlighted and will be discussed in the decision flow subtheme, but the connectedness can be demonstrated by the amenity discussions. These buildings do not operate in isolation, they will either provide a service and will therefore draw non-occupants, or they do not and the occupants will need to seek out amenities and services elsewhere, usually in nearby building. Introducing a new building, rather than redeveloping an existing one, certainly increases the number of people that will be in that space on campus. This increase needs to be considered with the capacity of the local and wider campus area. This could be in terms of amenities, or related to travel such as parking options, bike spaces, and accessibility.

Needs for, and impacts on, future occupants and non-occupants should be covered through a combination of representation directly in the team, involvement in subgroups and related groups, and through experts in the group. The extent of offline decision-making or conversations described by participants suggests that this representation is not ideal, stemming potentially from the identification of stakeholders stage. These offline discussions can be concerning for the team, responsible for delivering a project they need to be able to scrutinise and understand decisions that have been made on their behalf or outside of the group. This could be most challenging in the case of indirect stakeholders, where a user group that's ultimately not going to use the building will be impacted by project decisions. An example is the space that is expected to be vacated as a result of the project and how that will be used. The end users of this vacated space have a keen interest in the decisions made about the new space because one influences the other. There was evidence of missing input from a future occupant group in one of the projects, a participant indicated no one seemed to have spoken to the performing arts group about their needs for one of the spaces being designed. This demonstrated an issue in the identification of stakeholders and the measures taken to gather their input on requirements for the project.

The roles assumed by team members are fluid during a project. The multidisciplinary nature of the groups means individual members change their role within the same project depending on the demands of the group. They can take on the role of expert in the area they represent or be a gatekeeper to data for use in discussions. They could be brought on as a future occupant, but then act as a representative for a related group of non-future occupants because of their role at the university. Members can be tasked with data/fact finding for discussion as a sensemaking step to the group decision making. These mixed perspectives offer a challenge in how individual members and the group can scrutinise decisions in their role of ratifying them, or in exploring data to arrive at a decision when they have the autonomy to make one. Through sensemaking using relevant data, members could be upskilled sufficiently to act as decision makers alongside those that were initially described as experts. For certain topics of discussion and decisions being made some members moved into a role as a decision influencer, trying to steer discussion of the group ultimately to a particular decision point. This behaviour was most often seen where the discussion was most closely linked to a role a team member initially identified in the interview as their purpose in the group.

This theme reveals in many respects that the PMG acts as a central hub for the stakeholders in a project, and can be a well-situated mechanism for discussing and deciding on aspects of capital projects at the university, bringing together stakeholder needs and perspectives in assessing decisions.

V. Theme 2 – Data

Theme 2 explores the extent to which data are currently used by PMGs during a project and opportunities for further use of data. It also looks at some characteristics of the data that are used such as ownership and the trust in the data, and how it is presented.

A. Data Types

Across the projects it was apparent that data are used in the discussions and decision process, many of the same types of data are used across different builds. The most prevalent types align with the role of the management group and the nature of the buildings that each group was tasked with.

All participants indicated the extent to which the future occupant data were used in their decision making. This is expected as they are tasked with a building project to meet a need for a set of people, and the quantity and makeup the occupants would influence the solution that meets that need. The source of these data and the granularity of it varied. For one of the buildings the need being met by the project was focussed on teaching space and capacities, this meant that a significant source of data used was the university timetable

data. This data source was able to provide indications of the current situation on the campus, detail on the people, and the spaces they would be using, and led to decisions such as class sizes needed:

> "…the data for what areas of campus are going to be busy with what sized groups, how popular, you know what size lecture theatres, what size seminar groups, how many how busy places are going to be, how many labs they've got that sort of thing."

> "…we had lots of data on space usage…Yeah its class sizes and things like the percentage of, what I did was the amount of classes that I had to send to other areas of campus…And the amount of time waste walking backwards and forwards."

The timetable and future occupant data brought with it a spatial component, demonstrating some of the ways that the team could consider the project as part of a wider picture of the university campus, or in one case the city-scale situation for the university. Mentioned by nearly all participants was the amount of car parking before and after the builds, including the detail of different type of parking space that would be available. Similar to the data above, the car parking was often discussed in a spatial nature, relating the spaces that would be available to nearby buildings and landmarks. Here there is indication of related meta data to car parking, the walking distance from target buildings. This was not explicitly captured but indicated a further spatial element to the data type that was considered by some team members.

In discussing cars both groups also covered flow of traffic in the nearby area of campus and the impact of the new building and the construction on that traffic. Traffic flow of pedestrians was also covered by all participants. This will be explored in sub-sections to follow, but data were not used explicitly in either of these scenarios where the team discuss potential impacts of the build or the post-completion effects. These present a clear opportunity for collection and use of data to show the current situation and augment discussion on impacts.

The combination of vehicle traffic, car parking, and pedestrian flow combined for one participant and their concern for modalities of transport and the impacts of the build. This example will be returned to in the subtheme of decision flow in the next theme, "…if that is well we're gonna reduce the amount of parking space but increase the headcount and people will just have to use other transport approaches." But they were not convinced that sufficient alternative modalities existed or at least were not supported properly for the number of people they were expecting to introduce to the area with the new build. On talking about pedestrian flow, two participants indicated a more abstract element to the pedestrian data and its spatial component, this was the idea of pleasantness of walkways and environmental data such as noise levels and greenery.

The building process itself also highlighted data usage: underground service plans, furnishing and equipment mapping, project cost and project time. Each of these projects is assigned a budget and has constantly updated costs for the build which each decision could impact. Equally each project has a schedule for delivery, and milestones, with impacts for each decision.

B. Presentation and Visualisation

This theme highlights the ways data are presented to the group for discussion, and may demonstrate how the data that are not collected or used could be incorporated.

The most common tool for sharing data with the group was written reports, circulated ahead of every meeting, these were used particularly for the operational data highlighted in the previous subsection (time and cost). With these reports came more detailed data relevant to the discussion and decisions for that scheduled meeting in an addendum of papers with the headlines pulled into the main report. This addendum often included papers put together by the members such as evidence for the use of single-occupancy offices or the timetabling situation for future occupants.

Maps and building plans were presented to the group to aid discussions and to highlight some of the data being used. The maps were mostly restricted to service plans and construction impacts, while the floorplans would be used to highlight detail throughout the building. Maps and floorplans did not mean many data were being presented to the team, participants described that pedestrian and traffic flow would be highlighted with a couple of arrows of different sizes.

In terms of tools to present any data in the meetings, the circulated report displayed on a screen was used along with PowerPoint presentations to guide discussion and decisions:

> "There were presentations, we used Teams, so there was a Teams so everything was accessible so to be honest people were there with their laptops or iPads or whatever they were going through the documents live, there would be reports, I mean just the typical presentation either a pdf or a PowerPoint."

> "We'd normally put the PMG report up on the screen as well in that room, just to make sure people could look at it and actually focus people onto particular elements."

C. Data Flow

Considering the data that were available to the teams, and the ways they were presented with it, this section looks at where the data that were used came from, such as instances of when team members would need to provide the data.

The university and project leads, the contractors and Estates Office, were owners of data related directly to construction such as building plans and underground services. The management group as a collective generated data that were used in their discussions, this was centred mainly on the future building occupants and use. Individual members of the PMG also acted as sources of data, tasked by the group or Chair to provide some data as evidence for use in decision making from their position as an expert or representing future occupants: "I was asked for some evidence…I provided how much teaching time would take place."

The meeting reports were often a main source of data flow into the group:

"…what you got was an update on progress, you got an update on the finances every, you got a risk assessment to go through, a key milestones, a standard I would say a standard project report which is basically updated the group on the decisions that had been made, the actions that had been taken and any decision that was requiring the groups input."

There was significant flow through the group as the team communicated outwardly to the stakeholders and to related university committees they operated within: "I can remember quite a lot of discussions about when meeting dates were and how it was important to get this data to that group."

D. Trust/Validity/Veracity

This section now asks to what extent members trust the data in their discussions, if they can scrutinise one of the pieces of evidence presented for a decision made.

After one participant acknowledged most data were fed into the group, it was not clear whether it was always accepted at face value or challenged. A different participant described how this attitude may have changed over time depending on the source of data:

"I think when I came in the faith in timetabling was quite low at the university…people didn't understand timetable data back then, people didn't want timetabling data back then, but now our data is in such a good state that we're actually using our data as a source of truth for things like campus solutions."

The range of accuracy of data available to the group was exhibited by two examples of specific technical data from the earlier and later construction phases on the same project:

"The university no longer has accurate plans of the services, underground services."

"…we were then able to have technical teams go through literally room by room workout where every single power socket would go, internet socket, every item of equipment was mapped out in place and so the level of detail was phenomenal."

There was a desire to be able to challenge presented data more, particularly where it had been used to justify a decision:

"I think what would be useful in all projects is to test the validity of assertions, particularly around space usage…there's a theoretical usage and an actual usage."

Though PMG members were able to acknowledge that the data were not always valid, there were mixed responses on how that was dealt with, and how the data could be questioned. The issue of the underground services data highlighted above was remedied through several ground surveys to provide accurate data. This time to remedy inaccurate data were not always available. Space usage and occupancy illustrate the interaction of provenance and veracity of data being used in the team decision making. This is a data type being used for evidence in decision making but participants disagreed on whether it is accurate data being used, and their levels of trust in the data used and the conclusions varied:

"…yeah I'm surprised that I've not been asked to review it…But I'm guessing that if the space utilisation technology that we put in is working correctly then I wouldn't need to, so maybe they're getting it from there."

"…the occupancy levels aren't great and what we installed in Teaching and Learning Building was a sort of infrared room checking device or whatever it is, apparently it doesn't work so well."

A contradiction for some participants was particularly apparent discussing the accuracy of their data and how much it could be trusted in sensemaking or as evidence for decisions. Combined with the occupancy technology above, one PMG member explained:

"I can get the data for what areas of campus are going to be busy with what sized groups, how popular, you know what size lecture theatres what size seminar groups, how many how busy places are going to be, how many labs they've got that sort of thing"

While two described how and why there is a lack of trust in that type of data used:

"…we did a quick and dirty usage analysis a couple of summers ago round that and we reckon that no more than 50% of the rooms that were being booked were actually being used."

"…of teaching bookings probably about 70% were being used and the meeting room bookings, about 50% were being used…Now that's a massive waste of space when I'm saying look at all these bookings we need new buildings."

People movement both inside and outside buildings was another type of data that most participants agreed had a degree of fuzziness to it, and therefore the questioned the validity of a diagram showing predicted flow:

"…if you try and get from say the security station that or the cut through to the Pharmacy building up the road towards Trent and so on, if you try and get from there down to the QMC bridge there are so many different ways you can walk."

"People don't understand that you're in a lecture theatre of 300 people and 300 people could go 300 different ways."

E. Theme Summary

This theme has shown that there is large range of data types that can be used by these management groups, and the availability to them albeit limited in some cases. There are staple data types that are common across these capital projects. For the operation of the group these include the timing of the meetings, related committee schedules, build progress and forecasts, and financial data for the build as both an isolated project and as part of the larger university structure and budget.

Future occupant groups and numbers, transport modalities and car parking people flow in and around these buildings featured in discussion from all participants, but with disagreements. It was not consistent across or within projects the extent to which data present was questioned, whether valid data were driving a discussion, and the extent to which they

trusted the data or the conclusions.

As a data type in decision making, future occupants featured heavily in exercises of group members to provide numbers. The final occupants are negotiated throughout the project and so it must be questioned how much these figures at each stage of the project can be relied on or how uncertainty can be managed. This highlights some issue in: the data gathering exercise; the scrutiny of the future occupant data claims when presented; and how well the delivery of the project aligns with the planned occupancy. Consideration needs to be put into how team members can build trust in an important sensemaking data source if their experience is preventing them from trusting it.

Both projects presented scenarios where there was a question about the trust in how or where the data had been generated, and the veracity of it for use in discussions. This trust could be influenced by metadata such as the provenance, commonly it was guided by the individual's experience at the university. Most of the data are not interactable for the group. The presentation method and flow of the data made it difficult for a member to interrogate the data or test any assumptions. For some of the participants this may have been acknowledging the fuzziness of the data type. There was a desire to be able to test assertions either with data or assertions being made of the data.

Timetabled occupancy data presented a case for expectation versus reality and the validity of data in sensemaking and data-driven decisions. One participant described how it is being used as a source of truth but there is disagreement between at least four participants as to if that is valid data. Historic room surveys demonstrated 30-50% error on room usage against what was booked. Participants also agreed that for example a timetabled room for 100 people often is not filled with 100 people, at least not for every session it is timetabled over a term or year. If there is this mixed level of trust in the veracity of some data, what is the impact on the team sensemaking, and on the decisions that are made?

Looking at the discussions around space usage, there was evidencing of requirements using two different sources, timetables or installed sensors, that differed. These conflicting multiple sources demonstrate an opportunity for use of metadata, namely around provenance in this case, to allow team members to establish data quality and negotiate the truth as part of their sensemaking discussion.

Cost presented two types of data that could interact. The forms of cost included in meetings covered both historic and predicted type data. This parallel of forecasted project costs/ budgets and eventual spend could reveal useful data by tracing with the project timeline to identify significant deviations from prediction to reality. This could then feed back into the project or into subsequent capital projects on the campus.

There is a clear opportunity for introduction of grounded traffic and pedestrian flow data, it connects into the modality of transport. These are not just projects on the inside a building, but the building in situ, embedded in its surroundings, the rest of campus and communities beyond such as commuting occupants and visitors.

VI. Theme 3 - Decision

The third theme investigates the PMGs as decision making units. This considers the nature of the decisions that are made by the group, those that are made for the group, the granularity of these decisions, and the tools used to aid decision making.

A. Decision Flow

The PMG as a body sits among subgroups and wider university governance, and as with data, there is a degree of flow of decisions into and out of the group. They are not the single decision-making body on a capital project, but have the capacity to make a number of decisions during the process. These projects are created within the Estates Office and with university senior management to address one or more issues. Work is done by groups external to the PMG before one is formed, with a problem identified and proposed solution pulled together by the capital project team within Estates Office and some other stakeholders:

> "We went through all the committees last year with a business case and presented it, and eventually we got to Estates and said right we're at a stage, we want to progress it further, we need a PMG convening."

Responses did demonstrate that the team had the capacity to make decisions and influence change in decisions that were made earlier in the project or before the group was assembled. This was often driven by presenting evidence compared to an original case put forward:

> "The lecture theatre was originally planned to be a size 120 interactive lecture theatre and we looked at interactive lecture theatres and thought they're brilliant however there is no need for a size 120 within the area."

Within meetings the Estates Office representative would often highlight the potential impact of decisions the team could make, both on the building program and the larger strategy at the university for its capital projects:

> "…there's a lot of attention to that part of it, the program and how, if we make this decision what impact is it going to have on the program."

As with the data involved with the discussions, many of the decisions had their flow dictated by other more permanent groups within the university governance structure. The team may make a decision, but it could need approval, and therefore evidencing.

In terms of how decisions were arrived at, the Chair of the group mostly led a discussion around the issue for contributions and questions from group members until there was sufficient agreement. The discussions would be a sensemaking exercise for the team to understand the issue being addressed and the solution(s) being assessed, then work towards consensus through presenting data and papers in the reports, and discussion in the room.

B. Granularity

There is a range of granularity of decisions that the group can make on what the building looks like, the feel of it, and how it would work fundamentally. Even if the decisions in isolation are specific, it was demonstrated that the group does

have to consider the project program and the broader strategy for the university, and the impacts of decisions on these. The decisions made at the most granular could cover exact space use and equipment both in and around the site:

> "…not just that so for example do you want tablet-top tables in your lectures theatres, for example do you want how many left hand and right hand ones do you need, because of how many students are left handed and how many students are right handed…And if a left handed student gets a right handed one will it compromise them or will they complain, you know those sorts of conversations you get into quite granular detail."

Stepping back from exact furnishings in rooms, the groups did determine the usage of the rooms and the way this would influence the users:

> "…so the discussions around that were about not just the physical layout of the building but how can we naturally make it easier for people to have those accidental conversations."

At the broader level, the big items as described by participants were decisions that had the biggest impacts on the project and the implications of those decisions:

> "The biggest issues we dealt with were things like the tax which was a big thing because that was a you know a million pound plus decision and the bridge had to be built very long between the two bits of CBS BDI, planning permission and things were complicated."

> "…shown certainly at some point early on how the general philosophy of the university's campus plan was consistent with what they were doing, so there's long term plans for that portion of the campus."

Most concerns regarding decisions being made by the group were focussed on the immediate surroundings of the building, the neighbouring buildings. Participants indicated that the group did not always achieve the right considerations across the levels of detail for decisions made, that could affect both future and non-future occupants, such as the environmental factors and the student experience of the building. Influencing the granularity of decisions was the frequency of meetings, on average once every 2-3 months. There were disagreements between members on recalling the frequency, and this may relate to the fuzziness of the groups and its subgroups and related committees.

C. Tool

This final subsection explores the extent to which tools are being used by the teams as part of the decision-making, and indications of desire to use tools to support their discussions and decision-making process.

Bringing forward the methods of data presentation, participants portrayed the reports and presentations as tools, both as sources of evidence for decisions and steering for discussions in that meeting. One participant highlighted their use of a vision document as a tool for the group to assist in the conversations about the space use in the project, it summarised what they understood the identified problem and project as the solution to be. Maps were used across both projects, both presenting to the group members, and in one project as part of the discussion on pedestrian flow in the area with decisions being made based on that.

It was apparent that some forms of data were used as a tool for the team decision making. These included the timing and financial data when considering impacts of decisions on remaining project schedule or budget, and often when covering issues on space occupancy:

> "That's a fundamental thing of any decision we make so we have to make sure that if we're say, if we say to the PMG you can have pink carpets, but it's going to add 3 months to the program they need to know about that before they make the decision…same for costs, if you want pink carpets it's gonna be half a million pounds extra."

Across all participants there was a clear desire for more data as a tool for decision making in the group:

> "What I would have liked was the ability to challenge, with data, saying okay well this building is intending to provide X number of rooms totalling this capacity, what's our evidence that we need this and that were not just inefficiently using our spaces at the moment."

One of the participants also stressed use of tools to better engage the stakeholders, communicating decisions made as well as making them:

> "This group had a website…there was lots of communications, so good communications, particularly in projects like this impact upon lots of different people."

One representative showed a desire for a more in-depth reflective post-occupancy evaluation as a tool, enabling predicted data used in one project to be validated and able to inform future projects using the same or similar data sources.

D. Theme Summary

This theme highlighted the variation in perceptions of the management groups in their purpose and operation, and a number of opportunities to support the groups in carrying out the decision-making task as part of a broader strategy.

There was inconsistency in the understanding of which decisions are made for the team and they operate to ratify, which they are able to make with a degree of autonomy, and which decisions they can make that will also need to be passed to subsequent groups for approval. For the decisions that were made outside of the team there was an appreciation for the role of subgroups, future occupants and experts being given more control over the process, but it was ambiguous for some members as to the role that left them with, or how the decision fitted with a strategy they may not be aware of. When carrying out the task of ratifying these premade decisions, the groups had in some cases challenged with evidenced arguments and altered the decision for the project, but would have liked to scrutinise more of them. This interdependency of operating groups within the university structure means that although a capital project may take a number of years to complete, there is a low degree of pressure put onto the decision making for the teams to maintain the pace for other committees or boards.

Some of the most granular decisions such as furnishings

were made with the most autonomy as a group, with use of financial and construction program data of the project to understand the ramifications for decisions. The largest decisions that were made by the group involved the most interaction with related groups and an extended series of approval. These showed a much broader consideration for the strategy of the university, the motivation for the project, and the building in relation to its locality on the campus.

Whether or not the group was operating as a decision-making body or in ratifying a decision made for them, it was clear that there is an opportunity for greater use of data as a tool to enhance the team sensemaking process, to understand fully the issue they are resolving and the decision they make. Through this data driven decision-making they could also enable better assessment of assertions, and approval or recommendations for change, and eventually communication of the decisions.

Whether the group was making a decision or ratifying one, they commonly had to start by undergoing a team sensemaking process to understand the situation and demands, to be able to appropriately act. This is continuous throughout the project as it develops. It is important that the team members know the problem(s) being solved by a capital project, as it forms a significant driver in decision making and is a frame for goal-oriented sensemaking. Given the length of these complex projects it would assist joining team members to have a common basic framing of the identified problem and initial proposed solution. The vision document described by one participant presents an interesting sensemaking tool as a shared review of the "current" situation.

Participants highlighted multiple times the desire to challenge decisions or assertions with data, as an example wanting a clearer view of the future occupants. This points back to the need for accurate data. In the cases of asserted and eventual occupants of one build, and on student timetabling or space monitoring technology, participants demonstrated a scepticism around some data sources. For different reasons, some participants did not think the data they were using was accurate, therefore they did not trust it and did not have full confidence in the decisions made using those sources. There is a challenge then to provide data as a tool to these groups to enable the team sensemaking and decision making while engendering trust in that data and subsequently the decisions. These meetings have some tools (tablets and laptops) already available that could be used differently. Currently used to follow reports and agendas, they could also have access to interactive data, exploring as a team but also individually to interrogate before making a decision.

The teams did not function through voting on decisions, instead moved discussions towards a shared consensus to make a decision. This suggests a greater degree of shared sensemaking required rather than the case of a group voting approval of decisions. In the voting scenario individual members could reach their own conclusions on seeing papers/ data presented, make their decision and cast a vote, while a Chair aiming for group consensus requires more explicitly shared understanding and discussion. This discursive process to reach consensus may also lend itself to being more iterative and encourage scrutiny of assumptions or assertions.

VII. Cross-Theme Summary

There was a theme across the participants of a discrepancy between the expected or reported and the reality, such as timetable data for generating requirements and surveys of booked room usage in existing meetings. With this difference in claimed or assumed needs and evidence or knowledge of a different reality there is a degree of trust lost in the data used and the decision made. These assertions can be, and in some cases were, questioned by individuals, and discussions followed around this with the experts and other PMG members.

The operation of the team seemed most smooth when the flow of decisions and members involved matched the granularity of the discussion, properly representing future occupants and considering the implications on the neighbouring area and the longer-term strategy.

The acceptance and interpretation of assertions and any information presented varied across experts and non-experts in the areas. Certain roles, if they were tasked with evidence gathering in a report or were respective experts on the topic, were the gatekeepers for different decisions and data. Each member had their own perspective of the role of the project that was shaped by their experience with other projects, their role outside of the group within the university, and their awareness of concurrent projects and wider strategies for the campus.

The discussions about future occupants for a building highlight a number of shared issues in the themes. Groups did not want to know the name of every researcher or student that would be moving into or using the building, though they wanted to know the future occupants to build for. Research groups fluctuate in size, occupancy levels for lectures and booked rooms were up to 50% wrong, and attendance at lectures is not the same as the timetabled capacity of a module. These future occupant numbers were incorporated into the collaborative sensemaking and decision making on room sizes, equipment, and impacts on the surrounding area with pedestrian flow, transport modalities and amenity needs. This highlights some issue in: the data gathering exercise; the scrutiny of the future occupant data claims when presented; and how well the delivery of the project aligns with the planned occupancy. Consideration needs to be put into how team members can build trust in an important sensemaking data source if their experience is preventing them from trusting it.

VIII. Conclusion

The capital projects explored in this study and their management groups offer significant opportunities for greater data usage in a team sensemaking and decision-making environment. This study also suggests similar benefit could be found exploring other capital project examples. With respect to the initial research question on their operation and the

extent to which data are used there were a few key findings.

In cases that data were made available to the group, there were commonly issues with what was available, issues of accuracy highlighted by future occupant lists changing throughout the project that were incorrect still at the point of staff and students moving into the building. In many cases there was a desire for data from participants to enable them to test assertions or decisions being made.

In most examples reported by the participants the data used in discussions and arriving at a decision were not interactable. The presentation and visualisation methods made it difficult to interrogate the data or test any assumptions, and this contributed to some ambiguity for members as to the purpose of the PMG and the decisions it was able to take during the project. Though some tools for interacting with data were available in meetings such as the tablets being used to follow the reports, consideration should be given for this interaction by individuals and the team impact the collaborative sensemaking process.

One of the projects demonstrated that ambiguity in data impacted the decision-making process, reducing the confidence or satisfaction in the final decision. This asks the question of how transparency with the fuzziness or the veracity of data can change the confidence in assertions from the data or decisions reached? There is potential from enabling deeper questioning of assumptions and data for individuals and the team to have increased satisfaction in decisions made.

Trust can be engendered in data sources used during the sensemaking process. From the examples of student occupancy and timetabling in the interviews, this trust could be engendered through provision of metadata, highlighting characteristics such as provenance, allowing the individuals to make assessments of the data quality. Future work could consider the impact on the confidence of individuals and the team making decisions and communicating them to stakeholders.

The spatial-related context offers an opportunity for richer presentation and visualisation methods for data, which could better support the sensemaking process and decision making for the team. In a multidisciplinary team setting, with varied expertise and perspectives of decision makers, more work is needed to understand how an increased accessibility to and interaction with data changes how people perceive the data as a tool for decision making. In addition, work needs to be done to recognise how awareness of different characteristics of data affect the perception of validity and veracity, and the trust in data for use in the discussions.

In settings such as the projects explore in this study, a team needs to achieve consensus with these multiple sources of data and perspectives. They need to be able to interact with the data, assess its quality and interrogate assertions, ultimately engendering trust in some of the data, reaching a shared sense of situational awareness, and making a decision. Some of the most granular decisions such as furnishings were made with the most autonomy as a group, with use of financial and construction program data of the project to understand the ramifications for decisions. The largest decisions that were made by the group involved the most interaction with related groups and an extended series of approval. These showed a much broader consideration for the strategy of the university, the motivation for the project, and the building in relation to its locality on the campus. For capital projects with institutional framing to the complex team decision making there is more work that can be done to understand the relationship between the granularity of decision and the decision process. This would direct the sensemaking support requirements for these such as data treatment and presentation.

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Moving Oman's Economy to Knowledge-Based Economy: A Study on the Role of SMEs from the Perspective of Experts

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***Abstract*—** The knowledge-based economy, as its name implies relies on knowledge, information and high levels of skills made available for all economic agents. Delving a bit more deeply, the concept of a knowledge-based economy is showcasing four main pillars, which are: Education and Training, Information and Communication Technology, Economic incentives and Institutional regimes, and Research and Development (R&D) and Innovation system. A good number of researches are showing its positive contribution to economic diversification underpinning sustainable development and growth. The present paper aimed at assessing the role of SMEs in moving Oman's economy from a traditional economy to a knowledge-based economy. To lay down a groundwork that should lead to future studies, the methodology selected is based on exploratory research. Hence, the interview was conducted as a data collection tool. Based on a purposive sampling technique, seven handpicked experts have partaken in the study as they are working in different key organizations considered to be directly or indirectly the backbone of the Omani national economy. A thematic approach is employed for the purpose of data analysis. Results of the study showed that SMEs are not really contributing in the knowledge-based economy due to a lack of awareness about its importance to the country and to the enterprise within SMEs in Oman. However, it was shown that SMEs owners are interested in innovation and are trying to support innovative individuals by attracting them to their enterprises. On the other hand, the results revealed that SMEs' performance in e-solution is still not up to the level as 32% of SMEs only are using e-solutions in their internal processes and procedures like accounting systems. It is recommended to SMEs owners to use new and modern technologies in marketing and customer relation, encourage creativity, research and development, and allow the youth to have opportunities and facilitate the procedure in terms of innovation so that their role in contributing to the knowledge-based economy could be improved.

***Keywords*—** knowledge-based economy, SMEs, ICT pillars, research and innovation.

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Sustainability in Maritime Transport: Impact of Cruise Ships' Routing in Coastal Navigation

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***Abstract*—** This paper makes a review of present researches on sustainable development and sustainable maritime transport, and presents the problem of sustainability in the cruise ships industry. It deals with cruise ships' routing in coastal navigation and its impact on sustainability from environmental, economic, and social aspects. A review of researches available on maritime sustainability brings to the attention how sustainability from a maritime transport perspective is still not enough, analysed and researched as it is the case in other industries. The paper emphasises how the operational part of the cruise industry, in particular cruise ships routing in coastal navigation, is not yet researched or analysed from the aspect of sustainability. The author, based on his extensive senior officer experience in the cruise industry, makes an overview of cruise ships routing practice. Accordingly, based on present cruise industry trends, challenges are highlighted from the aspect of sustainable cruise ships routing in coastal navigation.

***Keywords*—**Sustainable development, maritime transport, cruise shipping, cruise ship routes, costal navigation

I. INTRODUCTION

Sustainable development can be defined as development that serves present generations to progress without compromising future generation requirements for their own development [1].

The general criteria of sustainability include economic, social and environmental conditions.

Definitions of economic sustainability are various depending on the approach. One of relevant definitions says that economic sustainability is a combination of diverse strategies with a purpose of achieving optimal use of available resources in order to make valuable and necessary longer-term balance [2].

Environmental sustainability could be defined as a state of balance and the resilient link between human society actions and ecosystems. In that relation, human actions satisfy their needs without compromising the ability of the supporting ecosystem to continue to regenerate the qualities required to meet those needs nor by negatively impacting on biological diversity [3].

Social sustainability, despite its frequent use in academic literature and public discourse, does not have common definition. Generally, it can be defined as the ability of society, or any social system, to persistently achieve good social wellbeing. But it has been argued that the concept of social sustainability is neither an absolute nor a constant, rather it is a dynamic concept that changes over time and place [4]. Examining sustainable development (Morelli 2011) analyse economical, environmental and social criteria in order to detect does their values have equal importance in sustainable development, or some criteria have priority over the others [3].

Among all components of sustainability, the environmental component is not dependant on either the social or economic components, it is independent and can stand alone in a sustainable system. An example of that can be found in nature. Social and economic sustainability are both dependant on each other and the environmental component. A sustainable society would be impossible to imagine without a sustainable productive environment that provides the necessary resource. On the other hand, a sustainable economy is dependent on the sustainable flow of material, energy and environmental resources; without it, a sustainable economy would be impossible.

The relationship between the economic and environmental components is analysed by Michael Porter, a professor at Harvard University. According to him, the conflict between environmental protection and economic competitiveness is false. Porter states that strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it. Turning environmental concern into competitive advantage demands the establishment of regulations that stress pollution prevention rather than abatement or clean up [5].

II. SUSTAINABILITY IN MARITIME TRANSPORT

Sustainability in maritime transport has been studied and researched mostly through the environmental protection component. Many environmental researches are related to the economic and social component of sustainability in maritime transport, some of them are elaborated in this paper [6], [7], [8], [9], [10]. They analyse environmental conditions and their impact on the economic or social criteria of sustainability.

A. *Environmental Component*

Environmental influence on ports' sustainability is discussed in the 'Environmental protection and sustainable ports' conference paper [6]. It is concluded that the environmental impact on ports causes environmental and economic losses. In addition, the study states that social and environmental accomplishments, beside profit, are an important measure of success.

The negative effect of shipping businesses on the marine environment as well as protection of the marine environment against pollutants from shipping activities is discussed in '*The shipping and marine environment*' conference paper [7]. The paper elaborates all types of maritime shipping pollutant and states that impact of shipping on marine ecosystem depends of multiple environmental factors such as geography, hydrology, ecology etc.

Research on waste water pollution from cruise ships in the Adriatic Sea has been done in '*Evaluation model of sanitary wastewater pollution from cruise ships in the Adriatic Sea'* [8]. The research brings to the attention cruise ships problematic of sanitary water discharge in coastal waters.

The special issue of '*Sustainability challenges in maritime transport and logistic industry and it way ahead*' [9] collected and examined various themes in recent sustainability studies, particularly relating to shipping, port and maritime logistic. The research shows that majority of analysis on maritime sustainability are related to environmental component in particular to ships exhaust emissions and its impact on environmental, economic and social components of sustainability.

B. *Economic Component*

Economic aspects of maritime sustainability have been examined through maritime transport and logistic.

The research of multiple ships routing and speed optimisation problem under time, cost and environmental objectives (Wen, Pacino, Kontovas and Psaraftis, 2017) is focused on operational optimisation of merchant ships [10].

The economic component is also present in the review of researches that calculate costs and benefits of emission reduction measures, speed reduction programs for emission reduction and researches that seek equally efficient energy replacement with alternative fuels (Tae-Woo Lee, Kyoung Kwon, Xiao Ruan, 2019) [9].

Di Pillo, Fabiano, Lucidi and Roma, (2020) analyse cruise itinerary optimal scheduling where focus is put on determination of cruise schedules with the aim to maximise the revenue provided by a given ship placement in a specified maritime area and in a selected season window taking into account a number of constraints [11]. This research is focused on optimal distribution of cruise fleet and itineraries in order to maximise profit. The most effective and economically optimal cruise ship scheduling is discussed by Hersh and Landany (1989) [12].

Rodrigues and Notteboomb (2013) in cruise itineraries research conclude that cruise industry sells itineraries not destinations [13].

Factors which determine and develop cruise ship itineraries in the luxury market are analysed and addressed by Barron and Bartolome Greenwood (2006) [14].

Revision of the cruise shipping industry carried out in the study by Wang, Wang, Zhen, Qu (2016) agrees that research works conducted for cruise shipping are quite limited and do not provide optimisation-based quantitative analysis on some operation planning problems [15].

C. *Social Component*

The social aspect of sustainability is present in researches that analyse high cruise industry growth in both passenger numbers and cruise destinations. The downside of this growth is the negative impact on both the environment and society created by cruise ship tourism. The presence of large cruise ships in small local and traditional communities creates congestion and leaves an impact on the traditions and social behaviour of local residents (V. Asero, S. Skonieczny, 2018), [16]. The social component is analysed in researches of ships exhaust impact on cities and ports. This problem is predominately related to the cruise industry, since cruise ship terminals tend to be built close to cities (Tae-Woo Lee, Kyoung Kwon, Xiao Ruan, 2019) [9].

III. SUSTAINABILITY IN THE CRUISE SHIPPING INDUSTRY

There are not many researches and analyses available regarding the sustainability of the cruise ship industry. Available researches are focused on cruise ship itineraries and their efficiency and optimisation from an economic and environmental perspective. The operational part of the cruise industry such as cruise ships coastal navigation impact on navigational safety and environmental preservation have not been the subject of analysis. In the absence of available researches and written references, an overview of cruise ships navigation and routing sustainability is carried out referring to the author's extensive expertise and experience as a senior officer in the cruise industry.

General definitions of sustainable development can be applied to sustainable cruise shipping routes where economic, social and ecological criteria also apply.

Economic criteria guarantee permanent, steady, profitable, competitive and safe cruise routes that will be accepted by the cruise market. Implementation of criteria will have additional influence on the ports and destinations economic expansion.

Social criteria promise that the planning of cruise ships routes will meet the required safety standards in order to secure safety of the passengers and crew and provide social satisfaction to the community of coastal settlements. In addition to that, secondary effect of sustainable cruise routes from a social aspect is the economic growth of destinations and social prosperity of a region.

Environmental criteria assure that cruise ship routes must be planned according to all safety, navigational and environmental standards in order to avoid direct and indirect environmental impacts. Direct impacts refer to risks such as grounding, collision and oil spill. They are immediate environmental risks that as a result create instant ecological damage and leave severe consequence on the environment. Indirect impact refers to the environmental influences that do not have an immediate effect. The outcome accumulates with time and has a long-term effect on the environment, flora and fauna. These impacts are ships exhaust emissions, discharge of garbage, grey and black water and noise pollution. Considering the impacts the cruise ship industry have on maritime transport sustainability, safe cruise ship navigation

and routing in coastal navigation are important factors of sustainable shipping.

IV. Principles of Cruise Ships Routing and its Impact on Maritime Sustainability

A major part of the cruising industry is seasonal, which means that most of cruise ships follow the season and shift from one region to another in order to achieve optimal passenger occupancy and offer attractive itineraries to passengers. In order to satisfy passenger demand for exciting itineraries and memorable experience the great part of itinerary cruise ships spend in coastal navigation. They select the most attractive world destinations and navigate along the most attractive coastlines, many of which are environmentally preserved regions with rich biodiversity and high national importance. The usual cruise industry concept is that cruise ship operations are regional and itineraries are repetitive, usually in a circular pattern with limited duration offering every day a different port experience.

Operational demand for attractive cruises and passenger experiences defines cruise industry unique passage planning requirements. Cruise ship passage planning differs from the standard maritime passage planning approach. Standard maritime requirements in passage planning are defined by economic factors and demand to create a route that is the shortest, safe and navigationally doable in order to arrive sooner at an economic speed with optimal fuel consumption. The cruise industry approach is different. Passenger experience and attractive cruise itineraries that are defined by time of arrival and departure to destination take priority over economic factors of cruise ship routing. The operational demand to create competitive and interesting itineraries bring cruise ships in coastal navigation on routes that are often challenging and questionable form perspective of maritime and cruise routes sustainability.

The question of cruise route sustainability becomes important due to the fact that most of time cruise ship spend in coastal navigation. In addition to that, cruising industry records high passenger demand for cruising tourism which results to high demand for new cruise ships and trend where cruise ships are becoming bigger. The expansion of the cruise ship industry is related to the cruise ship market expansion and the development of new cruising destinations.

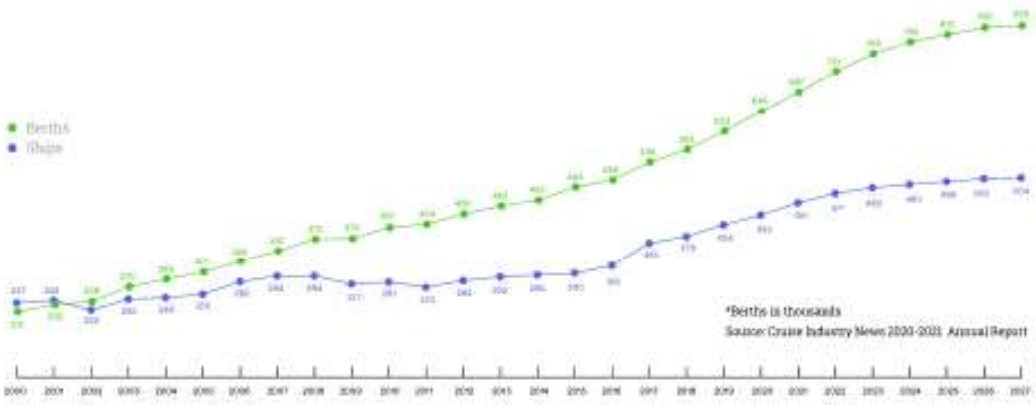

Fig. 1. Global cruise fleet and deployment of cruise fleet
Source: Cruise Industry News 2020-2021 Annual Report [17]

Fig. 1 shows relation between cruise ship numbers and cruise ship berths. Cruise ship berth in this context represents a bed of any type on the cruise ship [17]. For the period from 2000 to 2020, the relation between passenger movement trend (+5.5%) and cruise berths trend (+4.7%) indicates a higher cruise ship occupancy rate. On the other hand, the relation between cruise ships number trend (+4.1%) and cruise ships passenger movement trend (+5.5%) shows that cruise ships are becoming bigger. Predictions from the 2020 to 2027 period estimate that the number of cruise ships will grow on average rate of 2.48% while the number of cruise berths will grow on average rate of 3.67% [18], [19]. Growing trends will slightly stabilise but it still indicates delivery of larger cruise ships on the market in order to accommodate high passenger demand.

These factors predict further cruise industry development and cruise traffic expansion. In order to satisfy cruise market demand, it is to predict that popular cruising destination will maintain present status with controlled growth and less prominent destination will continue to grow on faster pace. It is to expect that future cruise industry expansion will focus on new regions that have never been cruising destinations before. Predicted cruise industry development such as the rise of cruise ships number and increase of passenger movement will impact on global, regional and local maritime sustainability. From the cruising industry perspective, aiming for sustainable operational development should be priority. In particular in environmentally delicate and navigationally challenging areas of coastal navigation which are frequent areas of cruise ships operation.

V. CONCLUSION

The rise in cruise ship numbers, cruise ship berths and cruise ship destinations prove how the cruise industry is still relatively new and has been developing. A review of present researches on sustainable development and maritime transport sustainability showed that operational aspects of the cruise industry and sustainable cruise shipping development are topics that are insufficiently present in research papers. Present trends and future cruise industry predictions forecast strong expansion. Strong cruise industry expansion will be followed by development of new cruising regions and cruising destinations. These prospects are beneficial for the economic component of sustainability; however, the environmental and social aspects have to be closely considered. In order to do that, maritime authorities of hosting countries have to create endurable and efficient operational criteria with high maritime standards and effective traffic control. While cruise companies have to operate in accordance to the host country maritime regulations, international maritime standards and good seamanship common sense.

This revision of present researches has highlighted importance of the impact of the cruise industry on maritime sustainability and gave a good base for further researches.

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Production of Metallic Titanium by Electrowning in Molten Salts of Titanium Oxycarbide Anode

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***Abstract*—** The main industrial route for titanium extraction is the Kroll process. Due to its energy consumption, low efficiency, complexity and its high production costs involved at all processing steps.

The need for cheaper and more compact processes has encouraged many researches and trials to develop alternative routes. The new methods, categorized into two groups: thermochemical and electrochemical, have been proposed to reduce the number of steps of the Kroll process, to obtain a product of high purity cheap and thus widen its applications. Several electrochemical processes have been developed so far: GTT (Ginatta Titanium Turin), FFC Cambridge (Fray, Farthing et Chen) and MER-process (or the similar Chinuka process and USTB process).

The aim of this work is to study the Chinuka Process. A titanium oxycarbide is used as the consumable anode. The ceramic TiC0,5O0,5 is obtained by carbothermic reduction of titanium dioxide at high temperature and sintered by SPS. Titanium oxycarbide is electrically conductive. During the electrolysis, the titanium present in TiC0,5O0,5 is dissolved as titanium ion which electrodeposited in the cathode, while C and O forms CO without any C or O left in anode.

The main issues for successful development of an electrochemical route for titanium production are associated with the existence of several titanium oxidation states (VI, III and İİ)in solution which involve multistep processes and lead to disproportionation reactions and low current efficiency.1,2

In this study, the salt has been investigated to avoid the formation of Ti2+ and stabilize Ti3+.

To understand the mechanism of titanium reduction in the studied molten salt, the first electrowning attempts were carried out using titanium plate anode. The experimental faradic efficiency is around 85% and the XRD analyzes show the presence of metallic titanium.

***Keywords*—** Chinuka process, electrowning, titanium, titanium oxycarbide.

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E-tongue Based on Metallo-porphyrins for Histamine Evaluation

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***Abstract*—** The general objective of the presentation is the development of an e-tongue like sensor based on modified screen printed electrode (SPE) structures with a receptor part made of porphyrins/metalloporphyrins chemically bound to graphene (the sensitive assembly) to act as antennas and "capture" the histamine molecules. Using a single, ultra-sensitive electrochemical sensor, we measured the concentration of histamine, a compound which is strongly connected to the level of freshness in foods (the caution level of histamine is 50 ppm, whereas the maximum accepted levels range from 200 ppm to 500 ppm). Our approach for the chemical immobilization of the porphyrins onto the surface of the graphenes was via substitution reaction: a solution of graphene in $SOCl_2$ was heated to 80^0C for 6 hours. Upon cooling, the metallo-porphyrins were added and ultrasonicated for 4 hours. The solution was then allowed to cool to room temperature and then centrifuged in order to separate the deposit. The sensitive assembly was drop casted onto the carbon SPE and cyclic voltammetry was performed in the presence of histamine. The reaction is quasi-reversible and the sensor showed an oxidation potential for histamine at 600 mV. The results indicate a linear dependence of concentration of histamine as function of intensity. The results are reproducible; however the chemical stability of the sensitive assembly is low.

***Keywords*—**histamine, cyclic voltammetry, food freshness, metallo-porphyrin.

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Influence of the Render Coat on the Carbonation of 100-Years Old Bridge Concrete

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***Abstract*—** During the diagnostics and research of 100-years old concrete bridges between 2014 and 2020, a thin (2-4) mm protective render coat (PRC) was found at four bridges in Slovakia. The results showed a close correlation between the surface permeability of the PRC estimated by the Torrent method and the carbonation depth of underlying concrete. Most of the measured PRCs appeared to be almost impermeable, showing the permeability coefficient below 0,01 $\times 10^{-16}$ m^2. The underlying concrete was at these places carbonated to the depth 0 up to 2 mm; when a PRC spalled up to 80 mm. In some cases, negligible carbonation was measured (3-4 mm) if the permeability results were a bit higher. The PRC consists prevailingly of compact carbonate microparticles thickened up to the boundary of the impermeable gel form, showing no open pores and such a density, which gives this extremely thin PRC layer non-permeability property for carbon dioxide penetration over time. The main scientific goal of this article is to explain the cause of the found extremely low carbonation depth of concrete under PRC. The repeated tests on-site and in a laboratory-confirmed the initial observations. The average carbonation of concrete under PRC with low permeability is found to be in a range between 0 % and 15 % when compared to carbonation depths measured in places where PRC has spalled. The relationship between the depth of carbonation, the quality and thickness of PRC and the quality of the underlying concrete from the point of material assessment and non-permeability, as well as a couple of important PRC and concrete material properties, are also revealed in this work. The old bridge concrete is specified by low compressive strength, that is, on average around 20 MPa. The formed, prevailingly highly compressed, amorphous-like carbonates, regarded as carbonation milk, in a narrow (2-4) mm PRC layer, densify its tight space in such a way as to create an impermeable barrier to further CO_2 ingress preventing further carbonation of the concrete beneath. The results of in-situ and laboratory research presented in this article give an explanation of these findings when discussed in more detail. Based on the previous investigation, we conclude that even for modern structures, a dense, thin, protective render coat with a very high cement content can easily serve as an effective anti-carbonation barrier. Investigation on the aspects of low carbonation depth thoroughly focused on the role of thin and dense PRC covering concrete beneath as well as material development of new PRC based on the present cement and sand, without and alternatively with use of some chemical admixtures (dry powder dispersion, cellulose) added to the PRC in negligible amounts, is also the subject of current research.

***Keywords*—**Carbonation, concrete, permeability, render coat.

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Bending Test Characteristics For Splicing of Thermoplastic Polymer Using Hot Gas Welding

Prantasi Harmi Tjahjanti, Iswanto, Edi Widodo, Sholeh Pamuji

***Abstract*—** Materials of the thermoplastic polymer when they break is usually thrown away, or is recycled which requires a long process. The purpose of this study is to splice the broken thermoplastic polymer using hot gas welding with different variations of welding wire/electrodes. Materials of thermoplastic polymer used are Polyethylene (PE), Polypropylene (PP), and Polyvinyl chloride (PVC) by using welding wire like the three materials. The method is carried out by using hot gas welding; there are two materials that cannot be connected, namely PE with PVC welding wire, and PP with PVC welding wire. The permeable liquid penetrant test is PP with PE welding wire, and PVC with PE welding wire. The best bending test result with the longest elongation is PE with PE welding wire with a bending test value of 179.03 kgf/mm^2. The microstructure was all described in Scanning Electron Microscopy (SEM) observations.

***Keywords*—** thermoplastic polymers, bending test, polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), hot gas welding, bending test.

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Novel Process for Extinguishing Magnesium-Fired in an Environmentally Friendly Way

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***Abstract*—** Metal fires are difficult to extinguish because of the high flame temperatures. Firefighters typically attack a metal fire, e.g. in a magnesium processing plant, with sand, to suffocate the flame. A disadvantage is that they have to approach the fire by a few meters distance only so that the sand can be thrown, which is dangerous, particularly when the sand is humid, since oxyhydrogen can form. Also, tossing the sand onto molten metal can increase the surface area and spread the fire in an uncontrolled manner. The authors have developed a novel process to control such fires, on a scale of a few kg to a few 100kg of burning metal, particularly magnesium, the melt of which is auto-ignites upon contact with air. The process is based on a modified blow-in insulation material, which is commonly used to save energy in residential buildings. Such blow-in insulation material contains 5% of borates to make it flameretardant. The cellulose flakes were coated or mixed with 10-15% of inorganic salts, such as sodium borate, magnesium sulfate or potassium chloride, and were blown through a hose (10cm diameter) onto the metal fire using compressed air from a distance of up to 10m at a rate of 10-50 kg/min of coated cellulose flakes. After approx. 5-30 seconds, when the fire had been covered, a fire water mist was applied to cool down the cellulose blanket. The material was subsequently found to be converted into a charred, solid body, which could be continuously cooled by water. Interestingly, the cellulose flakes provided sufficient shielding of the metal fire for the water mist. When no water mist is applied, it takes

approx. 10 seconds for the flames to become visible again, however, they are less intensive and after complete combustion of the cellulose flakes, a solid shield remains, which is first charred material and after a few minutes turns to a glassy remainder of the contained salts. The main advantage of the Cellulose flakes was found to be their low bulk density, which does not mix up the molten metal upon impact. For 150kg of burning magnesium, 30kg of cellulose flakes were sufficient to control the fire. The mixture with 15% of sodium borate was found to work best, by yielding the most stable crust.

The novel process allows to control a medium to large-scale magnesium fire within less than one minute, with substantially lower danger potential for fire fighters than in current practice.

***Keywords*—** fire, magnesium, extinguishing, sustainability.

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Development and Characterization of Expandable TPEs Compounds for Footwear Applications

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***Abstract*—** Elastomeric thermoplastics (TPEs) have been widely used in the footwear industry over the years. Recently this industry has been requesting materials that can combine lightweight and high abrasion resistance. Although there are blowing agents on the market to improve the lightweight, when these are incorporated into molten polymers during the extrusion or injection molding, it is necessary to have some specific processing conditions (e.g. effect of temperature and hydrodynamic stresses) to obtain good properties and acceptable surface appearance on the final products. Therefore, it is a great advantage for the compounder industry to acquire compounds that already include the blowing agents. In this way, they can be handled and processed under the same conditions as a conventional raw material. In this work, the expandable TPEs compounds, namely a TPU and a SEBS, with the incorporation of blowing agents, have been developed through a co-rotating modular twin-screw parallel extruder. Different blowing agents such as thermo-expandable microspheres and an azodicarbonamide were selected and different screw configurations and temperature profiles were evaluated since these parameters have a particular influence on the expansion inhibition of the blowing agents. Furthermore, percentages of incorporation were varied in order to investigate their influence on the final product properties. After the extrusion of these compounds, expansion was tested by the injection process. The mechanical and physical properties were characterized by different analytical methods like tensile, flexural and abrasive tests, determination of hardness and density measurement. Also, scanning electron microscopy (SEM) was performed. It was observed that it is possible to incorporate the blowing agents on the TPEs without their expansion on the extrusion process. Only with reprocessing (injection molding) did the expansion of the agents occur. These results are corroborated by SEM micrographs, which show a good distribution of blowing agents in the polymeric matrices. The other experimental results showed a good mechanical performance and its density decrease (30% for SEBS and 35% for TPU). This study suggested that it is possible to develop optimized compounds for footwear applications (e.g., sole shoes), which only will be able to expand during the injection process.

***Keywords*—** blowing agents, expandable thermoplastic elastomeric compounds, low density, footwear applications.

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Coastalization and Urban Sprawl in the Mediterranean: Using High-resolution Multi-temporal Data to Identify Typologies of Spatial Development

Apostolos Lagarias, Anastasia Stratigea

***Abstract*—** Coastal urbanization is heavily affecting the Mediterranean, taking the form of linear urban sprawl along the coastal zone. This process is posing extreme pressure on ecosystems, leading to an unsustainable model of growth. The aim of this research is to analyze coastal urbanization patterns in the Mediterranean using High-resolution multi-temporal data provided by the Global Human Settlement Layer (GHSL) database. Methodology involves the estimation of a set of spatial metrics characterizing the density, aggregation/clustering and dispersion of built-up areas. As case study areas, the Spanish Coast and the Adriatic Italian Coast are examined. Coastalization profiles are examined and selected sub-areas massively affected by tourism development and suburbanization trends (Costa Blanca/Murcia, Costa del Sol, Puglia, Emilia-Romagna Coast) are analyzed and compared. Results show that there are considerable differences between the Spanish and the Italian typologies of spatial development, related to the land use structure and planning policies applied in each case. Monitoring and analyzing spatial patterns could inform integrated Mediterranean strategies for coastal areas and redirect spatial/environmental policies towards a more sustainable model of growth.

***Keywords*—** Coastalization, Mediterranean, multi-temporal, urban sprawl, spatial metrics

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Probing Scientific Literature Metadata in Search for Climate Services in African Cities

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***Abstract*—**In the current context of climate change, supporting national and local stakeholders to make climate-smart decisions is necessary but still underdeveloped in many countries. To overcome this problem, the Global Frameworks for Climate Services (GFCS), implemented under the aegis of the United Nations in 2012, has initiated many programs in different countries. The GFCS contributes to the development of Climate Services, an instrument based on the production and transfer of scientific climate knowledge for specific users such as citizens, urban planning actors or agricultural professionals. As cities concentrate economic, social and environmental issues that make them more vulnerable to climate change, the New Urban Agenda (NUA), adopted at Habitat III in October 2016, highlights the importance of paying particular attention to disaster risk management, climate and environment sustainability and urban resilience. In order to support the implementation of the NUA, the World Meteorological Organization (WMO) has identified the urban dimension as one of its priorities and has proposed a new tool, the Integrated Urban Services (IUS), for more sustainable and resilient cities.

In the southern countries, there's a lack of development of climate services, which can be partially explained by problems related to their economic financing. In addition, it is often difficult to make climate change a priority in urban planning, given the more traditional urban challenges these countries face, such as massive poverty, high population growth, etc.

Climate services and Integrated Urban Services, particularly, in African cities are expected to contribute to the sustainable development of cities. These tools will help promoting the acquisition of meteorological and socio-ecological data on their transformations, encouraging coordination between national or local institutions providing various sectoral urban services, and should contribute to the achievement of the objectives defined by the United Nations Framework Convention on Climate Change (UNFCCC) or the Paris Agreement, and the Sustainable Development Goals.

To assess the state of the art on these various points, the Web of Science metadata base is queried. With a query combining the keywords "climat*" and "urban*", more than 24,000 articles are identified, source of more than 40,000 distinct keywords (but including synonyms and acronyms) which finely mesh the conceptual field of research. The occurrence of one or more names of the 514 African cities of more than 100,000 inhabitants or countries, reduces this base to a smaller corpus of about 1410 articles (2990 keywords). 41 countries and 136 African cities are cited. The lexicometric analysis of the metadata of the articles and the analysis of the structural indicators (various centralities) of the networks induced by the co-occurrence of expressions related more specifically to climate services show the development potential of these services, identify the gaps which remain to be filled for their implementation and allow to compare the diversity of national and regional situations with regard to these services.

***Keywords*—** African cities, climate change, climate services, integrated urban services, lexicometry, networks, urban planning, web of science.

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Promoting Adaptation to Changing Coasts: Creating a Model for Climate Change Adaptation of European Estuaries

Sam Bridgewater, Mike Williams

***Abstract*—** Human activity has radically altered coastal areas. Settlements and sea defences have been built, wetlands drained and reclaimed for agriculture and infrastructure, including roads, sewage treatment works, tips and recreational facilities placed in areas that were formerly floodplains. The sea level of the channel has risen by 16 cm since 1900. This trend is set to continue with a further rise of 70 cm predicted by 2100. With such a rise, many communities will need to adapt as maintaining sea defences comes at a high long-term financial and ecological cost. Ultimately, for some locations, this approach may not be a sustainable response. Two case study sites in Devon (Otter Valley) and Normandy (Saâne Valley) are combined to show how it is possible to act in advance to adapt to climate change. By assessing risks, highlighting best practices and valuing the societal and environmental benefits, the PACCo model will help ascertain whether adaptation is right for a coastal area and, if so, will provide guidance on how to proceed. Such an approach could benefit over 70 estuaries on both sides of the channel.

***Keywords*—** coast, estuary, estuaries, adaptation, carbon, sequestration.

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Influence of Covid-19 Pandemic in Shifting High Dose I131 Therapy to Outpatient Basis with Home Isolation

Tariq Munshy, Khalid Salman

***Abstract*—** Aim: to assess the agreement of health care providers concerned with I131 therapy in KSA on shifting to high dose I131 therapy on outpatient basis with home isolation (HDITO) HDITO during COVID19 pandemic .METHODS: A questionnaire of 21 questions was electronically dispensed to health care providers concerned with I131 therapy and collected within two weeks and data were statistically analyzed RESULTS: 50% of the respondents agreed to apply the therapeutic policy of giving HDITO.

***Keywords*—** Hi dose I131,Covid19,outpatent,therapy.

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New Neural Network Classification Method for Individuals Ancestry Prediction from SNPs Data

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***Abstract*—** Artificial Neural Network (ANN) algorithms have been widely used to analyse genomic data. SNPs represent the genetic variations, the most common in the human genome and they are involved in many genetic diseases. We propose here, a deep learning classification method based on input perturbation. The idea is first to use SVD to reduce the dimensionality of the input data and to train a classification network, which prediction errors are then reduced by perturbing the SVD
projection matrix.

***Keywords*—** neural network, SVD, genomic, classification.

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An Automatic Control System with Human-in-the-Loop for Training Skydiving Maneuvers: Proof-of-Concept Experiment

Anna Clarke, Per-Olof Gutman

Abstract—A real-time motion training system for skydiving is proposed. Aerial maneuvers are performed by changing the body posture and thus deflecting the surrounding airflow. The natural learning process is extremely slow due to unfamiliar free-fall dynamics, stress induced blocking of kinesthetic feedback, and complexity of the required movements. The key idea is to augment the learner with an automatic control system that would be able to perform the trained activity if it had direct access to the learner's body as an actuator. The aiding system will supply the following visual cues to the learner: 1. Feedback of the current body posture; 2. The body posture that would bring the body to perform the desired maneuver; 3. Prediction of the future inertial position and orientation if the body retains its present posture. The system will enable novices to maintain stability in free-fall and perceive the unfamiliar environmental dynamics, thus accelerating the initial stages of skill acquisition. This paper presents results of a Proof-of-Concept experiment, whereby humans controlled a virtual skydiver free-falling in a computer simulation, by the means of their bodies. This task was impossible without the aiding system, enabling all participants to complete the task at the first attempt.

Keywords—Motion training, human-in-the-loop, skydiving simulator, visual cues.

I. Introduction

FREE fall maneuvering requires maintaining a desired angular and linear velocity, and is achieved by continuously changing the body posture. Novices experience hard and protracted training due to 1. Exteroceptive sensory overload, with the external world changing at 220 km/h; 2. Blocking of kinesthetic feedback, due to muscle tension caused by stress; 3. The need to break the habitual ways of moving, noting that free fall maneuvering requires counter-intuitive movements, different from our daily movement repertoire. Moreover, it is impossible to demonstrate these movements since they are highly dependent on individual body parameters, involving the whole body with multiple Degrees-of-Freedom (DOFs). The trainees are taught only a few basic postures. All current training techniques are off-line: debriefing the jump videos, practicing the basic postures on the ground, and visualizing future maneuvers.

A new training method is needed due to the rapid growth of skydiving operations along with the number of fatalities [1], caused by novice skydivers lacking control.

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The training tool described here constitutes a hierarchical control system composed of a human performer, an autonomous system capable of performing the activity in a virtual way, and an interface between them. The strengths of control engineering are complementary to human motor-learning abilities. In many areas humans outperform computer algorithms, namely knowledge-based tasks, domains requiring expertise, tasks with high levels of uncertainty [2]. For sensory-motor actions, however, humans need a training period until they become automatic, particularly when acting in unfamiliar and stressful environments. Motor skills do not improve until the brain learns the environmental dynamics. Control engineering is a powerful tool for modelling complex dynamics, and designing controllers for maneuvering in challenging environments. In this work those strengths are turned into motor learning aids.

The proposed approach is conceptually different from a state-of-the-art semi-autonomous and human-machine systems. In such systems humans take a supervisory role over an automated process [3], [2]. In the proposed training tool the roles are reversed: the control system will guide human movements. The proposed control system will resolve on-line state and parameters estimation, plan the desired trajectory in 3D space, break down the trajectory into a series of maneuvers, track the linear and angular motion involved in each maneuver, and interpret the controller commands in terms of body posture. The body actuation will be the manual part: a human trainee will focus on making his current posture close to the one recommended by the control system.

Motor skills for physical education and sports are investigated in [4], [5], with theoretical teaching guidelines in [6]. Virtual and Augmented Reality technologies [7]-[10] noticeably improved training by providing feedback, which is an essential motor-learning aid [8], [11]-[14]. Movement feedback has become available via miniature wireless, wearable inertial sensors, and movement reconstruction from images. Relevant, easy-to-perceive, correctly timed feedback improves performance.

State-of-the-art sports training systems include: Tai-Chi gestures [15], [16], martial art training [17], golf swing [18], dance and other recorded moves [19], [20], [7], [16], all based on imitation: specific, precisely known moves are repeated after a coach/avatar through a virtual reality interface and the disparity in execution is the feedback. Feedback is supplied as a score, via superimposition of correct and trainee limbs trajectory, or via a multimodal (visual, vibrotactile,

sound) interface [8]. The question remains as to how to train in sport for which imitation is impossible. In skydiving posture adjustments happen very fast, can be barely noticeable but vital, simultaneous in all body limbs, and individual: templates of 'correct' moves don't exist. An elegant solution for real-time feedback was proposed in [21], [22] for novice snowboard training, and in [23] for expert alpine ski training. Since these activities are cyclic a characteristic dynamic variable for feedback was found: for snowboarding the weight transfer given as tactile stimulation [21]; and for skiing the lateral displacement during each turn given as audio feedback [23].

In free-fall motion is not constrained by the ground, all limbs are free to move as desired. Their slightest movement can cause large aerodynamic forces/moments that can produce uncontrollable body rotation and horizontal displacement with continuously increasing speed, something typical for students. The challenge is thus to acquire understanding and feeling of the environment dynamics, called the *Forward Model* in motor learning literature. This model allows the brain to predict the motion caused by different body postures, and issue desired posture adjustments to the somatic nervous system. However, acquisition of the Forward Model occurs only by actively moving inside the new environment and processing the sensory feedback [12]. Hence, the difficulty in skydiving training is moving in free-fall before the body has developed the necessary *movement patterns*: combinations of body DOFs activated synchronously and proportionally, as a single unit.

A sports technique can be viewed as a movement patterns repertoire. From the perspective of dynamical systems theory (the dominant motor learning theory), motor learning is the process when these movement patterns emerge [24]. First, the patterns are simple (coarse), providing just the basic functionality. Later, the movement patterns become more complex, providing adaptation to perturbations and uncertainties, and improved performance. However, in skydiving it is extremely difficult to control the motion using simple patterns, taught to novices, due to the unstable and highly non-linear aerodynamics of free-fall, shown in [25]. Students can spend most of their free-fall training session attempting to regain stability, i.e. stop an undesirable and often dangerous motion.

This vicious circle can be broken introducing our system [26], called Kinesthetic Training Module (KTM), into training. It supplies to the trainee the outcome of the missing Forward Model: the prediction of motion in inertial space. It also shows the control input required at each time instant in terms of the movement pattern being trained. Each exercise suggested by KTM is based on the student's current movement repertoire which is continuously monitored and analysed [27]. Students are given achievable tasks: desired maneuvers are outputs of simulations driven by trained patterns.

II. Methods

The experiments were approved by the Technion Ethics Committee. All participants expressed a written informed consent.

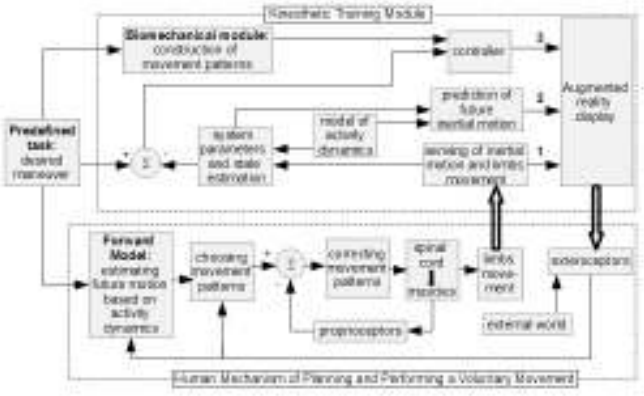

Fig. 1 Block Diagram of a natural neurophysiological mechanism augmented with KTM. The cues are denoted as (1) - Feedback Posture, (2) - Forward Model, (3) - Desired Posture

A. Concept Outline

KTM computes *Feedback Posture*, *Forward Model*, and *Desired Posture*, and displays them in real-time, as shown in Fig. 1 together with a block diagram representing human movement, as explained in Sec.I. KTM includes three hardware components: a sensor suite for tracking body movements, augmented reality goggles for displaying the cues, and a wearable computer for real-time computations.

The Forward Model provides future inertial position and orientation if the current posture is not altered. This cue functions like feed-forward in control theory. Its computation requires modeling body and environment dynamics, estimating system parameters and state variables, and solving the motion equations forward in time. The prediction time has to match the human sensory-motor bandwidth, to be found and tuned experimentally, individually for each trainee. The Skydiver Simulator, developed for this purpose, includes the modules briefly described below, while the exact equations can be found in [25].

a) Biomechanical Model: represents the body by 16 rigid segments (pelvis, abdomen, thorax, head, upper arms, forearms, hands, upper legs, lower legs, and feet) of simple geometrical shapes and calculates the local centre of gravity and principal moments of inertia for each segment. A set of rotation quaternions linking each two segments enables computation of the overall centre of gravity, inertia tensor, and their time derivatives. The model has altogether 45 DOFs: 3 rotation angles associated with each one of the 15 joints. These DOFs define an instantaneous body posture, which is the simulator's input. The biomechanical model has to be provided with anthropometric parameters specifying body size, shape, and weight of the skydiver under investigation.

b) Dynamic Equations of Motion: derived by the Newton-Euler method, provide six equations: 3D forces and moments.

c) The Kinematic Model: computes the body inertial orientation, and angles of attack, sideslip, and roll of each segment relative to the airflow. These angles are used in the aerodynamic model to compute drag forces and aerodynamic

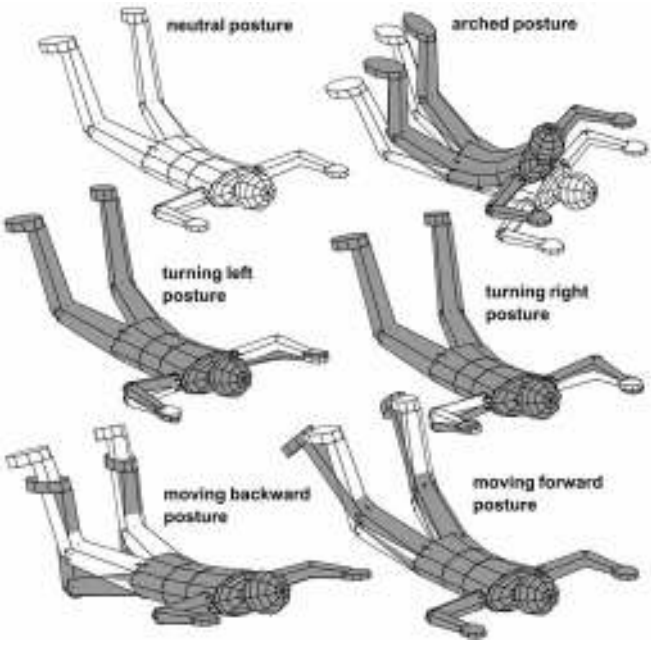

Fig. 2 The neutral skydiving posture and other postures (dark) superimposed over the neutral one

moments acting on each segment. The total aerodynamic force and moment together with the gravity forces are substituted into the equations of motion.

d) Aerodynamic model: is formulated as a sum of forces and moments acting on each individual segment, modelled similar to aircraft aerodynamics - proportional to velocity squared and to the area exposed to the airflow. The model includes six aerodynamic coefficients (maximum lift, drag, and moment coefficients; roll, pitch, and yaw damping moment coefficients) that were experimentally estimated, and has to be provided a set of configuration parameters specific to the skydiver under investigation (type of parachute, helmet, jumpsuit, and weight belt).

The skydiving simulator output was experimentally verified: Various skydiving maneuvers were performed by different skydivers in a wind tunnel and in free-fall, and the recorded posture sequences were fed into the simulator. The six aerodynamic coefficients were tuned so that all the manoeuvres were closely reconstructed. The errors RMS in angular and linear velocities were 0.15 [rad/sec] and 0.45 [m/sec], respectively.

The Desired Posture, constructed from the specific movement patterns currently being trained, superimposed on the Feedback Posture provides a cue of required instantaneous posture adjustments. Movement patterns for training can be generated from empirical databases of skydiving experts, and finalized with the Skydiver Simulator, such that each movement pattern has a good performance potential from control engineering perspective. For example, in [27] the trainee's movement pattern is adjusted in the simulator such that the overall open loop system (i.e. body in free-fall actuated by the refined movement pattern) acquires dynamic stability. For each movement pattern a controller is designed that tracks a matching component of the linear or angular velocity associated with the desired maneuver. The Desired Posture is thus a superposition of active controller outputs, see [28] where three controllers tracking longitudinal, lateral, and vertical motion define the final body posture command. In the general case the Desired Posture at every instant of time $P_{desired}(t)$ is computed as:

$$P_{desired}(t) = P_{neutral} + \sum_{i=1}^{N} u_i(t) \cdot MP_i \qquad (1)$$

where $P_{neutral}$ is the basic skydiving posture used to fall straight down in a belly-to-earth position (see Fig. 2), N is the total number of movement patterns involved in constructing the Desired Posture, $u_i(t)$ is the command computed by controller i at time t, and MP_i is the eigenvector (with norm 1) defining movement pattern i: the 45 components of this vector define the relative engagement of each body DOF.

Notice, that for efficient training $P_{neutral}$ and MP_i, $1 \leq i \leq N$ have to be designed individually for each trainee due to different anthropometrics. The input to each controller is the discrepancy between the relevant desired and measured velocity component (e.g. yaw rate error), and the output is the pattern angle in radians $u_i(t)$. Each controller is designed by a method most suited for dealing with the dynamics of the tracked motion. For example, in [28] a controller tracking the vertical velocity component is designed according to Model Predictive Control (MPC): a method that deals with state and actuation constraints. The reason is that the vertical velocity in free-fall is adjusted by arching ones back (as shown in Fig. 2), which has a very limited range for most people. In case a pre-defined trajectory is desired, linear and angular velocity profiles are computed by a path-following controller [25]. The desired velocities can enhance the Forward Model cue: the trainee can compare his future motion state with the state intended by the control system. If he implements precisely the desired posture, his future and planned motion will coincide.

Training practice starts with simple movement patterns, involving few DOFs. Gradually, the trained patterns become more complex, and more patterns can be practiced simultaneously. The trainee can be suggested other patterns for already mastered maneuvers, using different DOFs. This possibility, granted by the natural human kinematic redundancy, can be highly beneficial for accelerating the skill acquisition [6]. Theoretically, the KTM cues contain sufficient information to trigger the emergence of more complex patterns based on the combination of simpler, previously trained ones [29]. The coach can continuously monitor the progress, detect the emergence of particularly efficient patterns, and trigger their training in the next sessions, as shown in [27] for intermediate-level rotation training. Designing and adapting exercises to different types of learners is in the main stream of our future work.

We hypothesize that mastering maneuvers rapidly and maintaining dynamic stability will be best achieved if the subject focuses on causing the current body posture and the predicted inertial motion to coincide with the displayed cues, respectively. Due to the perception-action coupling we expect each learning step to include two sub-steps: After some

training the pattern becomes part of the muscle memory, the posture cue becomes redundant, and the Forward Model cue will be in focus. When the next pattern is practiced, the focus will return to the Desired Posture cue, etc. When also the Forward Model cue becomes unnecessary, the environmental dynamics has been learnt, and the trainee can perform the maneuver without the KTM.

B. Proof-Of-Concept Experiment

The KTM concept suggests that the trainee, guided by the visual cues, is part of the control loop. The trainee is the actuator: the real-time controllers compute a body posture command for the trainee to execute. The proof-of-concept experiment is meant to verify that one may design a stable hierarchical control system where the human implements the computed continuously changing body posture. Verifying the effectiveness of the KTM cues and display, and developing KTM-prototype guidelines are additional objectives.

In [25] a navigation and control algorithm for a virtual skydiver was developed. It enabled a skydiver in the simulation to fly from his current location to reach another skydiver. The navigation algorithm planned a path connecting the virtual skydiver to his target, and computed the desired yaw rate and speed profiles. The controller interpreted these profiles as two commands: 'turning' and 'forward-backward' movement pattern angles, respectively. These two patterns (see Fig. 2) defined the posture at each time instant. The 'turning' pattern, used for tracking the yaw rate, included four DOFs associated with the shoulders. The 'forward-backward' pattern, used for tracking the speed, included four DOFs associated with knees and hips.

The same task is used for our Proof-Of-Concept experiment. In contrast to the simulated autonomous skydiver, a computed body posture is executed by the trainees who view the skydive simulation on a screen in real-time. Thus, the Desired Posture cue displayed to the trainees is computed as:

$$P_{desired}(t) = P_{neutral} + u_{arms}(t) \cdot MP_{arms} + u_{legs}(t) \cdot MP_{legs} \quad (2)$$

where MP_{arms} is the 'turning' movement pattern eigenvector with 4 non-zero entries $MP_{arms}(i_1,i_2,i_3,i_4) = 0.5$, with $i_1 - i_4$ associated with right shoulder flexion and lateral rotation, and left shoulder extension and medial rotation; MP_{legs} is the 'forward-backward' movement pattern eigenvector with 4 non-zero entries $MP_{legs}(j_1,j_2) = 0.582$; $MP_{legs}(k_1,k_2) = 0.402$, with j_1, j_2 associated with the knees flexion and k_1, k_2 with hips extension; and $u_{arms}(t)$, $u_{legs}(t)$ are controller's commands computed as:

$$\begin{aligned} u_{arms}(t) =& G11 \cdot (F11 \cdot \Omega_{com}(t) - \Omega_{meas}(t)) \\ u_{legs}(t) =& G22 \cdot (F22 \cdot V_{com}(t) - V_{meas}(t)) + \dots \\ & G21 \cdot (F11 \cdot \Omega_{com}(t) - \Omega_{meas}(t)) \end{aligned} \quad (3)$$

where $\Omega_{com}(t)$, $V_{com}(t)$ are the yaw rate and speed commands at time t; $\Omega_{meas}(t)$, $V_{meas}(t)$ are the skydiver's yaw rate and speed at time t computed by the Skydiving Simulator that receives the measured trainee's posture at 240 [Hz] and propagates in time the equations of motion; and $F11, F22, G11, G12, G22$ define the control law and are given as:

$$\begin{aligned} G_{11} &= \frac{0.25(1+\frac{s}{3.5})}{s} \frac{1+\frac{s}{0.7}}{1+\frac{s}{10}} \frac{1}{1+\frac{s}{100}} \\ F_{11} &= \frac{1}{(1+\frac{s}{7})(1+\frac{s}{8})} \frac{1+\frac{s}{0.6}}{1+\frac{s}{1}} \\ G_{22} &= \frac{0.1(1+\frac{s}{1.5})}{s} \frac{1+\frac{s}{0.2}}{1+\frac{s}{0.6}} \frac{1+\frac{s}{1}}{1+\frac{s}{10}} \\ G_{21} &= \frac{-0.035(1+\frac{s}{3})}{s} \frac{1+\frac{s}{1}}{s} \frac{1+\frac{s}{0.5}}{1+\frac{s}{5}} \\ F_{22} &= \frac{1}{(1+\frac{s}{1})(1+\frac{s}{2})} \end{aligned} \quad (4)$$

where s is the Laplace variable The controller was designed using the Quantitative Feedback Theory (QFT) providing robustness against plant non-linearities and inaccurate execution of the movement patterns. The design procedure is described in [25].

Notice, that the yaw rate and speed commands $\Omega_{com}(t)$, $V_{com}(t)$ in Eq. 3 are not the same as the pre-planned desired yaw rate and speed profiles, which are computed offline along with the desired path and are a part of the task definition. The reason is that the real time yaw rate and speed commands have to account for heading and position errors produced by the trainee during task execution. Therefore, these commands are computed as:

$$\begin{aligned} V_{com}(t) &= V_{desired}(t, t_{LA}) \\ \Psi_{error}(t) &= atan\frac{Xpath(t,t_{LA}) - X(t)}{Ypath(t,t_{LA}) - Y(t)} - atan\frac{V_x(t)}{V_y(t)} \\ \Omega_{com}(t) &= 2 \cdot \Psi_{error}(t)/t_{LA} \end{aligned} \quad (5)$$

where $X(t), Y(t)$ is the horizontal position of the skydiver at time t; $V_x(t), V_y(t)$ are his horizontal velocity components; t_{LA} is the look-ahead time conveying the reaction time expected from the trainee, it can be individually adjusted and was between 2-2.5 seconds in our experiments; $Xpath(t,t_{LA}), Ypath(t,t_{LA})$ is the path point located at a distance $t_{LA} \cdot \sqrt{V_x(t)^2 + V_y(t)^2}$ from the path point closest to $X(t), Y(t)$; and $V_{desired}(t,t_{LA})$ is the speed from the desired speed profile corresponding to the path point $Xpath(t,t_{LA}), Ypath(t,t_{LA})$.

Trainees have to learn, firstly, to reproduce the 'turning' and 'forward-backward' patterns, and secondly, to use these patterns for flying the virtual skydiver. The Proof-of-Concept is a success if all the trainees complete the task after a small number of attempts. Without the KTM cues it is impossible to control the virtual skydiver. The reason is not only the unfamiliar environmental dynamics that drives the simulator, but also the total absence of kinesthetic feedback, since the action happens in the virtual world and the teleoperator's proprioceptors cannot feel the air flow, and his vestibular system cannot feel the acceleration and angular rates. Similarly for real skydiving novices: their kinesthetic feedback is blocked by the visual sensory overload and excessive muscle tension due to stress.

Fig. 3 Snapshots of the simulation screen when one of the volunteers performed the task. Light posture and dark arrow are the commands; dark posture and light arrow are the actual posture and future heading of the participant

C. Experimental Set-Up and Procedure

The Proof-Of-Concept included the following components:

1) Xsens motion tracking suit [30] with miniature inertial sensors that are fixed at strategic locations on the body. Each unit includes a 3D accelerometer, 3D rate gyroscope, 3D magnetometer, and a barometer. It has a battery and a small computer located on the back and not restricting the skydiving-specific movements. The Xsens output is wirelessly transmitted to a PC at 240 Hz. Each measurement set includes the orientation of 23 body segments (pelvis, four spine segments, neck, head, shoulders, upper arms, forearms, hands, upper legs, lower legs, feet, toes) relative to the inertial frame, expressed by quaternions. The measurements accuracy is less than 5 degrees RMS of the dominant joint angles.
2) Skydiver Simulator (PC/Matlab) that receives the measurements via User Datagram Protocol, computes the skydiver's movement and the KTM cues, and displays the results using the Matlab Virtual Reality Modeling Language.
3) Volunteers: four women and eight men aged 25-45 years.

The Experimental Procedure for one trainee at a time consisted of the following stages:

a) Preparation: The trainee's body parameters are measured and saved in Xsens software; he dresses the Xsens suit, and performs calibration. The calibration is needed for the Xsens internal biomechanical model to converge and includes standing still and walking back and forth for a couple of minutes. Next, the trainee sits on a chair in front of the virtual world display. The trainee is to move his lower legs and arms which is sufficient for this experiment. The remaining body is assumed to be in neutral skydiving posture. The virtual world includes the host and target skydivers and the sky, represented by a grid of stationary white dots, which enable the trainee to perceive motion of the host skydiver. The virtual world is viewed from behind and slightly above of the host skydiver.

b) Introduction: The trainee is introduced to the simulator and tries to fly the virtual skydiver using his body. After this acquaintance with the simulator, he gets the task to fly towards the target skydiver, without the KTM cues. The results are recorded.

c) Training: Planned according to the Explanation, Demonstration, Imitation, and Practice Method [31] originally developed for military training and also efficiently used for skydiver emergency procedures training.

1) **Explanation:** The two patterns to turn and to move forward/backward are explained to the trainee. The body feeling of the patterns is described, and what one needs to pay attention to. In addition explanatory aids were occasionally used: holding a stick emphasizes that the hands should stay in their original position, while the elbows move. Some trainees chose to keep the stick during the Imitation stage.
2) **Demonstration:** The patterns are demonstrated to the trainee, who is immediately asked to move the arms several times between two extreme positions of the 'turning' pattern. This is required for mapping, whereby the simulator can map the 'turning' pattern in a sitting position to a 'turning' pattern in an arched free-fall position.
3) **Imitation:** After mapping the trainee views himself in a belly-to-earth position in a virtual world and a half-transparent desired posture. Initially the desired posture corresponds to neutral fall, then continuous right turn, continuous left turn, and, finally, the desired posture becomes dynamic. The 'turning' pattern is activated in a slow sine wave:
$P_{desired}(t) = P_{neutral} + 10 \cdot \frac{\pi}{180} \cdot sin(2 \cdot \pi \cdot 0.25 \cdot t) \cdot MP_{arms}$
Notice that the maximum desired magnitude of the 'turning' pattern is small: 10 [deg], as can also be seen in Fig. 2. At each stage the trainee is required to make his posture coincide with the desired one such that the error between them stays within a pre-defined threshold for a few seconds. When all the imitating exercises are completed, the desired posture returns to neutral and the practice begins.
4) **Practice:** The purpose is to use the two patterns to fly to the target skydiver. KTM cues are continuously displayed, see snapshots in Fig. 3. Upon task completion the trainee is asked to state which cue was most helpful, and point out strengths and weaknesses of the user interface.

d) KTM Cues: The Feedback Posture is superimposed over the Desired Posture, Fig. 3, that is displayed half-transparent and in different color. The Desired Posture has a limited range, with each joint limited to a maximal allowed rotation, and rate of change. Thus the Desired Posture changes slowly enough to be perceived by a human observer, and stays within the ergonomic range of motion. The two arrows in front of the skydiver in Fig. 3 constitute the Forward Model cue: they show the predicted and the desired position and heading in $t_{predict}$ seconds, where $t_{predict}$ is a tuning parameter, here about 2 seconds. The position of the arrows, and pointing direction are computed by advancing the kinematic equations $t_{predict}$ seconds, undert the assumption that the following is known for the interval $[t, t+t_{predict}]$:

1) For the 'desired' arrow - the 'desired' angular velocity from the navigation module $\Omega_{com}(t)$, and the current linear velocity $V_{meas}(t)$, and
2) For the 'predicted' arrow - the current linear and angular velocities $V_{meas}(t)$ and $\Omega_{meas}(t)$, respectively.

The two arrows on screen start from the same point, in order to enhance their difference in orientation, and thus allow trainees to follow the path at their own pace, not necessarily

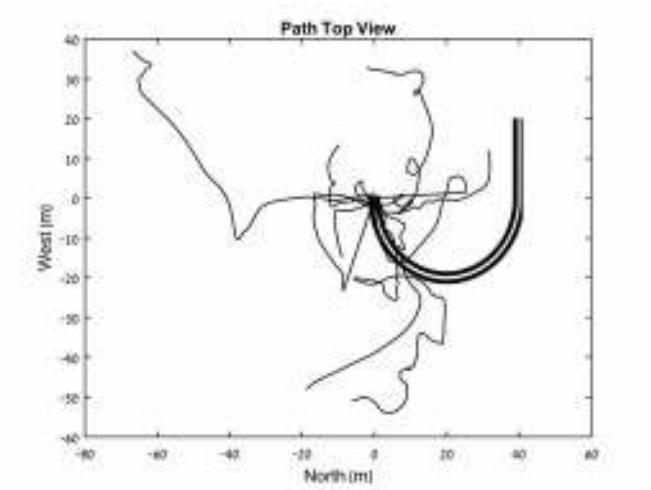

Fig. 4 Top view of the desired corridor (thick lines) and actual trajectories of participants 1-6 (thin lines) performing the task without the aid of KTM cues

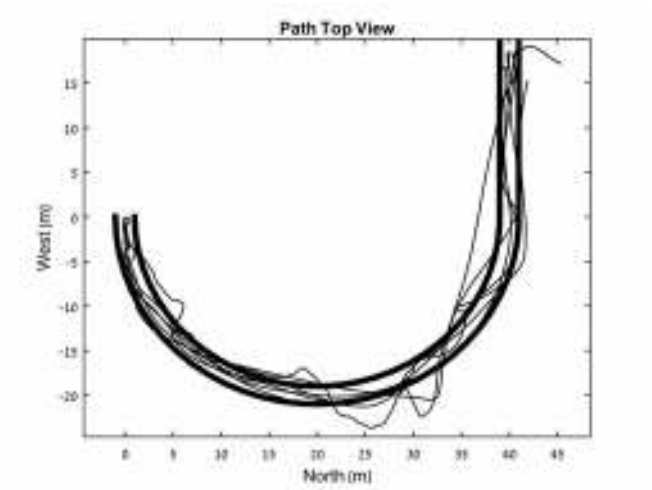

Fig. 5 Top view of the desired corridor (thick lines) and actual trajectories of participants 1-6 (thin lines) performing the task with the aid of KTM cues

as prescribed by the pre-planned speed profile.

If the trainee makes the two arrows coincide, his motion in the coming $t_{predict}$ seconds will be as desired.

e) The Desired Trajectory or Task: The Feedback and Desired Postures help to solve the Low Level Control problem: actuation, i.e. how to cause motion. The arrows representing the Forward Model help to solve the Medium Level Control problem: tracking the linear and angular velocity profiles, i.e. how much to move. One more cue is needed for the High Level Control problem: navigation, i.e. where to move. In our case this cue is a path connecting the initial location of the user with the targeted position, represented by two parallel lines, outlining a corridor of desired motion. The easiest and fastest way to the target is following this corridor at every time instant.

III. Results

Most important is that the KTM cues greatly improved the participants' ability to fly the virtual skydiver. Figs. 4 and 6 reveal that nobody succeeded to fly within the desired corridor without the KTM cues. After trying for a few minutes, all participants reported the task to be extremely hard and would probably take them hours or days of practice. However, after displaying the KTM cues, all the participants completed the task from the first attempt, within 1.5-2 minutes, see Figs. 5, 7 and 8-11!

As expected, see Section II-A, most participants reported that they focused on the Desired Posture cue. Two participants succeeded in switching between the mainly-in-focus Desired Posture and the briefly-glanced Forward Model arrow cues, allowing them to continuously keep in mind the deviation from the desired orientation, while concentrating on decreasing it by the posture adjustment. These participants completed the task faster, followed the corridor more accurately, and had less gap between the actual and desired body posture and yaw rate, for comparison see Figs. 8, 9. Notice, that in Fig. 9 the maximal required arm pattern angle command is

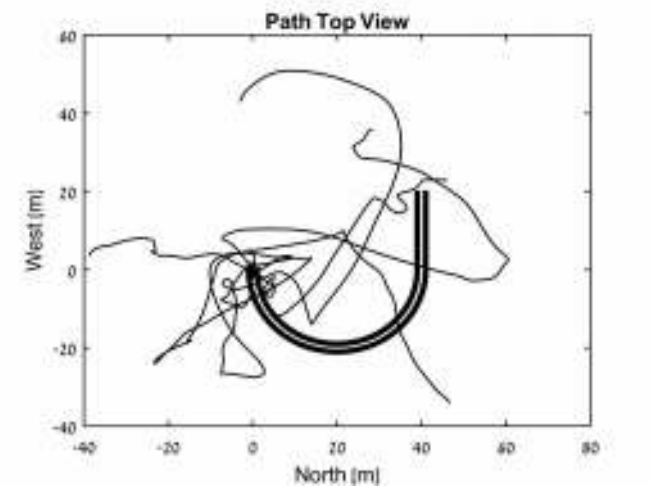

Fig. 6 Top view of the desired corridor (thick lines) and actual trajectories of participants 7-12 (thin lines) performing the task without the aid of KTM cues

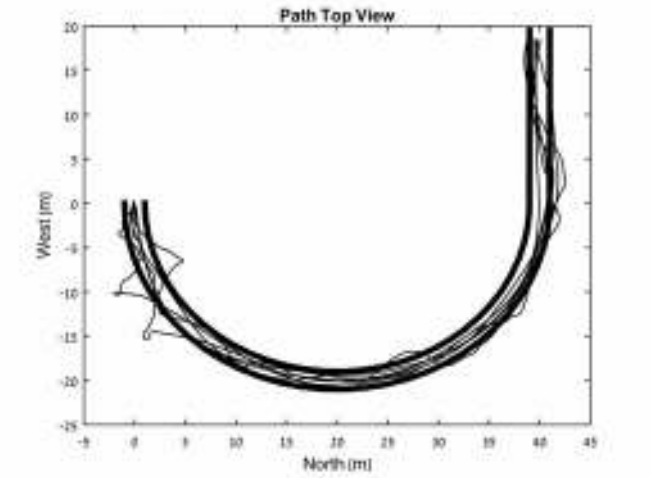

Fig. 7 Top view of the desired corridor (thick lines) and actual trajectories of participants 7-12 (thin lines) performing the task with the aid of KTM cues

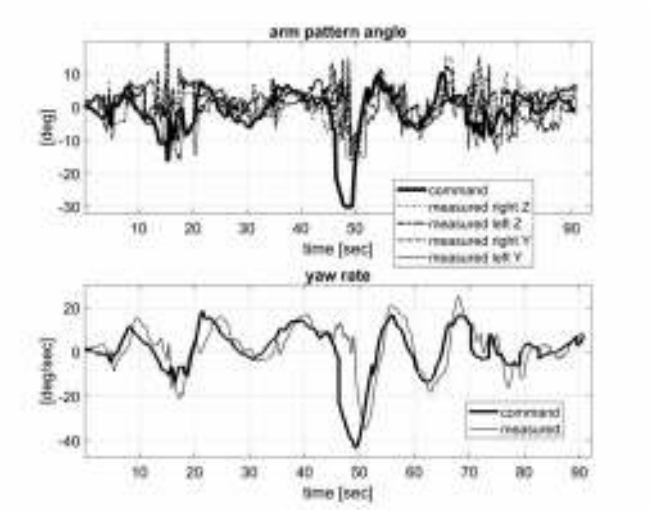

Fig. 8 Posture and motion of the participant, who focused only on the Desired Posture cue, compared to the commands. The shoulder flexion and rotation degrees-of-freedom are denoted by Y and Z, respectively

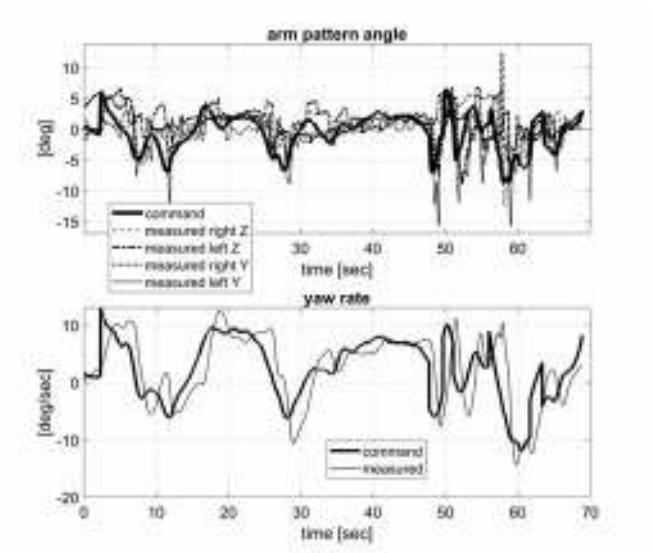

Fig. 9 Posture and motion of the participant, who focused on the Desired Posture cue but also glanced at the Forward Model cue, compared to the commands. The shoulder flexion and rotation degrees-of-freedom are denoted by Y and Z, respectively

8 [deg], and the maximal yaw rate command is 12 [deg/sec], while the corresponding values from Fig. 8 are 30 [deg] and 42 [deg/sec], respectively. This means that the participant who didn't look at the Forward Model cue had to apply more control effort, as he didn't look at the preview of how much effort is required. Instead, he learnt this from the posture adjustments he had to make, fixing the disparity between desired and measured yaw rate.

The participant with the most difficulty during the first attempt, reported that it took time to notice changes in the desired posture. Predictably, delay in following the desired posture caused the control loop to exhibit oscillations, see Fig. 10. Nevertheless, he completed the task within 110 [sec], compared with 70-90 [sec] for the others.

One of the participants focused mostly on the Forward Model cue, since she succeeded to acquire muscle memory for the 'turning' pattern from the Imitation stage. She was more focused and spent more time imitating the pattern than other participants. However, if one feels what the correct body movement is, it only remains to decide the movement amplitude, which is resolved by the Forward Model cue. The 'turning' pattern angle calculated by the KTM for this participant had the smallest variation over time among all participants, and the yaw rate command was followed most accurately, see Fig. 11. The maximal amplitude of the actually performed arm movement was 5 [deg], while it was in the range of 15-30 [deg] for the others.

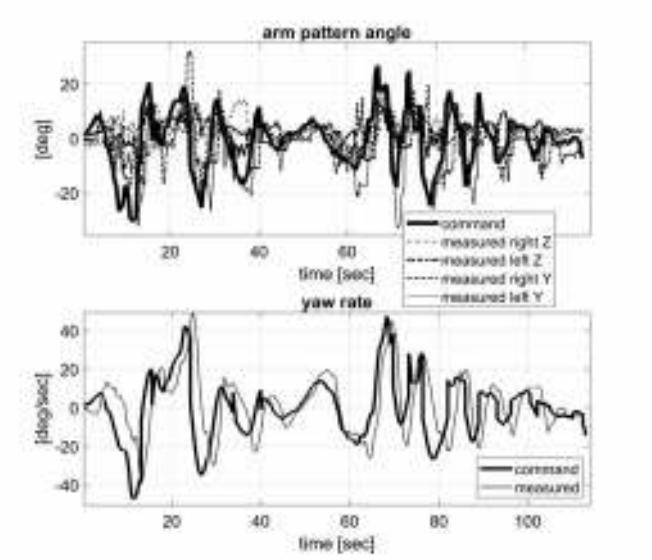

Fig. 10 Posture and motion of the participant, who felt a delay while focusing on the Desired Posture cue, compared to the commands. The shoulder flexion and rotation degrees-of-freedom are denoted by Y and Z, respectively

IV. Discussion

There were two additional volunteers who could not participate for the following reasons:

a) Restricted rotation of the shoulder joint: One person had much less freedom of movement in the shoulders and could not repeat the movement required by the 'turning' pattern. This problem is known among older people and those not engaging the shoulder joints in every day activities. The solution is to offer multiple movement patterns that involve different DOFs but produce the same maneuver, as was discussed in Sec. II-A.

b) Extremely unusual body dimensions: One volunteer was extremely tall (over 195 cm), and the neutral body pose offered by the simulator was highly unstable for him (caused backsliding). Also, the suggested 'turning' pattern caused more backsliding than the 'forward' pattern could compensate for. The compensation term is $G21$ in Eq. 4. Skydiving instructors report that teaching tall people is challenging as they need to adopt completely different body postures than others. The KTM is the tool to resolve this problem: It can determine the neutral posture and design efficient movement patterns for

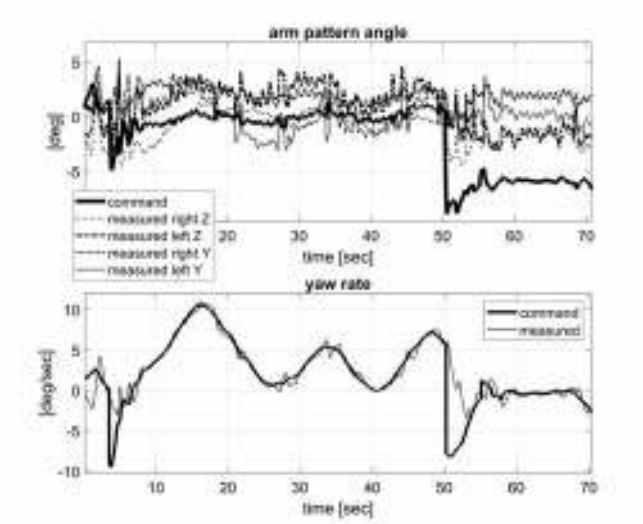

Fig. 11 Posture and motion of the participant, who focused mostly on the Forward Model cue, compared to the commands. The shoulder flexion and rotation degrees-of-freedom are denoted by Y and Z, respectively

any type/size of body. This should be done offline, by the means of Skydiving Simulator updated with the individual body parameters. For trainees with an intermediate level of skill, who already have an accustomed neutral posture, it is possible to measure this posture and use it in the KTM as $P_{neutral}$. The training system will be more effective if a neutral posture and movement patterns are designed individually and the controllers are tuned accordingly.

Based on the experiment results additional improvements for the KTM controllers can be suggested. Firstly, computation of the tracking errors ($\Omega_{com}(t) - \Omega_{meas}(t)$ and $V_{com}(t) - V_{meas}(t)$) can include prediction. Suppose, the trainee implements the desired posture with a certain delay, as in Fig. 10. It is possible to estimate this delay time t_{delay}, solve the equations of motion to predict his angular and linear velocities in t_{delay}, and use them for calculating the tracking errors, which are the controllers' inputs: $\Omega_{com}(t) - \Omega_{meas}(t + t_{delay})$ and $V_{com}(t) - V_{meas}(t + t_{delay})$

Secondly, in case of large gap between desired and executed postures, as in Fig. 8 around time=50 [sec], adaptive control can be introduced. The simulation computes at each step what would be the angular and linear velocities if same velocity profiles are tracked by an ideal performer. The disparity between these velocities and the 'measured' ones is fed into classic PI controllers. Their outputs are added to the angles commands describing the desired movement patterns.

Adjusting the controllers to match the trainee's learning ability will help the initial stage of practice, when the Desired Posture cue is the most dominant.

V. Conclusions

The Proof-of-Concept experiment, which required human subjects to control a virtual skydiver by the means of their body, has been conducted. The task was to fly along a pre-defined path. This path was calculated by the navigation module, which plans the desired path and speed profile off-line, and then calculates on-line the desired yaw rate. The yaw rate and speed profiles were tracked by the two controllers that output the angle commands for the two corresponding movement patterns. The movement patterns define the desired body posture. Every level of the control hierarchy was represented in the cues displayed to the trainees: the desired path, velocities, and posture. The cues proved to be very efficient, since all the participants completed the task from the first attempt.

This means that the trainees acted as a part of the closed control loop tracking the desired path, where they fulfilled the role of an actuator. Their body movements were continuously guided by the visual cues without sensing the actual motion and in the absence of knowledge about the free-fall dynamics. This system with human-in-the-loop was stable and enabled trainees to control the virtual skydiver, thus indicating the success of the Proof-of-Concept experiment. The hypotheses of the interface between the human and automatic control parts of the system were also verified: At the beginning of the practice the Desired Posture cue was the most dominant. The Forward Model cue became dominant when trainees were able to perform the pattern from muscle memory, i.e. without looking at the posture cue. At this stage, trainees learn to adjust the amplitude of the pattern to the task, using the Forward Model cue as a feedback. Next, a variety of tasks should be introduced to the trainees, so that they get acquainted with the maneuver range, that can be achieved by the trained pattern. Next step after that can be performing the same tasks by the means of different movement patterns. Designing an efficient training program and building a KTM prototype will be the future work.

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An Historical Revision of Change and Configuration Management Process

Expedito Pinto de Paula Junior

***Abstract*—** Current systems such as artificial satellites, airplanes, automobiles, turbines, power systems and air traffic controls are becoming increasingly more complex and/or highly integrated as defined in SAE-ARP-4754A (Society Automotive Engineering - Certification considerations for highly-integrated or complex aircraft systems standard). Among other processes, the development of such systems requires careful Change and Configuration Management (CCM) to establish and maintain product integrity. Understanding the maturity of the CCM process based in historical approach is crucial for better implementation in the hardware and software lifecycle. The sense of work organization, in all fields of development, is directly related to the order and interrelation of the parties, changes in time, and record of these changes. Generally, it is observed that engineers, administrators and managers invest more time in technical activities than in organization of work. Moreover, these professionals are focused in solving complex problems with a purely technical bias. The CCM process is fundamental for development, production and operation of new products, especially in safety critical systems. The objective of this paper is to open a discussion about the historical revision based on the standards focus of CCM around the world in order to understand and reflect the importance across the years, the contribution of this process for technology evolution, to understand the maturity of organizations in the system lifecycle project and the benefits of CCM to avoid errors and mistakes during the Lifecycle Product.

***Keywords*—**Change, Configuration Management, Historical, Revision.

I. INTRODUCTION

Most executives, consultants and project management consider that CCM (Change and Configuration Management) has some effect on the performance of the project. This observation is based in experience, intuition and personal value systems. Despite that, it is very hard to demonstrate the benefits of CCM. According to [2] in research realized in 2010, 2500 managers representing 120 organizations of different sizes from around the world, shows that the implementation of CCM increases productivity in projects by 40%. The research also includes better results:

1) Customer Satisfaction (~12%).
2) Employee Satisfaction (~7%).
3) Better Cost Management (~8%).
4) Specific Improvements in Efficiency (~15%).
5) Reducing time to respond customers (~5%).
6) Better standard quality (~15%).

Other additional aspects can be observed according with [4] includes:

1) Product attributes are defined as performance parameters.
2) The product configuration is documented as baseline to establish the control changes.
3) Production repetitiveness.
4) Product correlation with requirements.
5) Change proposals and their impacts are identified.
6) Unpleasant surprises are avoided.
7) Cost reduction during project execution.

II. DEFINITIONS

According to [8], the objective of CCM is to *"establish and maintain control of requirements; documentation; and artifact produced throughout the system lifecycle"*. However, [1] presents the most broader definition based in the principal standards used as references in different industries that *"configuration management is a process and/or discipline applying technical and administrative direction and surveillance to 1) identify and define; 2) controlling; 3) recording and reporting; 4) verify the functional and physical characteristics of configuration items; the release and changes of this items; the status configuration items and change requests completeness and correctness of configuration items throughout the system lifecycle"*.

III. THE IMPORTANCE OF CCM IN INDUSTRY

CCM focuses on establishing and maintaining consistency between assets of the product for performance proposals,

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including the functional and physical attributes with its requirements, design, tests, operational information, as well as other possible assets throughout the product lifecycle. Most certification authorities require in their process to product certification the implementation of the CCM process in the product lifecycle including software and hardware.

Once that most of the products has been more complex and highly integrated the CCM must be required to have a better management during the lifecycle otherwise all entire product lifecycle will be characterized as a "big mass" loosing market presence. The good sense of organization during the lifecycle product could be a differentiation to accelerate go to marketing, because for complex systems usually spent to much time developing and testing. Is not possible to develop and test the chaos. Around the world CCM has become essential as a best practice for several development methods and certifications such as PMBOK (Project Management Book of Knowledge), CMMI (Capability Maturity Model Integration), INCOSE (International Council of System Engineering), DevOps (Development and Operation Approach), PLM (Product Lifecycle Management) and other frameworks for product development. More than ever, CCM is become strategic specially because all entire product development organizations need to create multiple customizations of the products for multiple markets without multiplying engineering data, complexity and cost, otherwise the product could be impracticable and to maximize the investment in developing improving engineering efficiency and productivity reusing assets.

IV. A QUICK HISTORICAL APPROACH BASED ON STANDARDS

In order to understand the importance and the relevance of CCM process as bases for a product development the historical revision will help us the evolution of this process across decades and the expansion of the industry in the last century. In this paper, the historical approach is based in standards, manuals and best practices published and divided by 4 phases for organization proposals that includes:

1) Initiation (After II World War) – from 1950 to 1968
2) Military (During the Cold War) – from 1968 to 1991
3) Industrial (After Cold War) – From 1991 to 2000
4) Expansion (Nowadays) – From 2000 to Nowadays

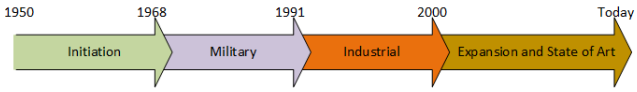


Fig.1 CCM Historical Phases

A. Phase 1 – Initiation (After II World War)

According with [6] the CCM emerged as a formal management approach by USAF (U.S Air Force) to US DoD (United State Department of Defense) in the 50th century for the technical management of hardware items. The first two standards including changes management concepts were ANA-BULL-390 (Change Engineering, to Aircraft) and ANA-BULL-391 (Change, Engineering to Aircraft Engines, Propellers and Equipment in Production) developed by USAF (United State Air Force) to control changes in aircrafts and aircraft engines. In 1963, emerged ANA-BULL-445 (Engineering Changes to Weapons, Systems, Equipment's and Facilities) focus in engineering changes unifying the two previously standards ANA-BULL-390 and ANA-BULL-391. In 1965, NASA adopt the concept of change management in Apollo using NPC-500-1 (Apollo Change Management Manual) standard that was wrote based in ANA-BULL-445 and AFSCM 375-1 (Change Management during the Development and Acquisition Phases by Air Force System Command). At this moment, the World was moving to the Cold War based in the Spatial Program. See Appendix A.

B. Phase 2 – Military (Cold War)

In 1968 emerged the military standards denominate "480 series". As the starting point ANA-BULL-445 for change management the new standards it was created, the MIL-STD-480 (Configuration Control-Engineering Changes, Deviations & Waivers) and MIL-STD-481 (Configuration Control-Short Form). Other standards also were created based in the Apollo program NPC-500-1. At this time, CCM process are used basically by military industry as a competitive and differentiation aspect, developed and maintained by DoD (US Department of Defense). Furthermore in 1980 emerged DO-178 (Software Considerations in Airborne Systems and Equipment Certification) which was intended to regulate the embedded software development in equipment's and aeronautic systems. See Appendix B.

C. Phase 3 – Industrial (after Cold War)

After consolidation by US DoD of 480 standard series, emerges a set of new standards in private sector for CCM as best practices or mandatory for project development. In 1996, ESA (European Space Agency) created the ECSS-M-ST-40A (Space Project Management – Configuration and Information Management) based in ESA-PSS-1-11/1989 (Configuration Management and Control for ESA space system) as the first public standard in European aerospace context. In addiction to the initiative of ESA, emerged the first maturity models by SEI (Software Engineering Institute) for software development in 1993. Shortly thereafter, arise the CMM (Capability Maturity Model) v 1.1 for systems engineering process. A new version of RTCA-DO-178B (Software Considerations in Airbone Systems and Equipment Certification) in aerospace emerged at the same time of the most used aerospace standard in the world SAE-ARP-4754 (Guidelines for Development for Civil Aircraft Systems). In this period, the first manual of systems engineering also appears, such as: NASA/SP-6150-1995 (NASA Systems Engineering Handbook) and the INCOSE Handbook of Systems Engineering. As the industrial sector emerges specifically standards about CCM such as ISO10007 (Guidelines for Configuration Management) and EIA-649 (Configuration Management). See Appendix C.

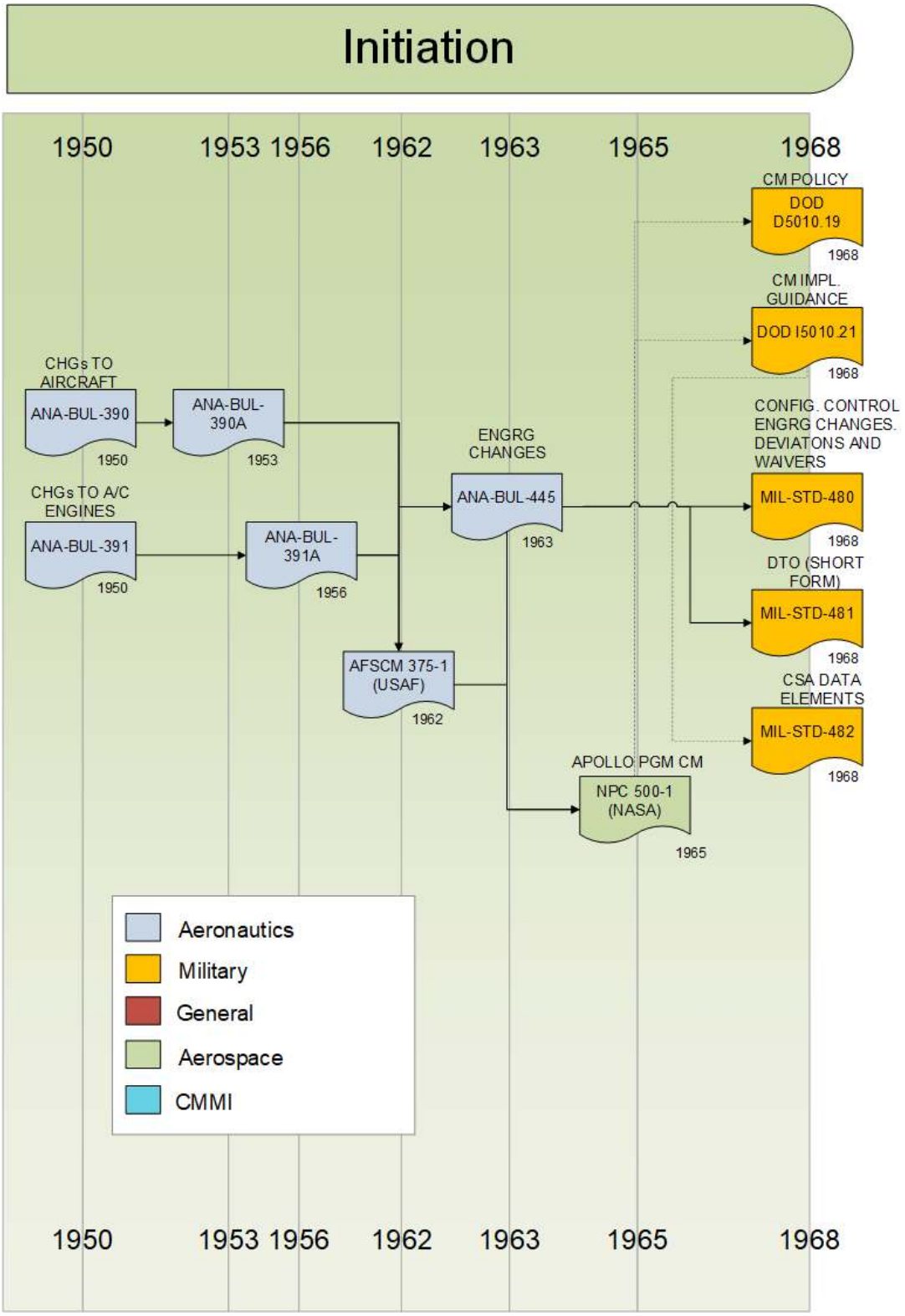
D. Phase 4 – Expansion

This phase is characterized as expansion of the concept to other field of studies such as logistics, IT, health, energy and others. Concepts as ALM (Application Lifecycle Management) and PLM (Product Lifecycle Management) has as bases CCM process to organize and accelerate the product development including automatic mechanisms. Most of these news areas adopt CCM as obligatory to guarantee traceability of the products and certification purposes as pre-requirements go to market such as medical devices, aircrafts, energy systems, rail systems, automotive and others. The new version of CMMI (Capability Maturity Model Integration) came with development, acquisition and services all including CCM as bases to implementation process. The MILHDBK-61 (Handbook for Configuration Management) it was updated two times. The same happen for ISO10007 and EIA649. The new version of ECSS-M-ST-40 it was consolidated. In aeronautics, ARP4754 and DO-178 it was updated for hardware and software porpoises. In 2001, NASA presents NASA-STD-0005 (Configuration Management Standard) based in EIA-649. New versions of ECSS-M-ST-40 were present. In aeronautics updates to ARP4754, DO178 and the emerging of RTCA-DO-254 (Design Assurance for Airbone Electronic Hardware) based in DO178B came to consolidate the concept of CCM as required to certification process. In 2001 NASA also present a unified standard that includes project management and systems engineering denominated as MSFC-HDBK-3173 (MSFC Systems Engineering Handbook). The systems engineering manuals were updated at this phase specially INCOSE with 6 updates. In 2002, FAA (Federal Aviation Administration) creates the systems engineering manual also updated furthermore.

V. CONCLUSION

The expansion phase present that based in the high regulated products such as aircrafts, automobiles, medical devices, electronics, transportation systems, nuclear systems and others process as CCM is the bases for the certification and best practices that includes development companies in the market. Based in the market requirements for certification products, development organizations must include CCM process in the product lifecycle as a competitive and obligatory issue. The CCM emerges in Aeronautic as a standard to support in the maintenance of the aircrafts during the cold war focus in cost management and is becoming one of the most strategic and required process in the industry as a differentiator in the business. The consolidation of the concept and dissemination throughout different areas has been required as basis to start new products in software and/or hardware systems. Several software companies are specializing in this process in order to offer suites to the market including concepts such as ALM and PLM offering competitive advantage to the entire product lifecycle. The adoption of the CCM process is not optional is mandatory to have a product in the market.

APPENDIX A


Initiation
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DOD I5010.21
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CHGs TO AIRCRAFT
ANA-BUL-390
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ANA-BUL-390A
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ENGRG CHANGES
ANA-BUL-445
1963
CONFIG. CONTROL ENGRG CHANGES. DEVIATONS AND WAIVERS
MIL-STD-480
1968
CHGs TO A/C ENGINES
ANA-BUL-391
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ANA-BUL-391A
1956
DTO (SHORT FORM)
MIL-STD-481
1968
AFSCM 375-1 (USAF)
1962
CSA DATA ELEMENTS
MIL-STD-482
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APOLLO PGM CM
NPC 500-1 (NASA)
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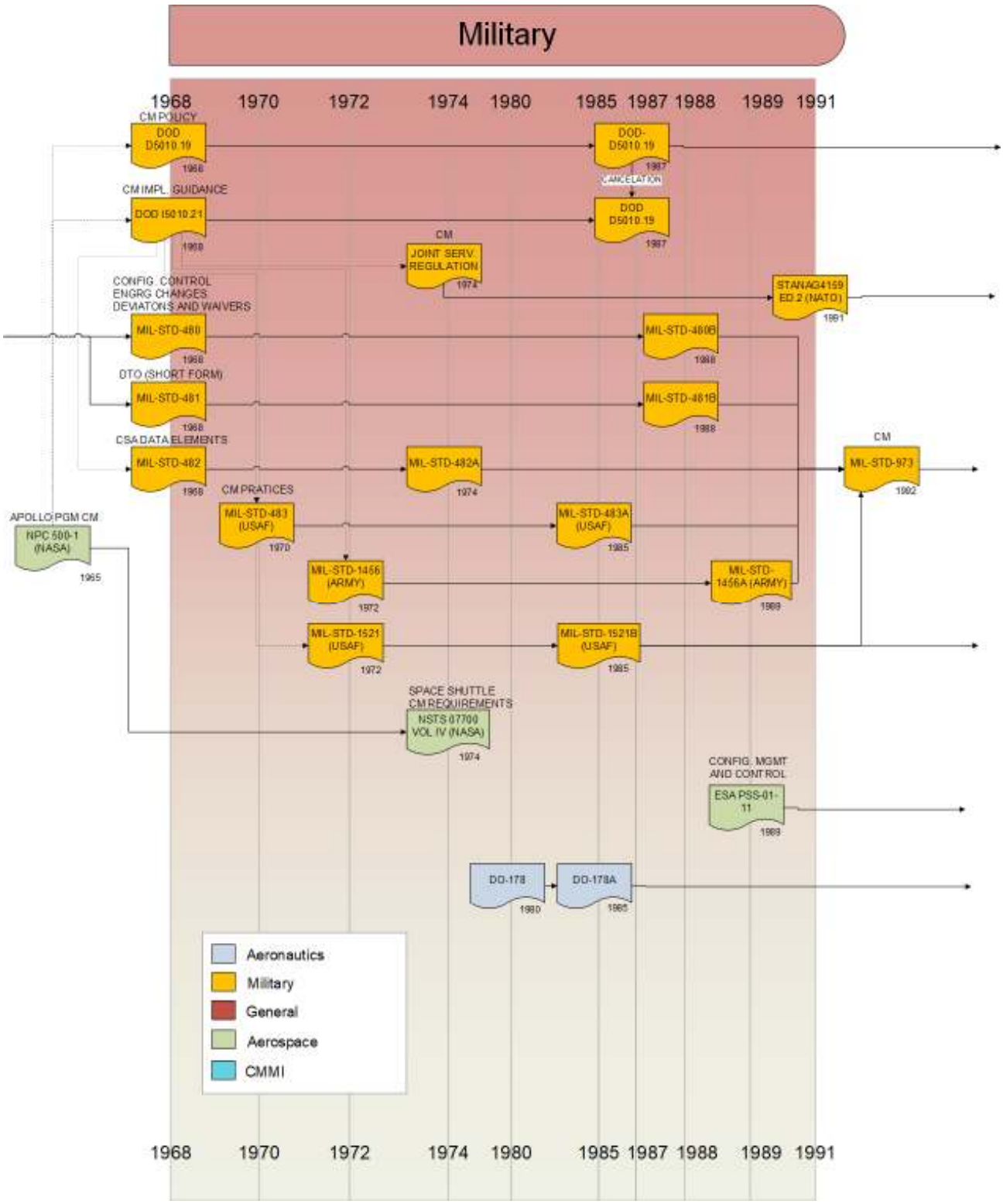
General
Aerospace
CMMI

APPENDIX B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CM IMPL. GUIDANCE
DOD I5010.21
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JOINT SERV. REGULATION
1974
CONFIG. CONTROL ENGRG CHANGES DEVIATONS AND WAIVERS
MIL-STD-480
1968
MIL-STD-480B
1988
STANAG4159 ED.2 (NATO)
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DTO (SHORT FORM)
MIL-STD-481
1968
MIL-STD-481B
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CSA DATA ELEMENTS
MIL-STD-482
1968
MIL-STD-482A
1974
CM
MIL-STD-973
1992
CM PRATICES
MIL-STD-483 (USAF)
1970
MIL-STD-483A (USAF)
1985
APOLLO PGM CM
NPC 500-1 (NASA)
1965
MIL-STD-1456 (ARMY)
1972
MIL-STD-1456A (ARMY)
1989
MIL-STD-1521 (USAF)
1972
MIL-STD-1521B (USAF)
1985
SPACE SHUTTLE CM REQUIREMENTS
NSTS 07700 VOL IV (NASA)
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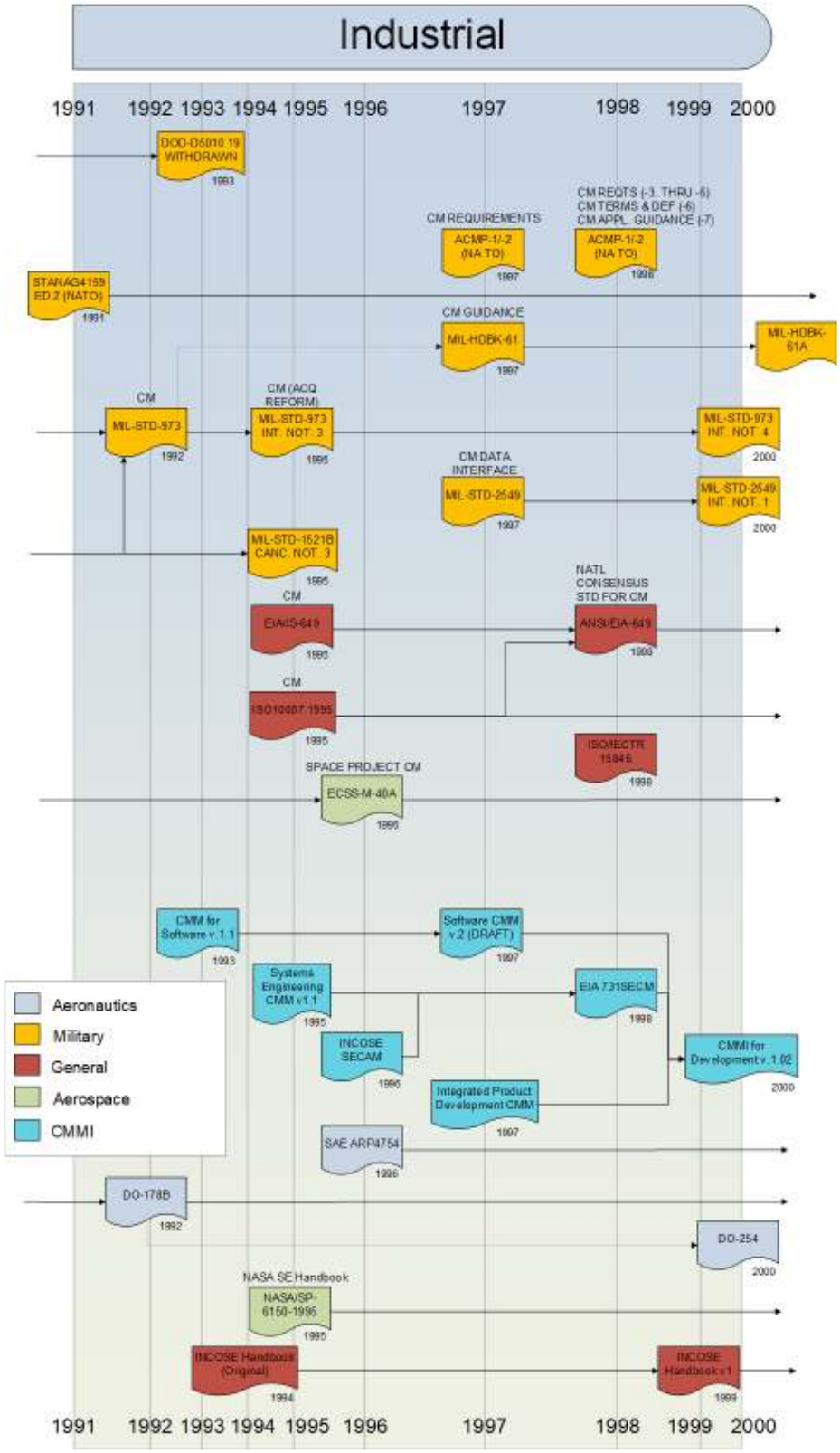
APPENDIX C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1997
CM REQTS (-3, THRU -5)
CM TERMS & DEF (-6)
CM APPL. GUIDANCE (-7)
ACMP-1/-2 (NATO)
1998
STANAG4159 ED.2 (NATO)
1991
CM GUIDANCE
MIL-HDBK-61
1997
MIL-HDBK-61A
CM
MIL-STD-973
1992
CM (ACQ REFORM)
MIL-STD-973 INT. NOT. 3
1995
MIL-STD-973 INT. NOT. 4
2000
CM DATA INTERFACE
MIL-STD-2549
1997
MIL-STD-2549 INT. NOT. 1
2000
MIL-STD-1521B CANC. NOT. 3
1995
NATL CONSENSUS STD FOR CM
CM
EIA/IS-649
1995
ANSI/EIA-649
1998
CM
ISO10007:1995
1995
ISO/IECTR 15846
1998
SPACE PROJECT CM
ECSS-M-40A
1996
CMM for Software v. 1.1
1993
Software CMM v.2 (DRAFT)
1997
Systems Engineering CMM v1.1
1995
EIA 731SECM
1998
INCOSE SECAM
1996
CMMI for Development v. 1.02
2000
Integrated Product Development CMM
1997
SAE ARP4754
1996
DO-178B
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DO-254
2000
NASA SE Handbook
NASA/SP-6150-1995
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INCOSE Handbook (Original)
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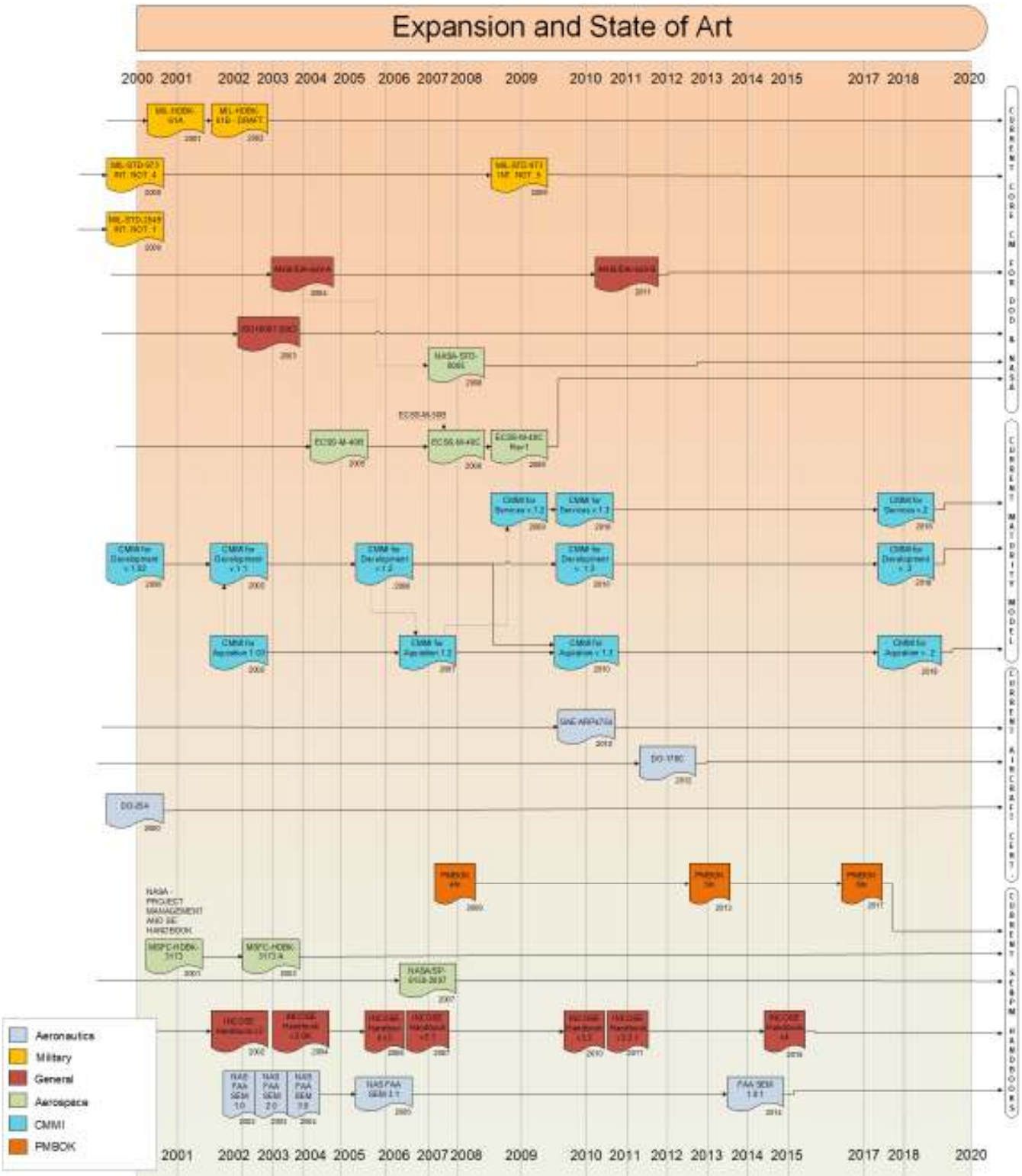
APPENDIX D


Expansion and State of Art
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CURRENT CORE CMM FOR DOD & NASA
CURRENT MATURITY MODEL
CURRENT AIRCRAFT CERT.
CURRENT SYSTEM HANDBOOKS
NASA - PROJECT MANAGEMENT AND SE HANDBOOK
Aeronautics
Military
General
Aerospace
CMMI
PMBOK

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Lemon Establishment and Production Costs and Profitability Analysis in Ventura County, 2020

Don Stewart

***Abstract*—**California lemon acreage was at ~47,000 acres in 2018-19 of which Ventura County accounts for 31%. Acreage in Ventura County was at 14,407 in 2019. There have been some increases in acreage since 2018 and according to the University of California Cooperative Extension (UCCE) Farm Advisor, Ben Faber, growers are planting in previous lemon ground and even in what used to be vegetable and strawberry crops grounds. The last cost study was published in 1997. Growers asked for new studies to evaluate if more expansion will be feasible. This study provides an estimate of sample costs to establish and produce lemons in Ventura County, California in 2020. We developed this study for growers, prospective growers, agricultural lenders, and all who are involved or have an interest in the establishment/reestablishment and production of lemons in Ventura County. We present estimates of per acre financial requirements for the establishment of a lemon orchard and production. Also, we analyzed enterprise profitability. The production practices are considered typical for lemon production in Ventura and obtained from local growers and Farm Advisor in 2019-20. Costs for labor, materials, equipment, and custom services were provided by growers and allied industries in 2019-20.

***Keywords*—** lemon, establishment, production, costs.

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Dragonflies (Odonata) Reflect Climate Warming Driven Changes in High Mountain Invertebrates Populations

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***Abstract*—** Much scientific research in the last 20 years has focused on the influence of global warming on the distribution and phenology of living organisms. Three potential responses to climate change are predicted: individual species may become extinct, adapt to new conditions in their existing range or change their range by migrating to places where climatic conditions are more favourable. It means not only migration to areas in other latitudes, but also different altitudes. In the case of dragonflies (Odonata), monitoring in Western Europe has shown that in response to global warming, dragonflies tend to change their range to a more northern one. The strongest response to global warming is observed in arctic and alpine species, as well as in species capable of migrating over long distances. The aim of the research was to assess whether the fauna of aquatic insects in high-mountain habitats has changed as a result of climate change and, if so, how big and what type these changes are. Dragonflies were chosen as a model organism because of their fast reaction to changes in the environment: they have high migration abilities and short life cycle. The state of the populations of boreal-mountain species and the extent to which lowland species entered high altitudes was assessed. The research was carried out on 20 sites in Western Sudetes, Southern Poland. They were located at an altitude of between 850 and 1250 m. The selected sites were representative of many types of valuable alpine habitats (subalpine raised bog, transitional spring bog, habitats associated with rivers and mountain streams). Several sites of anthropogenic origin were also selected. Thanks to this selection, a wide characterization of the fauna of the Karkonosze was made and it was compared whether the studied processes proceeded differently, depending on whether the habitat is primary or secondary. Both imagines and larvae were examined (by taking hydrobiological samples with a kick-net), and exuviae were also collected. Individual species dragonflies were characterized in terms of their reproductive, territorial and foraging behaviour. During each inspection, the basic physicochemical parameters of the water were measured. The population of the high-mountain dragonfly Somatochlora alpestris turned out to be in a good condition. This species was noted at several sites. Some of those sites were situated relatively low (995 m AMSL), which proves that the thermal conditions at the lower altitudes might be still optimal for this species. The protected by polish law species Somatochlora arctica, Aeshna subarctica and Leucorrhinia albifrons, as well as strongly associated with bogs Leucorrhinia dubia and Aeshna juncea bogs were observed. However, they were more frequent and more numerous in habitats of anthropogenic origin, which may suggest minor changes in the habitat preferences of dragonflies. The subject requires further research and observations over a longer time scale.

***Keywords*—** alpine species, bioindication, global warming, habitat preferences, population dynamics.

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Creating an Efficient Strain for Purity of TEV-Labeled Recombinant Proteins

Naieme Goharifar

Abstract— Peptide tags are protein sequences that are used in recombinant proteins mainly in order to increase the solubility or facilitate the purification of the proteins. Generally, the used tags need to be removed accurately and appropriately after the production and purification of the recombinant proteins. Using the some proteases such as TEV protease is a common method to remove the fusion tags. This protease is a highly sequence-specific cysteine protease, produced by Tobacco etch virus (TEV) and considered as one of the best endpeptidases for removing of the tags. We hypothesized that by induction of the bacterial cells to produce this protease at an appropriate time after production of the target recombinant protein, it is possible to digest and separate the tag from the target protein when the function of dissolution tag to improve recombinant protein solubility is completed. Accordingly, in the present study, a plasmid was constructed that exclusively encoded TEV protease using arabinose as the inducer. This vector was independent of the vector used to express the recombinant protein. In this plasmid, TEV encoding sequence was located under the BAD promoter, and p15A Ori, which is compatible with pBR322 Ori in pET expression vectors was used. We also used Neo-Kan resistance gene in the plasmid that allows the selection of transformed bacteria that already had pET vector with Amp resistance gene. This approach ensures that TEV encoding vector and pET vector expressing the recombinant protein to be compatible and can remain in the bacterial cells simultaneously. Following transformation of constructed TEV plasmid to *E. coli*, a new subspecies is acquired in which TEV protease is expressed by induction with arabinose that results in controlled production of TEV protease at an appropriate time to ensure that removal of the tag is taken place after completion of folding of recombinant protein.

Material and methods— First, the specific primers that contained suitable restriction enzymes at the 5' ends were designed for amplification of GST tagged TEV coding fragment (GST.TEV) form pGEX-4T1 vector. Amplified GST.TEV was cloned into a T vector and subsequently sub-cloned into the expression vector pBAD-GIIIA, called pBAD/GST.TEV. The transcription terminator (TT) sequence was then amplified from pBAD-GIIIA vector by proper primers and sub-cloned downstream of GST.TEV fragment in the pBAD/GST.TEV. The resulted vector was named pBAD/GST.TEV/TT. Moreover, the coding sequence of neomycin-kanamycin phosphotransferase (Neo-Kan) was amplified from pEGFPC1 vector by the suitable primers and was sub-cloned in pBAD/GST.TEV/TT, downstream of transcription terminator that resulted pBAD/GST.TEV/TT/Neo-Kan. At the end, the p15A Ori segment was amplified from the pG.TF2 vector by designed primers and sub-cloned into pBAD/GST.TEV/TT/Neo-Kan downstream of Neo-Kan fragment. The constructed final vector was pBAD/GST.TEV/TT/Neo-Kan/p15AOri, which was briefly called pBAD/GST. Also, the accuracy of all cloned sequences was confirmed by DNA sequencing. Finally pBAD/GST plasmid was used to transform Shuffle T7 Express *E. coli* cells and the expression of soluble TEV protease was confirmed using SDS-PAGE. The activity of the recombinant TEV protease was evaluated in the Shuffle cells that were previously transformed by a pET32 vector expressing IGF-1 tagged with Thioredoxin (TRX).

Conclusion— In this study, a new subspecies of Shuffle T7 Express *E. coli* was obtained by transformation of an expression plasmid, which could produce the soluble and active TEV protease. This protease could cleave its specific site between TRX and IGF-1 in the host bacterial cells and separate TRX tag from the recombinant IGF-1, which was expressed by an independent pET vector. Therefore, by this approach there is no need to digest the recombinant fusion protein after extraction from the bacteria. Indeed, *in vivo* digestion of recombinant fusion protein can have a significant effect on facilitating and reducing the costs of downstream purification process.

Keywords— E. coli, Expression vector, Fusion protein, Protein tag Recombinant protein, TEV protease.

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Analyzing Emerging Scientific Domains in Biomedical Discourse: Case Study Comparing Microbiome, Metabolome, and Metagenome Research in Scientific Articles

Kenneth D. Aiello, M. Simeone, Manfred Laubichler

***Abstract*—** It is increasingly difficult to analyze emerging scientific fields as contemporary scientific fields are more dynamic, their boundaries are more porous, and the relational possibilities have increased due to Big Data and the shrinking of governmental science budgets. In biomedicine where funding, medical categories, and medical jurisdiction are determined by distinct boundaries on biomedical research fields and definitions of concepts, ambiguity persists between the microbiome, metabolome, and metagenome research fields. This ambiguity continues despite efforts by institutions and organizations to establish parameters on the core concepts and research discourses. Further, the explosive growth of microbiome, metabolome, and metagenomic research has led to unknown variation and covariation making application of findings across subfields or coming to a consensus difficult. This study explores the evolution and variation of knowledge within the microbiome, metabolome, and metagenome research fields related to ambiguous scholarly language and commensurable theoretical frameworks via a semantic analysis of key concepts and narratives. A computational historical framework of cultural evolution and large-scale publication data highlight the boundaries and overlaps between the competing scientific discourses surrounding the three research areas. The results of this study highlight how discourse and language distribute power within scholarly and scientific networks, specifically the power to set and define norms, central questions, methods, and knowledge.

***Keywords*—**Biomedicine, Conceptual Change, History of Science, Philosophy of Science, Science of Science, Sociolinguistics, Sociology of Knowledge.

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Digital Inclusion Imperative for 4IR: Digital Skills Competence in Rural South Africa

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***Abstract*—** This paper explores digital skills competence in a rural province in South Africa and considers the alignment of digital skills competence to the national digital inclusion agenda. Digital skills competence can help stimulate socio-economic development in a developing economy. This paper explores the digital skills confidence of citizens who live on the fringes of the South African digital economy. This accelerated rate of technology adoption fueled by the pressures of 4IR present a new challenge of digital segregation where socio-economic standing dictates the digital skills competence of citizens. To establish the current level of participant digital skills competence, the researcher administered a questionnaire to collect empirical data for this qualitative study. This study relied on purposive sampling techniques to determine sample size. Understating the digital demands / capabilities of users will assist in planning for South Africa's transition into Fourth Industrial Revolution (4IR). The findings of this study show that rural users of technology have low-levels of confidence in using commonly adopted information and communication technologies. Based on these findings and the exacerbated 4IR technology demands as expressed in the National e-Strategy, this paper posits that rural communities are one of the economic clusters that must be rapidly digitally up skilled if they are to become meaningful contributors or beneficiaries to the 4IR digital socio-economy.

***Keywords*—** Digital skills, e-literacy, e-astute, e-skills for 4IR, Fourth Industrial Revolution, 4IR, Digital segregation.

I. Introduction

ADVANCES in technology are transforming how we connect, relate and engage with the world at a rapid pace. Technology is becoming a more powerful, mobile, accessible and more affordable daily. This ubiquitous adaption of technology exposes users to new technology linked challenges and limitations that proliferate in cases where access and usage of technology is limited. This is the case for developing economies in particular, they are characterized by the low levels of e-skills aptitude of their work force and general citizens. Technology is now an important factor in stimulating economic growth and it has the potential to address sustainable development challenges within communities [1].

The Commission of European Communities to the Council, the European parliament, the European Economic and Social Committee and the Committee of the Regions on E-skills for the 21st Century [2], deems it vital to address e-skills issues. This is in response to the growing demand for highly skilled practitioners and users of technology, necessitated by the fast-changing requirements of industry. Ensuring that every citizen is digitally literate will ensure that citizens become active contributors to this new digital economy.

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II. The Changing Digital Landscape

The Fourth Industrial Revolution (4IR) is redefining how the individual, industry and society conducts activities. This revolution is relies heavily on the use of technology to perform certain functions. These changes can occur at and individual *level (user-to-user communication / trade)*, organizational level (*user-to-organisation or organisation-to-organisation communication / trade*), or communal *(user-to-community communication / trade)*. The concept of a 'user' in the 4IR era is comparable to that of the 'consumer' in systems thinking. In 'Systems thinking' relations between technology and users are explained in terms of B-to-B *(Business-to-Business)* or B-to-C *(Business-to-Consumer)* or C-to-C *(Consumer-to-Consumer)*. However, for the purposes of this study the term 'user' is preferred instead of the term 'consumer'. The 'user' in seen as a co-creator of knowledge where the 'consumer' is a recipient. Similarly, the organization represents a broader view of an entity that could be a non-governmental organization (NGO), a Public Sector entity or a Private Sector entity. Unlike the 'Business' referred to in systems thinking the term 'organisation' is preferred. [3] suggests the fourth industrial revolutions has a resulted in the 'blurring' effect with regards to the roles between 'work of humans' and 'work of machines'. Within the framework of 4IR industry has evolved, the commercial industry now characterized by the flow of information or processes between people, people and machines and between machines themselves. Slusarczyk postulates that the Internet of Things (IOT) allows for carrying out an order for production, implementation and delivery of product with no human involvement in the process.

Explaining the transition for the first to the fourth 'Industrial Revolution' [4] refers to four stages of an ongoing process, namely:

I. *1st Industrial Revolution:* Mechanical production on the basis of water and steam (occurred towards the end of the18th century)

II. *2nd Industrial Revolution:* Introduction of the conveyor belt and mass production (occurred at the beginning of the 20th century)
III. *3rd Industrial Revolution:* Digital automation of production by means of electronics and IT began around the mid-70s [5].
IV. *4th Industrial Revolution:* Characterized by Cyber-Physical systems (which was looming on the horizon in 2014).

In 2016, [6] affirms the predicted shift towards the fourth stage when he refers to a 4IR vision characterized by production digitization and networking. According to him, the potential of 4IR was reliant on fundamental concepts such as 'Internet of Things services' and 'Cyber-physical production systems'. [7] defines a cyber-physical system as a mechanism controlled or monitored by computers, tightly integrated with the internet and its users. According to [7], smaller and more powerful sensors, the mobile internet, machine learning and artificial intelligence drive this revolution are drivers of 4IR. The Internet of Things services use various identification and tracking technologies in smart objects; practical use for these is in smart homes, traffic logistics, environmental protection, public security, intelligent fire control, industry monitoring, personal health and other fields [8].

Though we have much to look forward to with the advent of each industrial revolution, the 4IR is poised to bring both advantages and disadvantages for the South African economy. [7] notes that 4IR technological advancements have great potential to cause disruption. Cited in [3] are three 4IR phenomena now evident now evident in communities are:

TABLE I
4IR PHENOMENA *(SLUSARCZYK, 2018)*

Phenomena *(source Paprocki, 2016 cited in [3])*	**Examples of related technologies**
– common digitization and ensuring constant communication between people themselves, people and devices and between devices themselves	Social media platforms *(e.g Facebook, Twitter, Instagram)* Smart devices *(e.g. exercise, healthcare, cars, mobile phone)*
- more and more frequently implemented disruptive innovations, which allow for a stepwise increase in efficiency and effectiveness of the operation of the socioeconomic system	Transportation *(e.g Uber, Taxify, Ride share)* Accommodation *(e.g Airbnb)* Financial *(e.g. Crypto currency – BitCoin, Payment apps, Paypal, Crowdfunding)* Web based video *(e.g Netflix)*
- the achievement of such development of machines that they gain the ability for autonomous behavior through the use of artificial intelligence in the process of their control.	Advance Robotics *(e.g. surgical systems, robotic prosthesis, exoskeletons)*

[9] Cautions that every industrial revolution brings with it benefits and challenges to the socio-economic status of any country affected by it. There is a resultant need to align different communities with the rapidly changing world of technology, by empowering with digital skills.

III. DIGITAL SKILL AND COMPETENCIES

Each industrial revolution ushers in growing fears from the labour market about job losses that could result as systems and processes become more automated. [10] echoes that the success of a company now relies on the ability of its employees to use technology creatively and innovatively. While is it difficult to pre-empt changes to the labour market, [10] predicts that the advent of 4IR will required a shift in the type of skills needed in the labour market "In next 20 years, there will be a wave of technological changes that will affect both producers and consumers. Introduction of robots, artificial intelligence, 3D printing and other components of new industrial revolution will lead to spread of skills in use of digital devices among population and demand for highly qualified technical specialists." The accelerated pace at which these changes in technology are occurring necessitates that changes in the labour market also have to occur rapidly. In this 'digital era', jobs will require a certain level of digital competency. In response to these changes in 2014 the European Union (EU) developed a 'Digital Competence Framework' tool aimed at improving citizens 'digital competence, helping policy makers formulate policies that support digital competence building, and to plan education and training initiatives to improve digital literacy [7].

Fig. 1 EU 2014 - Overview of a Digital Competence Framework *(cited [7])*

The Digital Competence Framework 5 competency areas and 21 associated competencies and descriptors of three proficiency levels (basic, intermediate and proficient). [11] classifies 4IR developments according to the following two categories:

I. Developments that have shaped society *(People and the internet; Computing; Communications and Storage everywhere; the Internet of Things; Artificial intelligence (AI) and big data; the sharing economy and distributed trust; and the digitization of matter),* versus
II. Developments that have influenced the workplace *(Big-data driven quality control; Robot-assisted production; Self-driving logistic vehicles; Production line simulation; Smart supply network; Predictive maintenance; Machines as a service, Self-organizing production; Additive manufacturing of complex parts; and Augmented work, maintenance, and service).*

Changes observed in the labour market will respond to the demands of the development that have influenced the workplace. Whereas the concept of socio-economic development will respond to the developments that have shaped

both the workplace and society. The link between digital skills and socio-economic development is discussed in the next section.

IV. Digital Skills for Socio-economic Development

[8] Introduce the relevant topic of possible challenge of social inequality (con-centration of benefits in just a small percentage of people) aggravation, stimulated by the progression of 4IR. [12] elaborates on the concept of 'digital capital-ism' in developing countries linking it to the 'digital divide' (internet penetration reported at 45.3 percent at the end of 2018). This is still far behind the reported 80 percent reported for the same period in developed economies. This raises concern on Africa's ability to capitalize on the technological developments ushered in by 4IR to improve the socio-economic status of its citizens. According to Mahnkopf, only just over a quarter of Africa's population is using the internet. While South Africa has a greater internet penetration, most of its communication infrastructure is concentrated amongst the white affluent population [12]. De-spite these challenges, South African government has realized the urgency of aligning the country with 4IR. In the National Development Plan (NDP) [13] presented to parliament in 2012 likens energy, transport and ICT as enablers that can be used to speed up service delivery, support analysis, build intelligence and create new ways to share, learn and engage.

The South Africa government currently finds itself faced with a unique challenge; the country is 'techno-aware' enough to know the probable detrimental results of not positioning the country for 4IR, whilst dealing with the hereditary social-economic challenges pertaining to basic needs. The topic of 4IR has received support from the highest office in the country, with the establishment of a Presidential Commission on 4IR in April 2019. The mandate of this commission is to "identify relevant policies, strategies and action plans that will position South Africa as a competitive global player." South African legislation obliges government to address the prevailing national inequality. The National Integrated ICT Policy white paper [14] highlights a range of interventions to ensure that everyone in SA, regardless of who they are, where they live or their socio-economic status can improve the quality of their lives through accessing the benefits of participating in the digital society enabled by e-Skills. This White paper also introduces the National e-Strategy discussed below.

V. National e-Strategy and Roadmap

As discussed in the sector above, the South African government prioritises putting policies, systems, processes and implementing programs aimed at aligning the country with the demands of the 4IR. The tone of the South African government gravitated towards the adoption of 4IR as early as 2016 when the National Integrated ICT Policy White Paper was gazette [14]. This White paper was an indicator that government had taken decisive action by formalising their intention through legislation. *"This White Paper introduced a range of interventions to ensure that everyone in South Africa, regardless of who they are, where they live or their socioeconomic status could improve the quality of their lives through accessing the benefits of participating in the digital society."* [14] The White Paper (2016) identified three pillars that informed government's approach for transforming South Africa into a *Digital Society*: Digital Transformation of Government, Digital Access, and Digital Inclusion. Enhancing the digital skills capacity of citizens is aligned with the 'digital access' pillar. This pillar is defined in the white paper focuses "…on ensuring all citizens have the capacity to actively participate in the digital society and realise the potential of ICTs to improve their quality of life (including e-skilling, development of digital identity verification systems and promoting trust and security)."

The National e-Strategy [15] is the one piece of legislation envisaged in 2016 as a key success factor in supporting the South African government's efforts of creating an environment that would allow different societal and economic sectors to grow by using of ICTs. The proposed National e-Strategy and Roadmap (2017) provides details and timelines for achieving the target of a 'digitally enabled society' as it relate the digital skills of citizens [15]:

TABLE II
DIGITALLY ENABLED SOCIETY TARGET
(National e-Strategy extract [15])

e-Government Strategic Outcome	Deliverables	Target (3 years)	Responsible Party
Digitally-enabled Society	Develop e-Skills programmes for rural and underserved communities. Establish centres of excellence in the municipalities and provinces to capacitate and empower rural areas.	2017-2021	DTPS, NEMISA and all other government departments.

The gazetted National e-Strategy [15] also makes provision for an annual review of the document to accommodate the reports of the Digital Industrial Revolution Working Group. The strategy details specific interventions relating to 'skilling the nation':

I. Transformation of the National Electronic Media Institute of SA into a fully-fledged National e-Skills Institute shall drive the development of e-skills in society.
II. The e-Skills Institute shall collaborate with other training institutions to achieve through a National e-Skills Plan to be finalised in the first half of the 2018/19 financial year.

The National e-Skill Institute has the ambitious target of achieving over 70% digital literacy (number of South Africans who can use ICT services and devices to transact) rate. This study sought to determine the digital skills competence in a rural province in South Africa. The next section presents a discussion of method-ology followed in this study for sampling, collecting and analysing data.

VI. Methodology

This primary research study takes an interpretivist approach with quantitative methods used for collecting data. The research method for this descriptive study is primary data collection using a questionnaire. The aim of using a questionnaire is to receive comparable answers from all participants. To determine our sample size this study used purposive sampling (*a probability sampling technique)*. [15] defines this purposive sampling as a deliberate sampling process of choosing respondents based on their ability to provide needed information. A survey was administered to participants from the following representative groups: *unemployed youth and small medium and micro enterprises (SMMEs)*. Participants from these two groups are viewed as more prolific users of technology were invited to workshops during which the survey was administered. Over two hundred *(205)* questionnaire were completed. Thematic analysis was used to derive meaning to the data collected. A summary of the findings is presented in the next section.

VII. Results

A. Perceived digital skills competence

Demographic profile:

The respondents were young people all under the age of twenty-six but older than fifteen years. The race classification of ninety-five percent of the participants was 'Black Africans' and five percent was classified as 'Coloured'. There was a forty-five (Male) to fifty-five (Female) gender split. Thirty five percent of the respondents came from rural areas, with the remaining sixty-five percent residing urban / peri-urban areas.

ICT Applications (Knowledge):

The majority (70%) of the participants had received some computer related training in the past. The participants rated how much they knew about a number of commonly used applications, such as the internet, email and social media. Their responses are summarised in the Table III below:

TABLE III
ICT APPLICATIONS *(Knowledge)*

		Self-rated level of knowledge about:				
		Very Poor	***Poor***	***Average***	***Good***	***Very Good***
A	Internet	*5%*	*0*	*10%*	*35%*	*50%*
B	Email	*0*	*15%*	*25%*	*20%*	*40%*
C	Social Media	*0*	*0*	*10%*	*20%*	*70%*
D	Communication (e.g. Skype, You Tube)	*0*	*5%*	*25%*	*10%*	*60%*

The most widely known application by the study participants was social media applications all the participants acknowledging that they were in the (10%) average users of social media and 70% of the participants considered themselves to be very knowledgeable about social media. The second applications that a significant amount of the participants knew about were the applications used for communication or entertainment such as Skype or You Tube with 60% of the participants indicating that they knew these applications very well. Only 50% of the participants considered themselves to have a high level of confidence about what they knew about the internet. Participant knowledge was the most concerning with only 40% of the participant indicating their knowledge about email was very good. In the next section the participants' responses to questions related to their ability to use various applications is presented.

ICT skills (Confidence):

The sector above gave us an indication about the participant's presumed *ICT knowledge*. The findings tabled below show us the participants' level of confidence when it comes to using ICT technologies.

TABLE IV
ICT SKILLS *(Confidence)*

		Self-rated level of skills in:				
		Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
A	Use a computer.	*0*	*10%*	*20%*	*30%*	*40%*
B	Use word processing application.	*5%*	*0*	*25%*	*35%*	*35%*
C	Operate a mobile device.	*0*	*5%*	*10%*	*20%*	*65%*
D	Communicate via email.	*5%*	*5%*	*30%*	*20%*	*40%*
E	Use Social Media.	*5%*	*10%*	*10%*	*10%*	*65%*
F	Participate in online Forum discussions.	*25%*	*35%*	*15%*	*15%*	*10%*
G	Download/Upload content online.	*10%*	*0*	*40%*	*20%*	*30%*

An interesting aspect to note in the participants' responses to questions relating to their ability to use certain technologies, is that social media and mobile devices ranked as the two main applications that the majority (65%) of the participants were most confident in using. This discovery is not surprising as the ubiquitous adoption of mobile technologies and the increased

rate of social media assimilation to popular culture is a worldwide phenomenon. A more concerning discovery is the low level of confidence a significant number of the participants exhibited when it comes to using technologies such as: computers (30%), word processing application (25%), mobile devices (15%), email (25%), social media (25%), online forums (75%) and uploading / downloading content online (40%). These technologies are commonly used in workplaces and homes in today's society. Except in the case of using online discussion forums, the majority of the participant who are confident using all the other (computers, word processing, mobile devices, email, social media and downloading/uploading content online) technologies exceeds those who are not. This is an indicator that South African citizens may not be at the digital skills readiness levels required for them to make a meaningful economic contribution in this fourth industrial revolution.

Sharing information online:

The changes in technology and prolific use by citizens introduces a vulnerability inherent to use its use. Cybercrime is becoming synonymous with the use of Internet. The participants admitted to sharing personal data with strangers online (see summary below):

TABLE V
SHARING INFORMATION ONLINE

		Yes	***No***
A	Physical address.	*20%*	*80%*
B	Age or date of birth.	*70%*	*30%*
C	Gender.	*95%*	*5%*
D	Race.	*80%*	*20%*
E	Your real name.	*65%*	*35%*
F	Bank details.	*0%*	*100%*
G	Where you went to school.	*70%*	*30%*
H	Hobbies.	*70%*	*30%*
I	Religion.	*65%*	*35%*
J	Phone number.	*65%*	*35%*
K	Details about your parents.	*5%*	*95%*
L	Contents *(furniture etc.)* of your home.	*0%*	*100%*
M	Family activities (e.g. gatherings).	*35%*	*65%*

The majority did not have a problem with sharing personal information online. This information ranged from their date of birth (70%), gender (95%), race (80%), real name (65%), name of school attended (70%), hobbies (70%), religion (65%) and their phone number (65%). The data also revealed areas where participants exercised caution when sharing information online. The two most protected (by participants) pieces of personal information with 100% of the participants indicating that they would not share are banking details and the contents of their homes. The participants' address (80%) and information about family gatherings (65%) were the only other two areas where most of the participants indicated that they would not share these details online. The next section presents a discussion of the concluding remarks.

VIII. Conclusions & Recommendations

The results presented in the above section confirm the concerns raised by Guoping [8] (possibility of increased social inequality), and Mahnkopf [12] (dig-ital capitalism) as a probability in the case of South Africa. The margins between the participants who possess the minimum digital skills required to function in the digital 4IR economy are too far apart. There are skills that citizens would have acquired in the previous industrial revolution for example: ability to use a word processing applications, use a computer or email that remains a challenge for too many of the participants. These challenges are in some way related to a computer and this could be an indicator of a greater underlying problem of the participants' ability to access computers. In developing economies, access to technology infrastructure remains a challenge.

These challenges have not inhibited from accessing social media applications. Social media now forms an integral part of communication in a personal and organisational context. The number of participants who indicated they have good social media knowledge / skills confirms this. However, a challenge linked to social media / internet use are the associated cyber threats / cybercrime. The participants are candid with sharing personal information online, thus making themselves vulnerable to cyber criminals. Criminals are targeting vulnerable users through various means (phising, vishing, smishing, viruses, Trojan horses etc.). The e-astute citizen should have a good knowledge about the eminent threats, and as a result should behave, in a safe manner when using technology.

The findings of this study show that only a small amount of progress towards attainment of the ambitious targets expressed in the National e-Strategy of digitally skilling 70% of the South African citizens by 2021. South African government should accelerate efforts of capacitating citizens with the digital skills needed for them to make a meaningful contribution of the economy in the 4IR era. This process has to happen concurrently with the country's economic development initiatives. Digital skills competence in the near future will become a strong determinant of global socio-economic progression.

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Disruptive Behavior Thwarts Students' Academic Outcomes – Experimental Evidence on Students' Agency Mechanism

Tamas Keller

***Abstract*—** We test how disruptive school behavior thwarts students' academic achievement. Disruptive school behavior hinders students' focus on school-specific tasks, thus leads to lower school achievement. Therefore, freeing students of their disruptive school behavior (student-agency mechanism) may lead to better achievement. We designed a large-scale, pair-matched field experiment that randomized students at the classroom level (N = 1,789 students in 148 classrooms). Treated students received information and, in the accompanying period of practice, training to avoid disruptive school behavior. Students in the control condition received a placebo intervention about preventing the consumption of unhealthy food. In concordance with students' agency mechanism, treated (relative to control) students achieved higher scores on a computer-based, non-teacher-graded math test in schools with a more extended campaign practice period. We conclude that students perform higher if behavioral interventions release them from their disruptive behavior. Implications of our study design are discussed for future research.

***Keywords*—** academic outcomes, cluster-randomized field experiment, disruptive school behavior, effect modification, pre-registered design.

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Influence of the Pandemic Consequences on Information Technology Specialists: Self-Estimated Salary Level Relative to the Labour Market and Job Satisfaction

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***Abstract*—** The purpose of this paper is to discover the impact of the pandemic consequences on the self-estimated job satisfaction rate in the field of Informative Technologies. There are some studies that claimed that the majority of IT specialists benefited from telework and gave extra opportunities for further professional development.
The aim of the paper is twofold: Firstly, the self-estimate level rating of salary relative to the market in the Western Europe region in 2019 has been discovered. The current study has been undertaken among business and data analysts. It enables us to conclude that most professionals are satisfied by their salary rate and working conditions. Secondly, the poll has been repeated one year later. Some conclusions about how pandemic consequences change the IT professional opinion about their job conditions and salary rate were formed. The most professionals, who tried working by distant, marked that they would like continuing working using such technology. Whereas some of them preferred combining working in the office and working from home.

***Keywords*—** salary rate, innovative technologies, sociology of professions, pandemic consequences

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Ethnography Applied to the Architectural Design Studio. Case Study of Escola Superior Gallaecia

Monica Alcindor

***Abstract*—** Architects have a clear influence on their relationships through the buildings they make, but they usually have tacit knowledge of these anthropological issues when they provide architectural solutions being able to marginalize both the meanings of the place and an in-depth analysis of the social nature of the existing spaces which are inseparable from the technical, constructive and typological characteristics in a general architectural way. Through an ethno-historic study drawn on the life stories of four lecturers of architectural design studio carry out in a private university located in Portugal, it is defined an ethnographic methodology based on the assumption that the knowledge of reality is always polyhedral and is enriched by the confluence of different perspectives, strengthening joint action as a community. The goal of the development of this methodology is to provide the architect with a valuable working tool in an attempt to overcome the difficulties involved in giving and strengthening local relevance and to capture the factors that are significant for the community to which it is intended to provide a service.

***Keywords*—**Ethnographic Methodology, PAR, Portugal, Social Spacialities.

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Design and Implementation of a Platform for Adaptive Online Learning Based on Fuzzy Logic

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***Abstract*—** Educational systems are increasingly provided as open online services, providing guidance and support for individual learners. To adapt the learning systems, a proper evaluation must be made. This paper builds the evaluation model Fuzzy C Means Adaptive System (FCMAS) based on data mining techniques to assess the difficulty of the questions. The following steps are implemented; first using a dataset from an online international learning system called (slepemapy.cz) the dataset contains over 1300000 records with nine features for students, questions and answers information with feedback evaluation. Next, a normalization process as preprocessing step was applied. Then FCM clustering algorithms are used to adaptive the difficulty of the questions. The result is three cluster labeled data depending on the higher Wight (easy, Intermediate, difficult). The FCM algorithm gives a label to all the questions one by one. Then Random Forest (RF) Classifier model is constructed on the clustered dataset uses 70% of the dataset for training and 30% for testing; the result of the model is 99.9% accuracy rate. This approach improves the Adaptive E-learning system because it depends on the student behavior and gives accurate results in the evaluation process more than the evaluation system that depends on feedback only.

***Keywords*—** Soft Computing, Machine learning, Adaptive, fuzzy logic, data mining

I. Introduction

The educational system is a constant evolution to make the learning process better and meet the requirements of students with satisfactory results. Modern educational systems have evaluation methods that measure the students' performance while taking into consideration the differences between students. At the level of knowledge, it identifies students' interests and measures the degree of students' interaction with a specific topic [1]. In traditional education systems, the teacher should have the experience to determine the learning abilities of each student, to adjust the learning environment in the classroom to fit the students' needs. However, there are always limits to the levels where teachers can change the learning environment to give an ideal education for each student [2].

The needs and preferences of each student must be determined to enhance the learning process, but it is very difficult to provide all this attention to an individual student in the classic classroom of traditional education systems [3]. Online learning system has become very important for students because it can be used anytime, and anywhere, the ease of access and the quality of content made the E-learning platform highly used globally replacing the classic classroom learning system [4]. In addition, it will help to determine the average grades of the student and the difficulty criteria of the recommended online Course. Artificial intelligent technology such as fuzzy logic has been developed and applied in adaptive online education platforms to help Decide and adopt the Machine in a way similar to the way the human thinks [5].

II. Problem Statement

Adaptive online learning system uses student's feedback to evaluate the difficulty of the questions, the evaluation that depends on the student's feedback only is inaccurate for two reasons

- the students give inaccurate feedback based on their personal opinion.
- some adaptive learning systems ask for feedback after displaying a group of questions and use this single feedback as a perception of difficulty for several questions.

III. The Aim of the Paper

Improving adaptive learning system by using artificial intelligence techniques:

- Design and implement an adaptive learning platform that uses the fuzzy logic system to recommend online courses for the student by calculating the average grade of a student's exam, and determine the difficulty criteria of the recommended course.
- Build an adaptive learning system to evaluate the perception of question difficulty. By using data mining techniques and algorithms. Also, propose and evaluate a mechanism for a dynamic difficulty adjustment.

IV. Fuzzy C Means Adaptive System (FCMAS)

The proposed evaluation models to improve the adaptivity of the education system. The dataset used in this approach is based on the online system slepemapy.cz the data set collected almost 1,300,000 answers containing details about the question (target item, options), the student ID, the chosen answer, and also the timing information. This dataset is used to study the impact of adaptive behavior of an educational system for learning geographical facts. The appropriate di□culty of questions is evaluated using student feedback-reports (perception of question di□culty).

Depending only on the student feedback will not provide accurate evaluation, and therefore the second approach proposes an evaluation model depending on the proxy measure of student motivation (number of questions answered and the response time of each answer) without the student feedback. The adaptability is achieved by automatically applying different data mining techniques and algorithms for extracting and building evaluation models. The results show improvement in the adaptive behavior by clustering the difficulty level of the questions into three clusters (easy, intermediate, difficult). The Labelled data become input to a random forest classification algorithm to evaluate the system.

A. The Dataset

publicly available data set collected to evaluate online system slepemapy.cz as mention in chapter 2 and sample of the dataset The dataset contains 2 CSV files (commas are used as delimiter) [6]:

- answers of users practicing location of places; collected more than 1,300,000 answers from roughly 20,000 learners the dataset contain detail about (target item, options), the student ID, the chosen answer, also the timing information. The data set has no personal information about students, only log their IP address.
- users' feedback about difficulty. The learners evaluate the difficulty of questions. After 30, 70, 120, and 200 answers the system shows the dialog "What is the difficulty of asked questions?", learners choose one of the following options: "Too Easy", "Appropriate", "Too Difficult". Within 16 000 records. Units[7]

B. The Proposed FCMA System

The general structure of the proposed FCMA system consists of three phases: Data pre-processing, Clustering phase, and Classification phase, as shown in Fig. 1.

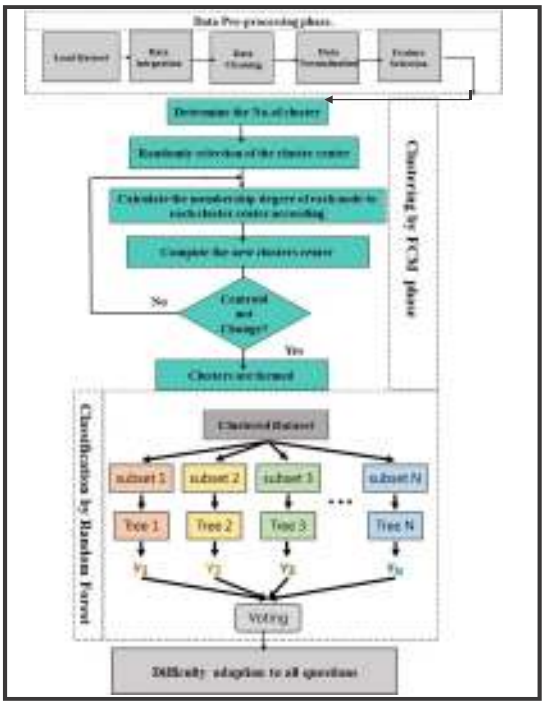

Fig. 1. The general structure of the proposed FCMA system.

C. Data Pre-processing Phase.

Data preparation comprises those techniques concerned with analyzing raw data of online adaptive systems to yield quality data, increase the efficiency and performance of the FCMA System. This mainly includes data collecting, data integration (combine the dataset CSV files into a single CSV file), data cleaning (Clean the missing value and rubbish Data), data normalization (Convert the dataset from symbolic to numeric value by coding method then apply Log2 method), data reduction (Apply feature selection to reduce Data). A sample of the pre-processed data is shown in Fig. 2.

```
3.43,3.62,3.62,3,1,2,4,9,2,2
3.63,3.62,3.62,0,2,1,2,9,2,2
3.34,3.62,3.62,2,1,1,3,9,2,2
3.43,3.63,3.62,2,1,1,3,9,2,2
3.85,3.62,3.62,2,1,2,1,9,2,2
3.24,3.63,3.62,4,1,2,3,9,2,2
3.48,3.62,3.62,0,1,1,3,9,2,1
4.14,3.62,3.62,0,1,1,3,9,2,1
3.77,3.63,3.62,2,1,1,1,9,2,1
3.56,3.62,3.62,2,1,2,4,9,2,2
3.41,3.62,3.62,2,1,2,1,9,2,2
3.59,3.62,3.62,0,2,1,1,9,2,2
3.81,3.62,3.62,6,1,2,1,9,2,2
4.35,3.62,3.62,3,1,1,4,9,2,2
3.78,3.62,3.62,2,1,2,4,9,2,2
```

Fig. 2. The pre-processed dataset

D. Clustering phase

In this phase, the pre-processed dataset is to divide into three clusters (Easy, Intermated, and Difficult) to label the difficulty of questions in the online learning system. Clustering is made by applying the Fuzzy C Mean (FCM) algorithm. In this algorithm all the nodes will participate in cluster formation; at the beginning, the cluster's center (c) is selected randomly by the sink from the nodes that deployed in the area of interest.

Fig. 3 below describes the flowchart of the FCM based on nodes clustering. Each row in the dataset has been processed one

by one and the result is labeled data for all the questions in the dataset. Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text

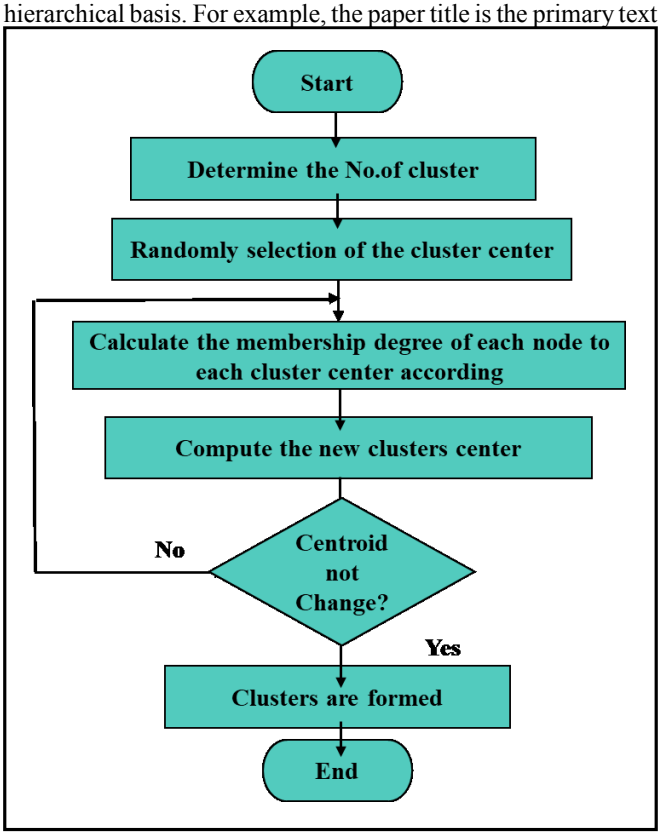

Fig. 3. FCM clustering algorithm.

The result of the FCM algorithm can be shown in Fig. 4 as two columns add to the pre-process dataset. The first columns consist of three values each value repent cluster category (1=easy cluster, 2=Intermediate, 3=difficult). The second column represents the degree of the clustering.

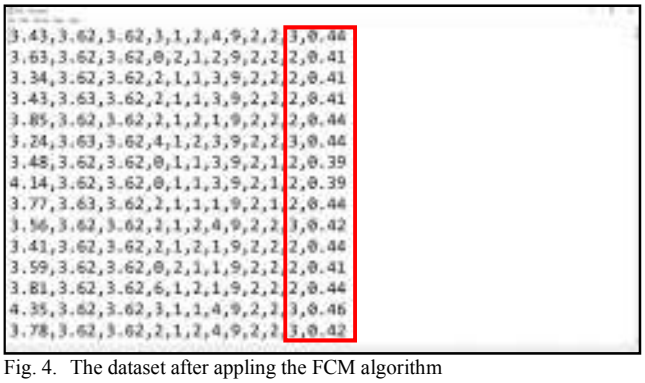

Fig. 4. The dataset after appling the FCM algorithm

E. Classification phase

The FCMA system uses the random forest algorithm for the classification of the clustered dataset file produced from the FCM algorithm. A file of 10 features and the class label was used as input to the random forest algorithm. The FCMA system uses samples of data to train the random forest classifier 70%, from the dataset and 30%, to test the model build by using the random forest algorithm. The models that are built using random forest classifier applied to data consist of 836,230 instances.

F. The Implementation of FCMAS

The implementation of FCMAS is a four-step process:

- Load Data: user can Load CVS File to apply the rest of the FCMAS steps.
- Standardization: the user can apply the Log2 Function on the Loaded Data.
- C-Means Clustering: user applies fuzzy clustering algorithm FCM on the pre-processed data.
- Classification Algorithm: user apply the Random Forest classifier algorithm to the Clustered Data.Table Type Styles

G.FCMAS Evaluation Results

The evaluation of FCMAS is presented in this section by finding the accuracy of difficulty level for all the questions and comparing them with feedback evaluation. The evaluation results of the FCMAS can be explained in Fig. 5 where the total number of data instances = 836230, FCM algorithm value that matches feedback value = 374893, and FCM algorithm value that mismatch feedback value = 461337.

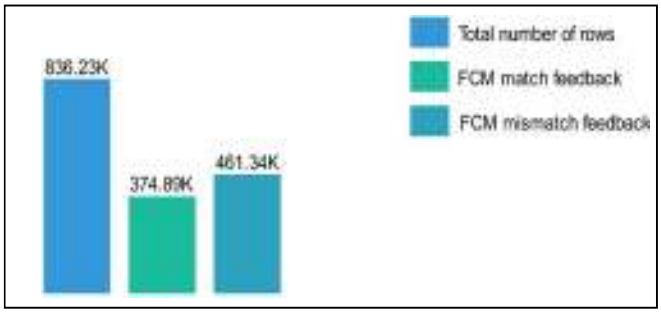

Fig. 5. Category of instances value

determine the number of match and mismatch value between FCM and the feedback value help to calculate the rate of change, which value remains the same, and which value has been changed. Fig. 6 shows the rate percentage where the rate in match value = 374893/836230 = 0.44. while the rate in mismatch value = 461337/836230 = 0.55. analyzing this result shows that the rate of mismatch value is bigger than the rate of match value which means Feedback evolution on the difficulty of the equations is not accurate.

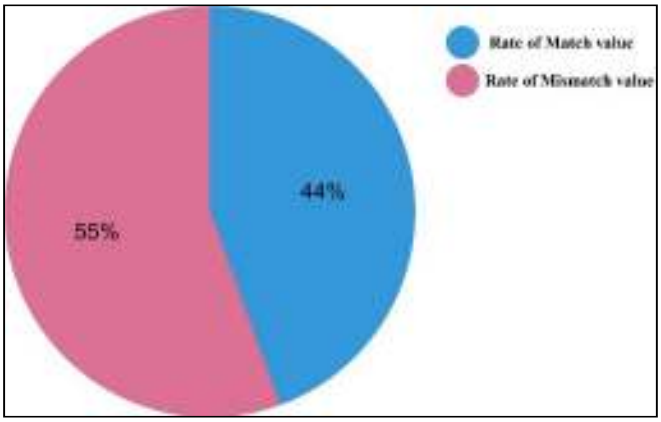

Fig. 6. The change rate percentage

A more specific evaluation has been made to determine the number of ranked values (Easy, Intermediate, Difficult) in the FCM algorithm value that match the feedback value, and the FCM algorithm value mismatches the feedback value As shown in Fig. 7. the rate of each ranked value is shown in Fig. 8.

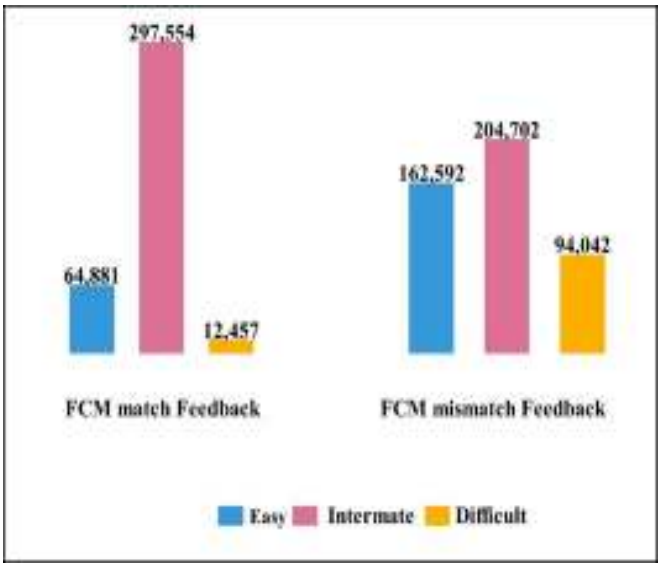

Fig. 7. Rank evaluation for match and mismatch value

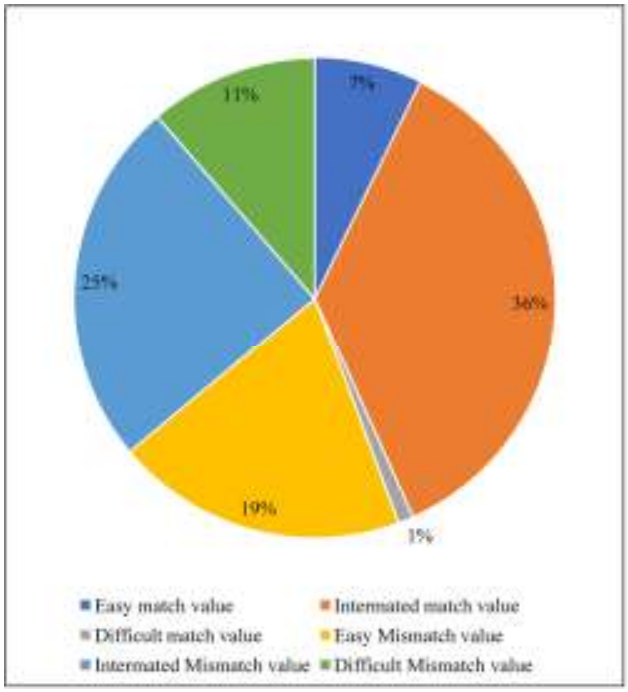

Fig. 8. Rate percentages of ranked evaluation

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I am very grateful to my lord almighty Allah Who guided me through my life and gave me this opportunity. and to my family

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E-Government and COVID-19: An empirical study in Greece

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Abstract**—**E-government and the implementation of ICT technologies in the public sector has been in the center of interest for a few decades now, but it is a fact that the Covid-19 pandemic and the worldwide lockdowns have given a boost on their prosecution in our everyday lives. The aims of this study were to i) examine the implementation of digital transformation best practices utilized by the governments globally and ii) take a thorough look in the case of Greece, to determine whether and to what extent the Greek government adopted similar practices and initiatives, allowing the use of online digital services to citizens in a wide array of public sector areas during the Covid-19 pandemic. Initially, we sent a questionnaire to 202 people in Greece, via email and social media platforms. In response, 150 useable questionnaires were received with response rate of 74%. We gathered responses were gathered between May and June 2021, and data gathered were analyzed with PSPP statistical program. The results showed that the majority of the practices used by the government were well communicated, as most of the digital services were acknowledged by the participants even if they had not used them. In particular, the taxation portal and the central digital portal for governmental services were used in percentages of 76% and 66% respectively. In terms of use and satisfaction, responses were also quite encouraging, with 72% of the participants mentioning being very satisfied with the speed and quality of the new digital services, though leaving room for further research to conclude on improvement methods. After in-depth examination of the global and Greek progress of digital transformation during the COVID-19 pandemic, it is essential to state that all governments have shown tremendous improvement in order to cover citizens' needs, while using the majority of the available digital channels.

Keywords**—**e-government, digital government, digital services, public sector, Greece

I. Introduction

The evolvement of world wide web in the last decades has caused tremendous effects in all business environments, with more and more companies adopting web-based technologies for the automation of their everyday tasks. In the contrary, although there have been several models for incorporating such a change in public organizations, governmental agencies have been more conservative and idle to adopting new technologies [1]. To be more accurate, the idea of citizens being treated as customers has been introduced in 1992, by Osbourne and Gaebler [2], to convince public organizations to adopt a more customer centric point of view while delivering their services. Although in 2005 Torres et al. refer to e-government being a global trend with new web-based technologies [3], we can now say there has been little change in the public sector, until e-government has become an absolute necessity with the Covid-19 outburst.

Luckily, the Digital Agenda for Europe had set among its targets the development of more efficient public services since 2010, with the last decade being essential for the positive exploitation of Information and Communication Technologies (ICT) in all private and public sectors for foreseeing problems and opportunities of the digital outburst [4], which was crucial for the confrontation of all physical, economical, and managerial boundaries caused by the worldwide Covid-19 lockdowns. It is undoubtable that despite the difficulties, the majority of businesses, organizations and people had the appropriate background in ICT, both knowledge wise and in physical infrastructure, so that most of their everyday tasks will not be ceased but continue to occur with the most normal possible flow in a digital form. The aim of this paper is to study and present the boost of the ICT usage in public sectors and e-government progress, and how their operations transformed through the Covid-19 outburst, setting Greece under the microscope to acknowledge the work done so far and identify best practices for future adoption.

II. Background

Analyzing some studies on the e-government implementation, it is observed that in the first steps of incorporating ICT in public organizations some findings come to an opposition to the overall e-government vision and scope, which has always been the elimination of discrimination between citizens, the provision of equal, fast services and treatment for all, and the performance excellence of public administration providing services with convenience, efficiency, and transparency [5].

In a general view of e-government implementation, Mishra analyzes the "Digital India" program, a program which aims to make India a truly and fully digital country after the Covid-19 outbreak and the new demand rules it has brought, introducing the implementation of ICT with a series of policies, initiatives, and excellence centers, that would offer services to citizens on demand [6]. During this program India has managed to digitize

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all departments to achieve the offering of digital services to all citizens, though several other problems are presented for the full success of the program, such as infrastructure, connectivity in rural areas, the amendment of restrictive regulations and most important, the digital literacy both of the citizens and the governmental employees [6]. Furthermore, Burlacu et al. [7] and Scupola [8] analyze the Covid-19 e-government management in Romania and Denmark respectively, and identify similar issues. In the first study, it is suggested that effective e-government practices can be implemented in a 5-step process, which includes the creation of webpages for all organizations and institutions, the extent of information coverage, the online availability of forms or facilities requested by citizens, followed by the possibility of obtaining/issuing important documents via the internet, and the overall expansion of services offered digitally [7]. Though the problems identified in both studies also concern the socio-economic status of a big portion of both countries' population, meaning that there are cases of inefficient knowledge or infrastructure to access those services [7,8] – to be more accurate, apart from concerns on data protection in Romania, public workers have proven not to be ready to completely embrace such a change [7] and more than a quarter of Denmark's population still lacks basic digital skills [8].

During the beginning of the pandemic, China has demonstrated a few successful practices on the improvement of everyday life though e-government too [9-13]. Studies have shown that most online interaction happens though mobile phones, online health information seeking behavior has also increased – especially during Covid-19, where isolation was essential, and hence many governments attempted to achieve social media presence by even using celebrities and word of mouth as a tool, in order to provide health guidance to people [9]. The role of e-government and word of mouth on spreading messages has proven to be very effective during quarantine, as the Chinese government has taken full advantage of the ability to be online present, and not only spreading messages for personal hygiene and social distancing, but also for promoting even more digital transactions [10,11]. Though it should be mentioned that Chinese government had already incorporated basic e-government operations in one of Chinas most popular social media platforms/applications, WeChat, before the pandemic. Such mechanisms included messaging for payments and similar electronic transactions, thus the online presence of government increased the usage of this service [11]. Additional practices that were used since 2018 in 80% of China's republics also included distance education and health, and were already suggested as best practices to be adopted by other countries too, though they require an extended combination of e-governance innovative use on advanced technologies and citizen participation to maximize the advantages of this effort, and the effective confrontation of the fact that 85% of the global population are still using the 3G network, which in many cases may not be quite efficient [11,12]. Agostino et al. have also identified social media as a more powerful tool for the digitization of public service deliveries over other ground-breaking tools, focusing on the digitization of cultural services. In their study they have identified that the usage of social media has changed from simple communication with users in a more creative and effective way, such as performing virtual tours or educational initiatives in order not to fend off their core operation [13].

Some further best practices that were identified in the public sector focus on the development of communication strategies and initiatives performed online, also based in the fact that most of the world population uses the internet and social media for fast and up to date information retrieval. In order to avoid miscommunication and the spread of misleading information regarding Covid-19, many governments proceeded with collaboration with digital companies and mass media [14]. Furthermore, some governments have even developed multi-purpose applications, such as the case of Italy, where collaboration with private companies was accomplished in order to provide free online services and internet access to the public during the lockdown [14]. Most of the countries have even developed mobility tracing applications to contact tracing of people entering the country and ensure that all quarantine measures were kept, as well as ensuring that the appropriate Covid-19 tests were performed so that people could act accordingly [15]. Regarding public sector capacity though, studies have shown that governments need to be more adaptive and attentive to people's needs, aligning public services to emergency situations. For instance, investment and coordination in public and private health sectors working remotely has proven to be effective, but public sector workers' needs should be taken more seriously under consideration, since there has been tremendous change in the way they work, and assistance was substantial [16,17]. Schuster et al. support that surveys of public servants are an important tool for such an implementation, as they can identify problems and provide solutions on online and remote interactions that are now needed for the completion of their everyday tasks. Furthermore, technical equipment and safe remote workplace environments can be more easily ensured, as well as best practices can be identifying by keeping constant communication and satisfaction measure of public workers [17]. In addition to this opinion, Cohen et al. suggest that user-friendly e-learning programs need to be organized by universities, for accounting systems in the public sector to acquire technical support, efficiently qualified staff and to achieve bridging the gap of academic and practitioner knowledge on the digital environment that navigates the current operation of the system [18].

From the aspect of public services in healthcare, education and news media, China was once again an example to follow, as great technological evolution occurred in a very short period of time to effectively confront the emergency situation. Numerous artificial intelligence (AI) and 5G applications were developed as a window to a whole new world of possibilities. 5G smart hospitals were established, with their operation being mainly based on cloud-working robots to eliminate human interaction. Their role was to perform important everyday actions such as temperature measurement, disinfection and cleaning of medical spaces and drug delivery, mainly with

drones and especially to vulnerable populations [19-21]. Moreover, with 5G offering wider and faster connectivity, many private companies have cooperated with governments introducing innovative health applications accompanying existing services. For example, there were cases of ambulances converted to smart ambulances, that would offer pre-hospital emergency treatment using video consultation during the transmission to the hospital, and what is even more worth mentioning is that during the pitch of the pandemic they performed even double daily trips than the traditional ambulances [20,22]. Similarly, many applications were also developed to provide eHealth literacy in older adults and their families or caregivers, ensuring that as vulnerable populations they would not be left sidelined [23]. In terms of e-learning capabilities, the necessity of remote education was also highlighted by the use of 5G, as there have also been cases of private companies cooperating with governments for providing full access to 5G networks and custom-made platforms, for live distance classrooms or clouds, aiming to better connectivity and synchronized classes without technical issues [19,24,25]. It is worth mentioning though that the pandemic has effected not only the traditional classroom operation, but also the adjacent functions supporting education. A research conducted in Bridgewater State University Library clearly presents the adjustments made in the academic library sector to continue operating as an auxiliary pillar to student's distance education, with a series of tasks including digitization of automated tasks, launching new digital services in the library's web page and even through social media, and online research consultations [26].

III. Research Method

Research methodology in this study was designed aiming to acknowledge digitization best practices adopted by governments around the world, and dive in the case of Greece, to identify similar practices and explore whether and how efficiently enough, Greek government established initiatives enabling the usage of online digital services to citizens in various public sector areas, during the Covid-19 pandemic. Empirical studies are an important methodology for evaluating real-life phenomena on specific issues, thus was identified as the best choice for performing a research to evaluate public opinion on the extend of performance excellence this digitization attempt had throughout the last year. For this aim, a quantitative research was conducted, and primary, descriptive data were gathered and analyzed with PSPP statistical program (2018 version).

For the development of the questionnaire a thorough search was conducted in governmental sites, aiming to identify the practices used for the digitization of existing services and the development of new digital functions for remote citizens' service. A questionnaire of 17 questions was developed based on the eGovernment practices identified, including only closed-ended questions of mainly 'yes' or 'no' answers, multiple-choice questions (with single and multi-selection answers), and Likert scale questions for the measurement of satisfaction of the services (full questionnaire available in the Supplementary file).

Survey questionnaire was created in Greek, data were collected via Google Forms, and distribution of the questionnaire occurred via e-mail and social media platforms. The questionnaire was initially tested with 10 people, and once finalized distributed to the public, in 202 people in total. Usable responses from 150 people were gathered between May and June 2021. Several covariates were used in the analysis included sociodemographic characteristics (sex, age, number of kids, working in private or public sector etc.) to identify the use of public services of each participant in accordance with their needs. The questionnaire was divided into six sections (including demographics), referring to measures related to eGovernment practices on information spread for Covid-19 pandemic, public agencies & remote services, public health services, cultural services, and remote work and education. Participation in the research was voluntarily and completion of the questionnaire was anonymous. All questionnaires were fully responded, and hence all data gathered were included in the analysis.

IV. Results

In order to identify whether the eGovernment practices followed during the Covid-19 pandemic in Greece were well communicated to citizens and successful in substituting the physical services, a total of 150 questionnaires were included in the analysis. To begin with, 72% of the participants were female, and almost half of the total sample (44%) were people aged between 19-25 years old. Regarding the occupation area of the participants, sample was split in three parts, were almost one third were private sector employees (34.67%), second part was students (34%), and the third part was distributed between public sector workers (16%), self-employed (8%) and unemployed (7.33%) people.

TABLE I
DEMOGRAPHICS (N=150)

	N	%
SEX		
Male	39	26
Female	108	72
Prefer not to say	3	2
AGE		
<18	6	4
19-25	66	44
26-35	45	30
36-45	9	6
>46	24	16
OCCUPATION		
Public sector worker	24	16
Private sector employee	52	34.67
Self-employed	12	8
Unemployed	11	7.33

TABLE II
CITIZEN'S FAMILIARIZATION ON EGOVERNMENT PRACTICES FOR INFORMATION SPREAD DURING THE COVID-19 PANDEMIC EVOLUTION (N=150)

	YES		NO	
DIGITAL MEANS OF INFORMATION	*N*	*%*	*N*	*%*
TV/radio advertisements	117	78	33	22
Cooperation with celebrities (Word of Mouth)	84	56	66	44
New governmental websites (e.g. live COVID-19 map)	50	33.33	100	66.67
Email/phone/SMS for increased risk areas	64	42.67	86	57.33
Social media governmental profiles	76	50.67	74	49.33

The second section of the questionnaire was related to eGovernment practices for information spread during the Covid-19 pandemic evolution. Participants had the option to choose multiple means of information and practices that they were familiarized with. All means and practices mention were identified, though TV and radio advertisements appeared to be more popular with 78% percentage of acknowledgement, while new governmental sites such as the live Covid-19 map streaming increased risk areas and restrictions, was in the last position with 33.33%.

In relation with public agencies and remote services, an attempt was made to identify both the most frequently digital public service used, and user satisfaction. It is worth mentioning that 85.33% of the participants were not aware of digital transformation bible of Greece, which is a holistic digital transformation strategy for the Greek society and economy, but they were familiar with most of the digital services launched during Covid-19 pandemic.

TABLE III
PUBLIC AGENCIES & REMOTE SERVICES AWARENESS (N=150)

AWARENESS OF THE BIBLE OF DIGITAL TRANSFORMATION FOR GREECE	N	%	N	%
Yes	22	14.67	22	14.67
No	128	85.33	128	85.33

REMOTE USE OF PUBLIC SERVICES	TOTAL USE	DEGREE OF SATISFACTION				
	N (%)	*Not at all satisfied (%)*	*Slightly satisfied (%)*	*Neutral (%)*	*Satisfied enough (%)*	*Very satisfied(%)*
Digital Services of Citizen's Service Center (myKEPlive)	13 (8.67)	15.38	0.00	23.08	46.15	15.38
Digital Services of Manpower Employment Organization (myOAEDlive)	8 (5.33)	0.00	12.50	0.00	75.00	12.50
Taxation Services (TaxisNet)	114 (76.00)	0.88	7.89	24.56	50.00	16.67
Central Digital Portal (Gov.gr)	99 (66.00)	2.02	7.07	25.25	47.47	18.18
Municipality Digital Services (myDimoslive)	5 (3.33)	20.00	0.00	20.00	60.00	0.00
Digital Services for Occupational Safety (e-EFKA)	53 (35.33)	0.00	5.66	22.64	52.83	18.87
Public payments (e-fees, state pensions etc.)	50 (33.33)	4.00	8.00	20.00	52.00	16.00
ERGANI (portal for work insurances, movement certificates of employees etc.)	58 (38.67)	1.72	5.17	32.76	43.10	17.24

COMPARISON TO PHYSICAL PRESENCE USE OF PUBLIC SERVICES	N	%
My request was successfully completed easier and faster with the online services	109	72.67
My request was completed but the online services were complicated/not easy to use/took longer than usual	35	23.33
My request was not completed, and I had to book a physical appointment with the service	6	4

As mentioned in the table above, taxation services (TaxisNet) and the central digital portal (Gov.gr) were the most used digital services during the pandemic, with 76% and 66% use, respectively. From people using TaxisNet, 50% were satisfied enough with the portal, while 77,19% mentioned that their request was completed easier and faster compared to the physical presence services in tax offices. Similarly, 47.47% and 18.18% of those who used Gov.gr were satisfied enough and very satisfied, while only 2.02% mentioned that their request was not complete through the portal. The least popular digital service was MyDimosLive, which is related to municipal issues and was used by only 3.33% of the participants. In the total point of view of satisfaction, users were satisfied enough with most of the digital services, and 72.67% mentioned that their request was completed easier and faster with the remote services. Regarding user experience, ERGANI was rated as the one with the most successful services with a percentage of 81.03% completed requests.

The fifth section of the questionnaire was related to public health services, as they were transformed by the government to serve people with as less interaction as possible. The most used digital service related to health appears to be the self-test declaration platform (39.33%), followed by the individual electronic health record for intangible prescription via emails

and electronic appointments with health scientists (26.67%). On the contrary, medicine delivery to remote areas was a service that the majority of the participants were not even aware of (62.67%), followed by the automated procedures initiated in specific hospitals (such as measurements and chatbots for the diagnostic initiation), with 54.67%.

On the cultural services, 92 of 150 participants were aware of digital events performance, and 53.33% of them mentioned that they did not attend any digital cultural event during the quarantines. Among the rest 46.67%, most people attended online concerts and live theater plays (33.33%), fewer attended virtual tours in museums (18%) and art exhibitions (6%), and only 6.67% attended an online reading event. Participants mentioned that they were satisfied with their digital experience in general, with the highest rates of satisfaction being in virtual tours in museums (48.15% were satisfied enough, and 40.74% very satisfied).

TABLE IV
PUBLIC HEALTH DIGITIZATION SERVICES DURING COVID-19 PANDEMIC (N=150)

	I AM AWARE OF THIS SERVICE AND I HAVE USED IT		I AM AWARE OF THIS SERVICE, BUT I HAVE NOT USED IT		I AM NOT AWARE OF THIS SERVICE	
REMOTE USE OF PUBLIC HEALTH SERVICES	*N*	*%*	*N*	*%*	*N*	*%*
Individual Electronic Health Record (for intangible prescription via sms/emails, electronic appointments, etc.)	40	26.67	58	38.67	52	34.67
Self-test declaration platform	59	39.33	71	47.33	20	13.33
Online appointments at Primary Health Care Units (idika.gr)	29	19.33	72	48	49	32.67
E-consultation/distance support of Covid-19 patients (EODY)	13	8.67	90	60	47	31.33
Medicine delivery to remote areas or vulnerable populations (with drones or other means)	6	4	50	33.33	94	62.67
Automated temperature measurements/chatbots as a diagnostic initiation	16	10.67	52	34.67	82	54.67

TABLE V
DIGITIZATION OF CULTURAL SERVICES (N=150)

	N (%)	*NOT AT ALL SATISFIED (%)*	*SLIGHTLY SATISFIED (%)*	*NEUTRAL (%)*	*SATISFIED ENOUGH (%)*	*VERY SATISFIED (%)*
Virtual tours in museums	27 (18.00)	0.00	0.00	11.11	48.15	40.74
Virtual tours in art exhibitions	9 (6.00)	11.11	33.33	0.00	33.33	22.22
Online concerts/Live theater plays	50 (33.33)	4.00	8.00	28.00	34.00	26.00
Online reading events	7 (4.67)	14.29	42.86	14.29	14.29	14.29
I did not attend any event	80 (53.33)	-	-	-	-	-

Regarding remote work and education, it is observed that 66% of public sector employees did work remotely during the Covid-19 lockdowns, though only 31.25% of them mentioned that they received the appropriate technological and infrastructure assistance from the government so that they can be as productive as in their offices. For students and freelancers, it is observed that a percentage of 100% stated that they had to work or follow their courses remotely, while 40.38% of private sector employees (21 from 52 participants) proceeded with teleworking.

Most used applications for teleworking and online education during the pandemic were zoom (63%) and webex (29%), while in figure 1 it is presented that eGovernment means assisting distance work and online education were not very popular among citizens. A total of 42.70% were not aware of any of these assisting tools introduced by the government, while from the rest 57.30% webex assistance gained cognition of 44.70% between participants, and the digital school 24%. On the contrary, the cognition percentages of citizens' digital academy (a tool for adult education on digital skills to be promoted for the pandemic needs) were very low (6.70%).

TABLE VI
REMOTE WORK AND EDUCATION (N=150)

	N	%
PERFORMANCE OF REMOTE WORKING/EDUCATION		
Private sector employee	21	40.38
Public sector worker	16	66.67
Freelancer	12	100.00
Student	51	100.00
ASSISTANCE OF GOVERNMENT FOR REMOTE WORKING IN PUBLIC SECTOR WORKERS		
Yes	3	18.75
No	13	81.25

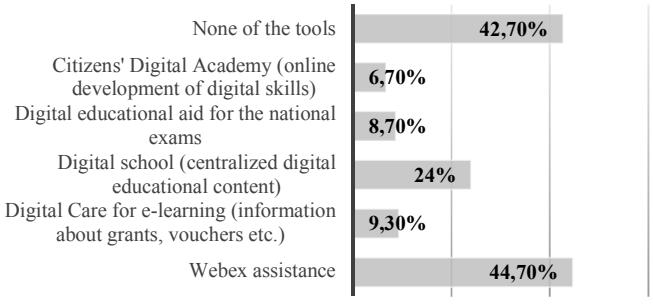

Fig. 1. Awareness of tools supporting remote working/education

V. DISCUSSION

The whole pandemic situation has caught everyone by surprise. It has exposed many deficiencies and brough up many functionality issues of everyday operations, while causing irreparable damages to the economy and society [27]. In the contrary, such situations that lead to radical changes usually cause versatile effects, both negative and positive ones. In the case of the pandemic, technological innovations and procedures

have been rapidly sped up and it has been showcased how the next normal might look like, at least for the majority of our world.

Having proceeded with a closer look on the global and Greek landscape of digital transformation during Covid-19, it can be stated that all governments have done a remarkable effort, using multiple channels to cover citizens' needs. As multiply stated, during the pandemic the information flow was accelerated, making it difficult for many people to distinguish which information should be seriously taken under consideration and which not [28-30]. Undoubtedly, social media platforms have gained more ground with the passage of time and their purpose becomes more and more serious than just entertainment. According to our results, Greek government has taken good advantage of the opportunities they offer, although their high popularity of 50.67% among participants to ensure valid information on Covid-19 evolution may also be justified by the fact that almost half of the sample size (44%) in the research was aged among 19-25 years old, which is the most active group on such platforms [31]. Additionally, similarly to what is indicated by Yasir A. et al. [10], governmental appearance using the technique of Word of Mouth was also quite effective in the case of Greece, as it was acknowledged by 56% of the participants in the research. In Greece though, TV and radio advertisements still remain people's top choice when it comes to information, as they are by far the most approachable means of information.

The fact that taxation services (TaxisNet) and the central digital portal (Gov.gr) were the most used public digital services during the pandemic was expected, as both portals had been in use prior to Covid-19, specifically since the European Union financed 2014-2020 project of the Ministry of Digital Governance, and thus citizens were quite aware of their existence. It is a fact though that the pandemic operated as a cornerstone that sped up the enrichment, the functionality and processes offered for both portals, leading to higher popularity in a short period of time. In overall, the Greek government's online services seem to be effort and time effective compared to the physical use of them as 72.67% of the participants suggested.

In relation to health services, Greece did not proceed with any massive changes or disruptive technologies similar to the ones identified for the case of China [19-22]. In a few hospitals though innovative technologies such as automated measurements were established, but as they were isolated cases they were not widely spread and advertised, thus most of the citizens were not even aware of such services. Though an ambitious effort has been made with the introduction of the individual e-consultation services and self-declaration tests platform (73% and 86.66% of awareness respectively), as well as the individual electronic health record (65.34%) and the platform for online appointments at primary health care units (67.33%).

On cultural services point of view, even though the majority were aware with actions taken from organizations not to eliminate their presence in everyday life, participation rates were rather low. Regarding satisfaction of the alternatives offered, virtual museum tours achieved really high scores though satisfaction was neutral in relation to live concerts (28%) and low for reading events (42.86%), which means that virtual experience is far from replacing the real-life experience related to entertainment, although this might not be the case for all countries. For example, Bin E. at al. have performed a research of 750 people (mainly located in Italy, Sweden, and India) and identified that there is high likelihood of keeping their new habits related to free time after the pandemic period, too [32].

Limitations

This study has some limitations. First of all, further research could be done with a bigger sample size, also considering the confidence interval estimation, to ensure greater liability for our conclusions. Achieving a bigger sample size would also help to identify broader eGovernment practices, as according to what has already been mentioned, 44% of the current sample were students aged 19-25 years old, thus they might not have the same needs and demands on public services as working adults (for example on taxation on insurance services). Finally, due to limited possibilities of the PSPP statistical analysis package, dependent and independent variables were not taken under consideration during the analysis.

VI. Conclusion

The Covid-19 pandemic has brought up enormous changes in everyday life operations, both in public and private sectors. It has to be acknowledged that all governments have made huge efforts to correspond in the demanding situation and isolation requirements, without though seizing their activities. More or less measures taken around the world followed similar patterns, though differentiation in each country's background led to diverse results in each case. Factors such as infrastructure, economy, citizens' status and education should seriously be considered before the implementation and further development of digital services, in order for e-government not to result in being a means of discrimination. For the case of Greece, it could be mentioned that e-government practices were quite acknowledged by the public in relation to the hustle under which they were implemented, though for sure there is room for further improvement, as there has been observed a difference in citizens knowledge and satisfaction while using the e-government services.

Future Research

With this study a spherical point of view is presented on what digital means were implemented through the pandemic in Greece and whether they were well communicated with citizens, though since each service has multiple functions, it would require an in-depth qualitative research to measure accurate satisfaction, and identification of flaws or strong points on their operation.

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Receptive Vocabulary Development in Adolescents and Adults with Down Syndrome

Esther Moraleda Sepúlveda, Soraya Delgado Matute, Paula Salido Escudero, Raquel Mimoso García, M Cristina Alcón Lancho

***Abstract*—** Although there is some consensus when it comes to establishing the lexicon as one of the strengths of language in people with Down Syndrome (DS), little is known about its evolution throughout development and changes based on age. The objective of this study was to find out if there are differences in receptive vocabulary between adolescence and adulthood. In this research, 30 people with DS between 11 and 40 years old, divided into two age ranges (11-18; 19 - 30) and matched in mental age, were evaluated through the Peabody Vocabulary Test. The results show significant differences between both groups in favor of the group with the oldest chronological age and a direct correlation between chronological age and receptive vocabulary development, regardless of mental age. These data support the natural evolution of the passive lexicon in people with DS.

***Keywords*—** down syndrome, language, receptive vocabulary, adolescents, adults.

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Language Policy Buds for English Generated off Language Management after a Hundred-Thirty-Two Year French Landscape: Algeria and the Blessed Movement

Ahmed Zeghar

***Abstract*—** This paper is a live-ins and outs eye witness light shed on the birth of a new government-authorized language policy imposed by the people (language management) in Algeria, 2019. It delves tacitly into the query, which probes how come a given language policy raises overnight, leaving behind a whole second language. What are the motives, the circumstances and the timing are offbeat questions that this paper tries to decipher, a sound sample explaining that unexpected language management generated by the people in an unexpected timing can adapt the polity's choice to a given language policy more efficient over another. Indeed, the French language, which is a second language, knows a substitution to the English language instead while coinciding with the potential "hyrak" following February 22, 2019. The incarnation of fruitful features of the latter movement appeared unpredictably thanks to some new laws adopted in a daily one-by-one rhythm by all of the ministries of education, higher education, and trade. In fact, such language policy fields would sharpen a new path to a whole country's language policy, trade quality, language prestige within the people, dialects, borrowings, etc., just the same way happened to the previous cases around the world.

***Keywords*—** English, French, government, language policy, people weight.

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Reading and Writing in a Diglossic Context: A Multifaceted Perspective

Aula Khatteb Abu-Liel

***Abstract*—** Arabic is considered a classical case of diglossia because conventionally, one form of Arabic is spoken (SA) and another is used in the domain of written language (MSA) (Ferguson, 1959). In the recent past, globalization of English-based technology, together with the absence of Arabic supporting keyboards, had resulted in the reliance on Latin script as the main writing system when communicating through computers (CMC) (Palfreyman, 2001). This writing was known as 'Arabizi', which represents Spoken Arabic (SA) (Bashraheel, 2008). The advent of Arabic supporting software has allowed the writing of SA in Arabic letters, but has not completely eradicated Arabizi. Although the use of Arabizi today is less ubiquitous than it was half a decade ago, its effects on the cognitive processes involved in literacy are scientifically interesting. The study explores the way that Arabizi affected reading, writing, and personal and social dynamics in a sample of Arabic-speaking adolescents in 2014. We focused on three areas of inquiry: The first aimed to provide a description of writing practices, perceptions, and attitudes for the two writing systems, Arabizi and MSA. The second examined literacy skills and abilities in MSA and Arabizi. And the third tried to evaluate the stability of the Arabizi orthography in order to evaluate to which instance it is standardized.

Our finding indicated that all of the participants in our study reported using Arabizi more frequently than MSA, English or Hebrew to communicate in CMC, and, a substantial portion of the sample accepts the colloquial as a written language. Our students indicated that while MSA has its own stringent and standard rules, Arabizi is considered more flexible given its informal nature and its spontaneous emergence. MSA remains a highly valued variety, existing alongside the high acceptance of Arabizi as a written language. There are no indications that Arabizi is a threat to the significance of MSA, which keeps its position as a prestigious language, alongside the colloquial varieties. In the reading tasks, the results revealed a significant effect of word type (vowelized MSA words, unvowelized MSA words, Arabizi). In our reading comprehension tasks, there was also an effect of type and genre.finally, we found high stability in the use of orthographical conventions, and only marginal variability in the Arabizi orthography.

There are still many aspects of reading in Arabizi which remain unknown. It will be especially interesting to examine the similarities and complementarity of writing SA in Latin letters or in Arabic letters. Further research is necessary to establish whether our findings are replicable and generalizable to writing SA in Arabic letters. Additionally, it is worth examining if reading disabled students behave similarly to skilled readers while dealing with Arabizi, or they would benefit more than typical readers because of the similarities between Arabizi and spoken language

Abbreviations: MSA=Modern Standard Arabic; SA = Spoken Arabic; CMC= Computer-Mediated Communication.

Key words: Arabic, diglossia, sociolinguistics, literacy skills, grassroots orthography.

***Keywords*—** Arabic,diglossia,sociolinguistics,literacy skills,grassroots orthography.

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The Novelty of Mobile Money Solution to Ghana's Cashless Future: Opportunities, Challenges and Way Forward

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***Abstract*—** Mobile money has seen faster adoption in the decade. Its emergence serves as an essential driver of financial inclusion and an innovative financial service delivery channel, especially to the unbanked population. The rising importance of mobile money services has caught policymakers and regulators' attention, seeking to understand the many issues emerging from this context. At the same time, it is unlocking the potential of knowledge of this new technology. Regulatory responses and support are essential, requiring significant changes to current regulatory practices in Ghana. The article aims to answer the following research questions: *"What risk does an unregulated mobile money service pose to consumers and the financial system? "What factors stimulate and hinder the introduction of mobile payments in developing countries?* The sample size used was 250 respondents selected from the study area. The study has adopted an analytical approach comprising a combination of qualitative and quantitative data collection methods. Actor-network theory (ANT) is used as an interpretive lens to analyse this process. ANT helps analyse how actors form alliances and enrol other actors, including non-human actors (i.e. technology), to secure their interests. The study revealed that government regulatory policies impact mobile money as critical to mobile money services in developing countries. Regulatory environment should balance the needs of advancing access to finance with the financial system's stability and draw extensively from Kenya's work as the best strategies for the system's players. Thus, regulators need to address issues related to the enhancement of supportive regulatory frameworks. It recommended that the government involve various stakeholders, such as mobile phone operators. Moreover, the national regulatory authority creates a regulatory environment that promotes fair practices and competition to raise revenues to support a business-enabling environment's key pillars as infrastructure.

***Keywords*—** Mobile Money; actor-network theory (ANT); cashless future; Developing countries.

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What is the Impact of Mobile Payments on the National Payment Systems in Developing Countries in Africa? And Does Financial Innovation Reduce Information Asymmetry in Developing Countries in Africa?

James Obuobie

***Abstract*—** As African economies evolve, the use of Mobile Money and Mobile payments will continue to dominate these developing countries, and this will in turn move these countries into a cash-lite economies.

The use of financial innovation technology such as mobile money and mobile payments has been shown to be a key driver of socio-economic development in developing countries. However, the impact of the use of Mobile Money and Mobile payments on the national payment systems of developing economies is yet to be empirical investigated.

This paper proposes to empirically examine the link between Mobile Money and Mobile Payment on the national payment systems of developing countries in Africa and present evidence on its impact using structural Vector AutoRegression and Vector Error Correction Models.

The study will provide policy makers, investors, central banks and stakeholders further insight into how financial innovation technologies such as Mobile Money and Mobile Payment impact on the national payment systems in developing economies in Africa.

Additionally, information asymmetry continues to be a major problem, hindering the asset growth of lenders in developing economies. This paper proposes a model that incorporates financial innovation that reduces the problem of information asymmetry via consumer credit scoring.

I show that, financial innovation reduces information asymmetry and loan default using a total of 255,168 observations (14,176 loans) disbursed by a lending institution in Ghana, Sub-Saharan Africa.

The findings will aid policy decisions by central banks, and finance providers to price loans that reflect the risk profile of clients, and to increase investment in technology for consumer lending in Africa for economic growth.

***Keywords*—** Africa, Developing countries, Financial innovation, Mobile banking, Mobile money, Mobile payment, Information Asymmetry.

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Access and Utilisation of Academic Social Networking Sites for Research Among Postgraduate Students in South-West, Nigeria

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Abstract
Academic social networking sites (ASNS) are technologies that facilitate academic interaction, collaboration and deliberation among stakeholders. Research is not limited to visitations to the library for book consultations, but has extended to the use of the Internet resources like virtual library search engines and ASNS such as Academia, ResearchGate, Google Scholar and LinkedIn. The study examined the awareness of ASNS among postgraduate students in South west, Nigeria. This study utilized a descriptive research of the survey method. The population for the study consisted all the 76,372 postgraduate students in South-west, Nigeria. A total of 1,506 respondents were drawn from the selected universities using Research Advisor's Model (2006). Data were collected using a researcher developed structured questionnaire. The instrument was validated and tested for reliability. Descriptive statistical tools, frequency counts and percentage were employed in the analysis of the data collected. In addition, inferential statistics like *t*-test were used to test the research hypotheses at 0.05 level of significance. The findings of the study were that: 55.8% postgraduate students had access to Internet connectivity, computer desktop/laptop, mobile devices, gadgets and email to register on ASNS and most of the students utilise ASNS for their research with a grand mean score of 3.01 using a benchmark of 2.50. The study concluded that postgraduate students had access to Internet connectivity, computer laptops and utilise ASNS for research purposes Based on the findings, the study recommended that postgraduate students should engage more with ASNS for their research activities in order to improve their research productivity.

Keywords: ICT, Learning, ASNS, Research and Education

Introduction

Education is a light that has shown mankind the right direction. The purpose of education is not just making a student literate but adds thinking, knowledgeability and self-sufficiency. When there is willingness to change, there is hope for progress in any field. Education can be seen as any act or experience that has a formative effect on the mind, character, or physical ability of an individual. Education in Nigeria is adopted as an instrument "per excellence" for effecting national development National Policy on Education (Federal Republic of Nigeria, FRN 2014). Adomi and Kpangban (2015) noted that in recognizing the roles and integration of Information and Communication Technology (ICT) in education, the Nigeria government enacted a policy on computer education in 1998. The field of education has been affected by ICTs, which have undoubtedly affected learning and research (Yusuf, 2005).

ICT has been described as an essential tool in any educational system which has the potential of being used to meet the needs of individual students, promote equality of educational opportunities, offer high quality learning materials, increase self-efficacy and independence of learning among students and improve student's development (Abolade & Yusuf, 2005). The extended use of ICT drove the society into a new knowledge-base where the information plays an important role in students' satisfaction (Xin, 2010). To further facilitate better social interaction, social networking sites (SNS) have been created for online interaction and communication from one user to another.

Literature Review

Information and communication technology (ICT) is widely used in educational research, policy and practice. Jimoh (2010) refers to ICT as the handling and processing of information

(text, images, graphics, instructions) for use, by means of electronic and communication devices such as computers, cameras, and telephone. When combined with Internet, it creates a channel for students to obtain a huge amount of human experience and guide students to enter the community. In this way the students not only can extend their personal view, thought and experience but also can learn to live in the real world (Jimoh, 2010). ICT is a term that includes any communication device or application, encompassing radio, television, cellular phones, computer and network hardware and software, satellite systems, as well as the various services and applications associated with them, such as video conferencing and distance learning (Azeez, 2014).

Social Networking Sites (SNS) are web-based applications that allow individuals and organizations to create, engage and share new user-generated or existing contents in digital environments through multi-way communication. It refers to websites and applications "that enable users to create and share content or to participate in social networking. They are also technologies that facilitate social interaction, make possible collaboration, and enable deliberation across stakeholders. Specifically, SNS have been used for intereaction and research purposes but academic SNS have now been created for research purposes, whereby researchers can download journals, publications, discuss with researchers and collaborate with authors. Academics are increasingly using Academic Social Networking Sites (ASNS) and they are expected to have a professional online presence (Gruzd, Staves & Wilk, 2011). ASNS are platforms that allow users or people to come together around an idea or topic of interest. Kelly (2013) defined ASNS as technologies that facilitate academic interaction, make possible collaboration and enable deliberation across stakeholders to access journals, articles and publications. El-Berry (2017) defined ASNS as the virtual platform where researchers can create

a personal profile, collaborate and interact with other researchers and academics with shared research interest from around the world.

Similarly, Jeng, He and Jiang (2015) defined ASNS as platforms that help researchers facilitate various activities online through the use of academically inclined tools, features and services that enable researchers to build a professional network with other researchers on ASNS. In the year 2013, ASNS became one of the most powerful sources for research through platforms like Academia.edu, Google Scholar, LinkedIn and ResearchGate (Kelly & Delasalle, 2014). Barbour and Marshall (2012) listed the characterisics provided by differernt ASNS, which are: high popularity, collaboration services, online personal management, research dissemination, document management capabilities and impact measurement services. With regards to research dissemination, Academia.edu, ResearchGate and Mendeley provide more tools for researchers to find communities and expose findings to a broader audience and also allow uploading publication files, follow and being followed by peers.

Academia.edu and ResearchGate allows linking users' non-academic social networking sites accounts like Twitter and Facebook. Out of all the sites listed, Mendeley is the only site that facilitates uploading and managing a library of documents, as well as importing libraries and references from other services. Postgraduate education in Nigeria involves research, learning and studying for academic or professional degrees, academic or professional certificates, academic or professional diplomas, or other qualifications for which a first or bachelor's degree generally is required, and it is normally considered to be part of higher education. In Nigeria, this level is generally referred to as postgraduate school. Research is the systematic inquiry that investigates hypotheses, suggests new interpretations of data or texts, and poses new questions for future research to explore (Creswell, 2014).

In research, the researcher has to choose and focus on a research been conducted, find background books that give information about the topic, find articles that give information about the topic, evaluate the information found and citing the information used in research. Research by Trochim (2012) is the investigation and writing based upon the idea of scientific inquiry. Research is not limited to visitations to the library for book consultations, but has extended to the wide use of the Internet, virtual library, e-library and search engines such as Academia.edu, ResearchGate, Google Scholar and LinkedIn to access information and resources on a research being conducted. Academic Social Networking Sites (ASNS) are platforms that facilitate academic interaction, collaboration and enable deliberation across academic stakeholders to access journals, articles and publications. Majority of Nigerian postgraduate students are neither familiar nor skillful in employing these tools for research purposes. It is important that the visitations to the library for book consultations should be supplemented with the use of the Internet resources like virtual library, e-library and ASNS such as Academia, ResearchGate, Google Scholar and LinkedIn, among others, to access resources on the research being conducted which can arouse students' interest in sourcing for information.

However, that library-based research combined with the use of Internet, virtual library, e-library and core academic research search engines such as Academia.edu, ResearchGate, Google Scholar, LinkedIn and Mendeley can greatly enhance easy access to information, materials and resources. This study thus investigated the awareness and utilisation of ASNS with a focus on postgraduate students. It focused postgraduate students' attention on the use of a more productive platform like ASNS for research purposes. Hence, this study was conducted to address the awareness and utilisation of ASNS for research among postgraduate students in South-west, Nigeria.

Research Methodology

This study was a descriptive research of the survey type. It was a quantitative form of research which investigated the access and utilisation of academic social networking sites for research in south-west, Nigeria. The population for the study consisted of all postgraduate students in South-west, Nigeria. The target population consisted of all postgraduate students of Federal and State government universities in South-west, Nigeria which is 76,372. Six Federal and State universities were sampled for this study. Respondents were postgraduate students from Federal and State universities in the South-west, Nigeria. The sample size for this study was 1,506 and was determined from the total number of postgraduate students from the selected universities in South-west, Nigeria. The total population of postgraduate students in the selected universities in South-west, Nigeria for the research was 76,372. Research Advisors' Model (2006) proportional sampling was used to determine the appropriate sampling size for the study based on the population of postgraduate student in each universities in the zone. In all, the research instrument was distributed to a sample of 1,506 postgraduate students and 1,338 were collected and responded to correctly. Postgraduate Diploma in Education (PGDE), Masters, M.Phil./Ph.D. students were surveyed (proportional sampling) using survey questionnaire for the selected postgraduate students. The researcher designed questionnaire titled "access and utilisation of academic social networking sites for research in south-west, Nigeria". The adapted questionnaire for this study was validated by the researchers supervisor, three lecturers from the Department of Educational Technology and the researcher's Internal/External examiner from the Department of Library and Information Science, University of Ilorin, Ilorin Nigeria, to determine the relevance and suitability of the instrument considering the clarity to the respondents, content coverage in terms of adequacy and its relevance to the stated objectives. The questionnaire was trial-tested on

50 postgraduate students (PGDE, Masters, M.Phil./Ph.D.) at the University of Ilorin. The results were 0.86 on the access to the ASNS for research and 0.98 on the utilisation of ASNS for research. Therefore the instrument is reliable for the study.

Research Questions

In this study, answers were provided to the following research questions:

1. How do the postgraduate students access ASNS for research?
2. What do the postgraduate students use ASNS for?
3. What is the gender difference of postgraduate students' access to ASNS for research?
4. What is the gender difference of postgraduate students' utilisation of ASNS for research?

Research Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

H_{O1}: There is no significant difference between male and female postgraduate students' access to ASNS.

H_{O2}: There is no significant difference between male and female postgraduate students' utilisation of ASNS.

Results and Discussion

The four major research questions were answered using percentage mean while the hypothesis was tested using *t*-test.

Table 1:

Demographic Distribution based on Respondents' Institutions

S/N	Name of Institution	Frequency	%
1.	University of Ibadan, Ibadan (UI)	219	16.37

2.	Obafemi Awolowo University, Ile-Ife (OAU)	251	18.76
3.	Federal University of Technology, Akure (FUTA)	46	3.4
4.	University of Lagos, Lagos (UNILAG)	235	17.6
5.	Federal University of Agriculture, Abeokuta (FUNAB)	45	3.4
6.	Ladoke Akintola University, Ogbomoso (LAUTECH)	64	4.8
7.	Osun State University, Osogbo	30	2.2
8.	Adekunle Ajasin University, Akungba-Akoko, Ondo State (AAUA)	35	2.6
9.	Ekiti State University, Ado Ekiti, (EKSU)	128	9.6
10.	Lagos State University, Ojo Lagos (LASU)	222	16.6
11.	Olabisi Onabanjo University, Ago-Iwoye, Ogun State (OOU)	63	4.7
	Total	**1338**	**100**

Table 1 illustrates the demographic information of respondents by institutions. It revealed that majority of the respondents were from Obafemi Awolowo University, Ile – Ife with 18.76% and University of Lagos with respondents of 17.6%. Adekunle Ajasin University, Akungba-Akoko, Ondo State (AAUA) with respondents of 2.6% and Osun State University, Osogbo with 2.2% with the lowest of respondents. Obafemi Awolowo University, Ile-Ife has the highest no of respondent with 18.77% because it has a larger no of respondents and so many postgraduates students while Osun State University with 2.2% has very few postgraduate students. The total number of respondents for the study was 1338 across all universities in South-west, Nigeria.

Research Question 1: How do the postgraduate students access ASNS for research?

Table 2:

Respondents' Access to Academic Social Networking Sites for Research

S/No	Access to the Academic Social Networking Sites	Yes	No
1	Internet connectivity to access ASNS	779	559
2	a computer desktop/laptop to access ASNS	987	352
3	a mobile device to access ASNS	1228	110

S/No	Access to the Academic Social Networking Sites	Yes	No
4	gadgets to access ASNS	725	613
5	an institutional email to access ResearchGate	455	883
6	an email to register on Academia.edu	455	883
7	an email to register on Mendeley	455	883
8	an email to register on LinkedIn	892	446
	Average	**747**	**591**
		(55.8%)	**(44.2%)**

Table 2 presents the result of the postgraduate students' accessibility to academic social networking sites (ASNS) for their research. It showed that majority of the students have a mobile device to access ASNS with 1228 respondents and very few of them has no mobile device to access the ASNS with 110 respondents. I have an institutional email to access ASNS with 455 respondents while 883 have no institutional email to access the ASNS. Therefore, it was deduced that most postgraduate students had mobile devices such as mobile phones, ipads and tablets to access ASNS at their own convenient time.

Research Question Two: What do the postgraduate students utilize academic social networking sites for?

Table 3: Respondents' Utilisation of Academic Social Networking Sites for Research

S/No	Utilisation of Academic Social Networking Sites for Research	Mean
	I use Academic Social Networking Sites:	
1	as discussion boards with other researchers to improve my research	3.52
2	to send emails to researchers and authors to improve my research	2.56
3	to check my citation counts to improve my research	3.23
4	to collaborate with other researchers to improve my research	3.78
5	to promote my own academic publications	3.04
6	to find out about new publications of interest	2.59
7	to get more citations to improve my research work	3.12
8	to ask questions regarding my research, which will add quality to it	3.09

9	to link up with authors with articles that I have downloaded on the sites	2.34
10	to follow researchers or authors of the same specialization with high citations	3.00
11	to connect with researchers working on similar project topic to improve my research	3.45
12	to upload my publications online	3.37
13	to link information to other social media sites	2.70
14	for group collaboration with other researchers to improve my research	2.91
15	for content gathering	3.38
16	for video and picture sharing	2.04
	Grand Mean	**3.01**

Utilisation of academic social networking sites for research was investigated and the results were presented in Table 3. The result established that most of the respondents collaborate with other researchers to improve their research with a mean of 3.78, as discussion boards with other researchers to improve their research with a mean score of 3.52 and to connect with researchers working on similar project topic with a mean score of 3.45. Postgraduate students use ASNS often to collaborate with other fellow researchers across the globe which will add good quality to their research. Few of the students' uses academic social networking sites for video and picture sharing with a mean of 2.04. Apparently, it is evident that postgraduate students uses ASNS to collaborate, discuss, check citation counts and connect to other researchers more than video and picture sharing among users across the globe. The grand mean score was 3.01 which is greater than the benchmark of 2.50 (since the response mode was 4-likert scale). It can be deduced that most of the respondents use ASNS for their research basically to collaborate and discuss with other researchers across the globe.

Research Hypothesis
Hypothesis One

There is no significant difference between male and female postgraduate students' access to academic social networking sites.

In determining whether there is any significant difference between male and female postgraduate students on their access to academic social networking sites for research, the null hypothesis was tested by using independent *t*-test as shown in Table 10.

Table 4:

***t*-test Procedures for Significant Differences between Male and Female' Access to Academic Social Networking Sites**

Gender	N	Mean	Standard Deviation	Df	T	Sig (2-tailed)	Remarks
Male	821	0.617	0.387	1338	0.231	0.115	Not Rejected
Female	517	0.573	0.455				
Total	**1338**						

Table 4 indicates that t (1338) = 0.231, p = .115. This means that the stated null hypothesis was not rejected. This was as a result of the t-value of 0.231 resulting in 0.115 significance value which was greater than 0.05 alpha value. In other words, the null hypothesis, which states that there is no significant difference between male and female access to academic social networking sites was not rejected. It was deduced that there was no significant difference between male and female postgraduate students' access to academic social networking sites. However, the male students have high mean scores of 0.62 than their female counterparts of 0.57. Thus the male students have access to the ASNS than their female counterparts which could be as a result of higher population of male students over the female.

Hypothesis Two

There is no significant difference between male and female postgraduate students' utilisation of academic social networking sites.

In determining whether there is significant difference between male and female postgraduate students on their utilisation of academic social networking sites, the null hypothesis was tested by using independent *t*-test as shown in Table 5.

Table 5:

***t*-test Procedures for Significant Differences between Male and Female Utilisation of Academic Social Networking Sites**

Gender	N	Mean	Standard Deviation	Df	T	Sig (2-tailed)	Remarks
Male	821	2.974	0.119				
				1338	1.109	0.023	Rejected
Female	517	2.501	0.200				
Total	**1338**						

Table 5 indicates that t (1338) = 1.109, p = .023. This means that the stated null hypothesis was rejected. This was as a result of the t-value of 1.109 resulting in 0.023 significance value which was greater than 0.05 alpha value. In other words, the null hypothesis, which states that there is no significant difference between male and female postgraduate students' utilisation of academic social networking sites was rejected. However, the male students have high mean scores 2.97 than their female counterparts of 2.50. Thus the male students use ASNS than their female counterparts which could be as a result of higher population of male students over the female student. It was deduced that there was significant difference between male and female postgraduate students' utilisation of ASNS in favour of the male' respondents.

Discussion, Conclusion and Recommendations

The study examined access and utilisation of academic social networking sites for research among postgraduate students in South-west Nigeria. The findings revealed that respondents had access to Internet connectivity, computer desktop/laptop, mobile devices and email to register on academic social networking sites with 55.8% and most of the respondents used academic social networking sites for their research with a grand mean of 3.01. Similarly, the study revealed that there was no significant difference between male and female postgraduate students' access to academic social networking sites with t(1338)=0.231 and p=.115 and there was significant

difference between male and female postgraduate students' utilisation of academic social networking sites in favour of the male' respondents with t(1338)=1.109 and p=0.023.

The study concludes that academic social networking sites are platforms that build and promote academic relationships among postgraduate students, lecturers, researchers, higher institutions and other stakeholders within the academic community to discuss, collaborate and access academic materials such as journals, publications, thesis and articles. This academic relationship is specifically targeted at enhancing research activities and other academic needs or interest among users. It offers uploading and sharing of academic publications, various forms of international collaboration, exposure and interactions among users, problem solving through questions and answers in discussion forums and feedback.

Based on the findings and conclusion of this study, the following recommendations were made: Universities should provide computers, tablets and Internet facilities to students for easy accessibility and also encourage them to download research and course content materials from ASNS so as to further acquaint students at all levels with the use of ASNS and universities should encourage students to register on at least one or two ASNS and remain active users on the platform. This is because ASNS have become one of the factors to measure universities academic excellence, popularity and online presence, which would be greatly influenced by students' active use of ASNS.

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Culturally Responsive Teaching for Learner Diversity in Czech Schools: A Literature Review

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Abstract:

Until recently, the Czech Republic had an educational system dominated by indigenous people, who accounted for 95% of the school population. With the increasing influx of migrants and foreign students especially from outside European Union, came a great disparity among the quality of learners and their learning needs, and a consideration for the challenges associated with being a minority and living within a foreign culture. This has prompted the research into ways of tailoring the educational system to meet the rising demand of learning styles and needs for the diverse learners in the Czech classrooms. Literature is reviewed regarding the various ways to accommodate the international students considering racial differences, focusing on theoretical approach and pedagogical principles. This study examines the compulsory educational system of the Czech Republic and the position and responsibility of the teacher in fostering a culturally sensitive and inclusive learning environment. Descriptive and content analysis is relied upon for this study. Recommendations are made for stakeholders to imbibe a more responsive environment that enhances cultural and social integration of all learners.

Keywords: Culturally Responsive Teaching, Cultural Competence, Diversity, Learners, Inclusive education, Czech Schools.

Introduction:

The Czech Republic adopted a restrictive and selective policy for migration resulting in strict visa policy and high financial deposits to enter the territory, after the inflow of asylum seekers and immigrants in the early 1990s, (Felčer, 2020). According to the migration catalogue provided on the foreigners in the Czech Republic by the Czech Statistical Office (2020), a high percentage of the foreigners migrating to the Czech Republic are from Slovakia, Russia, Poland, Ukraine, Germany, Bulgaria, and Viet Nam, and can work legally or obtain resident permits and to live within the region since after 2010. Migration is very commonplace across the globe, and the International Migration Report from the United Nation (2020) stated that as of 2020 over 281 million people live outside their countries of origin. (Jungwirth, Boumová, and Harušťáková 2019). These migrants move for different purposes and often with their families including school aged children or those born to immigrants. The interconnectedness of the globe has ensured higher degrees of migration and more diversity with the classrooms, (Kerkhof & Cloud, 2020), placing a demand on the Czech educational system to assimilate these children and ensure their access to quality education as well, (Hasman, Kostelecká and Hána 2016) The number of foreign learners is gradually increasing with more of the focused in the larger Czech cities like Prague, Brno, and Ostrava, (Šimon, Křížková, and Klsák 2020), going from about 6.3% in 2010 to 8.5% of the general population in 2019, (OECD, 2021), and gradually but steadily increasing. Our classrooms now consist of individuals from all around the world, and this world system will continue for as long as globalization and migration continue.

Culturally Responsive Teaching (CRT):

This term has earned different names such as culturally responsive pedagogy or global teaching practices and has been defined in various ways over the years. This work will consider some state-of-the-art definitions of culturally responsive teaching. It has been defined by Cowden, et al. (2021) as the type of teaching that understands the importance of adjusting curriculum contents and instructional techniques to adequately meet the cultural needs and preference of the learners. A Culturally Responsive Teaching should be focused on discovering how the cultural background of students can become a strength to help them understand the curriculum, by making a connection between their home experiences and desired classroom objectives (Lim, Tan and Saito 2019). Samuels (2018) defines CRT as a student-centred approach to learning. CRT advocates for pluralism of curriculum content and its transmission, in the place of the singular method of teaching for every student within the classroom. Cowden, et al. (2021) establishes a simultaneous progression between students' cultural experiences and academic achievement. Important things to note from the following definitions are the emphasis on learners and the need for teachers to device appropriate teaching methods and goals. Culturally Responsive Teaching bears in mind individual cultural differences and diversities. This allows for students' reflective thoughts and the expression of their individual cultural experiences. Teachers will be able to achieve culturally responsive classroom when they have a clear understanding of the interconnected world, thereby guiding students towards the building and application of experiential and reflective thinking in classroom discussions and analysing global concerns.

The position of the theory of critical pedagogy is highly reflected in the implementation of CRT Culturally Responsive Teaching. Traditional teaching methods that gave the teacher exclusive rights as the custodian and executor of the entire learning process is challenged by the foundational proponent of this theory, Paulo Freire. The author advocates for a student-teacher relationship that involves communication and contributions from both parties; the

teacher acts as the facilitator while the students understand and learn through the application of their cultural knowledge and experiences (Cowden, et al. 2021). The entire process of Culturally Responsive Teaching embraces the importance of the students' cultural background as being essential for their engagement in reflective learning. They are then able to make connections between their experiences and the learning taking place in the classroom. Reflective learning refers to a self-directed learning (Gencel and Saracaloğlu 2018), that involves a deliberate and conscious thinking about learning concepts. This allows a learner to form a deeper understanding of the relationship between one experience and another (Balta and Ankara 2018). Reflective learning is thus crucial for Culturally Responsive Thinking to establish a connection between individual experiences and those made within the classroom.

The Czech education system:

The Czech society places a lot of value on education for citizens, as it embraces traditional European values. Itis overseen by the Ministry of Education, Youth and Sports, which makes policies, strategies, and guides the overall school system (OECD, 2016). Despite this position maintained by the Ministry, schooling decisions are still made mostly by the individual schools (OECD, 2020). This school autonomy was created in 2004 with the amendments of the Framework Educational Programme, allowing schools to create their own School Educational Programme to meet the needs of learners (National Institute for Education 2021).

The governmental Strategy for Education 2020 contained priorities as reducing of inequalities, supporting quality teacher education, the effectively managing the educational system. The recent Strategy 2030+ aims to modernise the Czech educational system to meet the demands of the 21st century by reducing inequalities in education and by preparing students for active personal, civic, and professional life (Eurydice - European Commission, 2021). These educational policies and frameworks are mostly associated not only with the

compulsory school years (pupils within the ages of 6 to 15) but also with the upper secondary education (students within the ages of 15 to 19).

The school level curriculum which is used within the Czech Republic according to Pešková, Spurná, and Knecht (2019) is formulated by the School Education Program which allows for schools as well as the teachers autonomy in the techniques and method of instruction but maintains the position of overseeing curriculum content and objectives. This should provide opportunities for patterning classroom activities to suit any agenda pushed forward by the instructor, and in this context, this would be to achieve a culturally responsive learning environment. Studies conducted by the authors revealed that in the Czech Republic, changes and reforms made in the educational policies were met with certain resistance by the schoolteachers, with as little as 19% of the sample population accepting educational reforms made in the state. Educational reforms are essential for educational development, and the teachers' ability to adopt and implement them will ensure changes in line with the objectives of such reforms. Educational reforms that meet the needs of the 21st century diversified classrooms are needed to address the demands of globalization, hence the need for the teachers in the Czech Republic to consider culturally responsive teaching, especially in the formative years of learning.

Preparedness of the teacher

Currently the popular approach to teaching and learning are those that focus on the learner, making room for the learner to be seen and heard, encouraging, and supporting them to grow in their learning environment. To learn and develop, the learner must feel safe and able to be creative. Every learner is unique and different, and in today's world stage our classrooms are filled with learners who represent different cultures, who speak different languages and possess different ideologies about the world around them (Zaidi 2020). Culture, according to research carried out by Krasnof (2016) and numerous other works, has shown to have a strong

influence over the attitudes, values and behaviour of both students and teachers, and is brought into the learning environment. This fact has led to the urgency for teachers to be prepared to attain cultural competence, manage diversity in the classroom in order to guide every child towards achieving learning outcomes. According to Krasnof (2016), the teacher must be culturally responsive to meet students´ unique learning needs and styles. The teacher must be trained or retrained with the right knowledge and skills to attain cultural competence, which will in turn lead to the adoption of healthy teaching practices and techniques.

The ability to build a positive learning environment for every student in the Czech Republic will impact the ratings of teachers´ support in the classroom (OECD, 2019). The ratings for teachers support in PISA 2018 assessment showed the data collected from the students varied significantly from the data collected from the teachers.

Various models of culturally responsive teaching have suggested steps to guide the classroom teacher. The teacher oversees the learning experience and, therefore, has a major part to play in ensuring a culturally sensitive classroom. Samuels (2018) stated that various research carried out amongst pre-service teachers shows the level of knowledge they possess regarding other cultures turned out very low. The author suggests that educators of pre-service teachers must, hence, shoulder the responsibility of preparing teachers to be advocates for educational equality and foster an inclusive curriculum. The educational policies in Czech Republic have given teachers more autonomy, and this has shown to be empowering (Pešková, et al. 2019). This provides room to experimentally and progressively device methods to achieve a culturally responsive learning environment in the Czech schools.

The challenge the Czech teachers are facing is the preparedness to embrace diversity in their classrooms. Another is their ability to harness this quality to their advantage in achieving, not only the lesson objectives, but ultimately build independent and critical thinkers, who can reflectively proffer solutions to societal issues.

Promoting Diversity in the Classroom

Promoting and maintaining a culturally responsive learning environment is important because it provides equity for all learners and gives equal opportunities for excellence. The benefit of teaching students to embrace diversity is necessary for globalised societies. There are certain practices and activities required of the teachers, as the facilitators of the learning process, to achieve a level of cultural responsiveness,

Know Yourself and the Learner

It is important to note that due to the sociocultural experiences and training that every individual goes through, people are predisposed to conceiving ideas about others. This includes teachers, who have already formed perceptions regarding student behaviours, backgrounds and capabilities (Cowden, et al. 2021). The authors express concern about stereotypes and assumptions as the most common challenges to attaining a culturally responsive learning environment. It is imperative for teachers to recognise themselves as cultural beings to help students to come to the same understanding (Kerkhoff and Cloud 2020). A sound communication structure and healthy relationships between the teacher and the students will ensure that the teacher has sufficient knowledge about the students to reach the success of their academic performance. The teacher must understand what makes each student unique: their cultural inclinations and attitudes, language and communication styles, values and traditions and their learning styles (Lim, Tan and Saito 2019). If a teacher remains unappreciative of the diversity of cultures, they may unwittingly reinforce stereotypes and prejudices in the classroom (Samuels 2018). The teachers therefore must be committed to achieving cultural competence and see themselves both as facilitator of the learning process as well as a learner.

Sociable Classroom Atmosphere

According to Cowden, et al. (2021), creating a friendly classroom atmosphere where students can introduce themselves to each other without necessarily divulging personal information, will help them establish some level of trust between them, and create the awareness of shared values for human lives, (value for peace, work, family, friends, leisure time and politics), Zaidi (2020) noted that encouraging students to share ideas and experiences about certain concepts taught in lessons helped to explore and establish similarities among the cultures of diverse students represented within the classroom. Ethically, it is important to find out what our similarities and differences are so we can value and respect each other. There are cultures that are connected to others, establishing this will help build relationships between people and culture. An essential aspect of active dialogue among students to foster culturally responsive learning is the ability to ensure collaborative learning during the exchange, (Samuels 2018).

Developing an Inclusive School Culture

An inclusive school culture is one that reflects the ethnic and cultural diversity of the broader school community and implements supportive, influential, and easily understood policies and practical measures against racism and stereotypes; defaulting them frowned upon. This includes maintaining a school culture where students from diverse racial, ethnic, and social groups feel that they are heard and valued. Cowden, et al. (2021) opined this to be achievable if teachers are informed about the different communication patterns of the individual students in their classes. Additionally, encouraging students to assess projects and classwork from their peers will generate a deep insight into their thought patterns and cultural experiences. Group-related teaching techniques can be adopted by teachers to ensure that students work together and are responsible for one another (Krasnof 2016). Inclusive school culture recognizes the uniqueness of every learner, and the need to include different approaches to support their specific needs, and this can only be achieved with a clear understanding of each individual learner (Education Review Office 2018).

Representative Media to Boost Cultural Awareness

In 2018, The Education Review Office of the New Zealand government discussed cultural responsiveness with implications, that there should be some level of cultural awareness embedded in the school curriculum which should be reflected in classroom activities to sensitize students to the nature of their experiences of diversity in the society. A research carried out by Zaidi (2020) elaborately showed that the use of multi-lingual books will not only help students understand the content of the lessons, but also help them learn about different languages and create room for curiosity. This concept known as Content and Language Integrated Learning (CLIL) is classified under innovation of teaching resources to achieve a culturally responsive learning environment, irrespective of the subject (Bruen and Kelly 2016; Diáz, 2018). The studies conducted in the Educational Review suggested printing classroom instructions in multiple languages or pictograms. Certain studies have stated that organizing culture celebration events for students to share interesting aspects of their culture, with poems or songs in the mother-tongue, food and native attires, is beneficial for cultural enlightenment and sensitivity, celebrating students' cultures and values (Education Review Office 2018).

Cultural Competence Research and Findings:

Kirkhoff and Cloud (2018) carried out among students in a Master of Education Course in the United States Urban University who were also in-service teachers, using discussions, completed lesson plans and self-inquiry to find out the degree to which these teachers in training understand and implement global teaching practices. The study used a focal and control groups with the focal groups receiving lessons in global competence. Results from the study showed that the in-service teachers were able to help students cultivate cultural identity by creating wholesome learning content and resources.

Samuels (2018) carries out a qualitative research to determine the perception of 200 in-service k-12 teachers in the United States on culturally responsive teaching, over a period of 4 months. The research revealed a lot of advantages of applying culturally responsive teaching with the limitations of time and relevant materials. However, the advantages exceeded the disadvantages with the responses on the ability this method had to help students appreciate diverse cultures, build trust, and ensure inclusiveness for all, while welcoming different world views from students. The students felt connected, included and valued, based on the responses of the in-service teachers.

Additionally, the works of Bruen and Kelly (2016); and Zaidi (2020) all experimentally show that more academic successes were recorded by teachers who practiced culturally responsive teaching, finding out the strength of each student because of the participation it enhanced. Every learner is different and has something to offer, and with adequate attention paid, were encouraged to express themselves and work with others.

There are many benefits to the inculcation of culturally responsive teaching into the Czech Education system. Effectively managing and harnessing student diversity will ultimately lead to:

1. Preparing students to become global citizens
2. Building collaboration and teamwork among students
3. Developing respect and love for others
4. Reducing prejudices and stereotypes
5. Providing a safe learning environment
6. Encouraging healthy relationships now and in the future
7. Building confidence and self-esteem
8. Acceptance and empathy
9. Acknowledgement and expression of individual differences

Whereas the inability to handle it properly will essentially lead to cases of bullying, stereotype threats, isolation, increased stress levels for students who are victims of isolation or negative stereotypes which will ultimately lead to poor academic performance.

Recommendation:

The following recommendations are made for the purpose of ensuring the adoption of culturally responsive teaching within the Czech schools:

1. The School Education Program should contain content about the changing conditions of society.
2. The school board and management should develop inclusive educational policies that address diversity in the classroom.
3. Educators of teachers at the Faculties of Education should intentionally teach how to achieve cultural competence both in theory and practice.
4. The teachers in the Czech Republic should embrace culturally responsive teaching, as doing that has shown a better academic performance of students (Zaidi 2020).
5. The society, both locals and foreigners, should cooperate with educational institutions; providing resources that would help achieve a culturally responsive learning environment.

Conclusion:

Teachers, as the facilitators of the learning process, should indulge in self-evaluation of the influence of their personal sociocultural experience on teaching techniques employed in the classroom, their knowledge of individual students and cultures represented within the classroom and their response to different students' behaviour. The major challenge of adopting culturally responsive learning techniques is teachers' resistance to new reforms and

changes from traditional or familiar methods of instruction. If embraced by the society, with teachers pioneering the venture, students and the society at large will be prepared to reap the benefits of a diverse society. Students who are culturally diverse tend to achieve better academic success if encouraged to think and understand basic classroom concepts in their native language and from their cultural experiences.

Declaration of Interest Statement

In accordance with the policy of Taylor & Francis, the authors of this review would like to declare that we have received no funding from any company nor organization and therefore have no competing interest.

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North Korea:A New Nuclear State and East Asia Key Player ?

Otniel Sinaga., Farhan Nurruzzaman., Muhammad Ricky Pratama., Akmal Aldino

***Abstract*—**East Asia has nowadays become the most dynamic region in the world. This is because of the one state called North Korea. North Korea or it's official name Democratic People's Republic of Korea or acronym as DPRK was the country that always attract issue in international research study. It because of this state always show of force of it's military capabilities and also their weapon of mass destruction.. North Korea, also has lot of armed forces with a high military equipment including Nuclear weapon whom has make the world scared upon them, this weapon will change all perspective in studying North Korea. The latest news from North Korea they have displayed their latest weapons even their nuclear arsenal in October 10th Parade, so this paper will explain of North Korea as Asia player.

***Keywords*—**DPRK,Nuclear,Weapon,Asia

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Fostering Ties and Trusts through Social Interaction within Community Gardening

Shahida Mohd Sharif, Norsidah Ujang

***Abstract*—** Recent research has shown that many of the urban population in Kuala Lumpur, especially from the lower-income group, suffer from socio-psychological problems. They are reported as experiencing anxiety, depression, and stress, which is made worst by the recent COVID-19 pandemic. Much of the population was forced to observe the Movement Control Order (MCO), which is part of pandemic mitigation measures, pushing them to live in isolation as the new normal. The study finds the need to strategize for a better approach to help these people coping with the socio-psychological condition, especially the population from the lower-income group. In Kuala Lumpur, as part of the Local Agenda 21 programme, the Kuala Lumpur City Hall has introduced Green Initiative: Urban Farming, which among the approaches is the community garden. The local authority promotes the engagement to be capable of improving the social environment of the participants. Research has demonstrated that social interaction within community gardens can help the members improve their socio-psychological conditions. Therefore, the study explores the residents' experience from low-cost flats participating in the community gardening initiative from a social attachment perspective. The study will utilise semi-structured interviews to collect the participants' experience with community gardening and how the social interaction exchange between the members' forms and develop their ties and trust. For a context, the low-cost flats are part of the government social housing program *(Program Perumahan Rakyat dan Perumahan Awam)*. Meanwhile, the community gardening initiative *(Projek Kebun Kejiranan Bandar LA21 KL)* is part of the local authority initiative to address the participants' social, environmental, and economic issues. The study will conduct thematic analysis on the collected data and use the ATLAS.ti software for data organization and management purposes. The findings could help other researchers and stakeholders understand the social interaction experience within community gardens and its relation to ties and trusts. The findings could shed some light on how the participants could improve their social environment, and its report could provide the local authority with evidence-based documentation.

***Keywords*—** community gardening participation, lower-income population, social attachment, social interaction

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Metabolomic Approach of 'Arbequina' Olive (*Olea Europaea* L.) Leaves Dried by Different Technologies to Identify Polyphenols Related to Antioxidant Capacity

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***Abstract*—**Nowadays, more than 3.3 million tons of olive oil are annually produced worldwide, and Spain is the main producer. On the other hand, olive oil industry generates a large number of wastes and only the 20 % is transformed into olive oil. The high organic content and phytotoxicity of these residues entails an environmental problem. Olive leaves, which are separated from olives before olive oil production, have been traditionally consumed as a remedy in Mediterranean countries for their health benefits that had been related to their phenolic composition. Extracts of these compounds could be used in food products as bioactive compounds. In consequence, the extraction of these phenolic compounds from olive leaves could be a way to valorise this residue. 'Arbequina' olive leaves were studied to assess the effectiveness of different drying methods (vacuum, oven, air and freeze-drying) on the preservation of the phenolic compounds and the antioxidant capacity in those olive leaves. Briefly 24 samples ('Arbequina' olive leaves from 4 different drying methods) were prepared ground and then extracted in MeOH/H_2O (70:30). Antioxidant capacity (AOC) of these olive leaves extract was assessed using the 2,2-diphenyl-1-picryl-hydrazyl-hydrate (DPPH) free radical scavenging activity method. The Metabolomics profile focused on phenolic compounds was carried out on a Vanquish Ultra High Performance Liquid Chromatography (UHPLC) system with a Hypersil gold, 1.9µm column (2.1 mm id x 100mm) coupled to a Q Exactive™ -Orbitrap High Resolution Mass Spectrometer (Thermo Fisher Scientific, San Jose, CA, USA). All the samples were analysed by negative and positive electrospray ionization in full scan MS mode.Electrospray ionization (ESI) data-dependent MS-MS spectra were generated with Quality Control (QC) pool samples, for identification purposes. The acquired data set composed of full MS and data-dependent MS-MS raw files, was processed using Compound Discoverer 3.1. An untargeted metabolomics workflow with putative identification through in-house mass list, and databases were used for processing the raw data. Antioxidant capacity (AOC) and phenolic profile compounds were further analysed by Principal Component Analysis (PCA) and correlation analysis using Phyton programming.

In the correlation analysis of the different free polyphenols with antioxidant capacity, several polyphenols were found to be highly correlated either positively or negatively. In the PCA analysis, it can be observed how 4 different drying system affect phenolic composition. This means that the drying method significantly influences the final polyphenol profile of the dried olive leaf. Metabolomic approach allows not only to get to a deeper knowledge of the type of phenolic compounds present in this type of dried olive leaves, but also to select the best drying method according to the final AOC properties of the dried material.

***Keywords*—** Antioxidant capacity, Arbequina, Metabolomics Phenolic compounds, Olive leaves.

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Metabolic modeling of gut-dysbiosis associated in autism spectrum disorder and potential strategies for dietary intervention

Faiz Khan Mohammad, Swagatika Sahoo and Raghuanthan Rengaswamy

Abstract—The human Gut microbiome has become an emerging field of research for numerous diseases. The abnormal composition of harmful and beneficial microbes in the human gut is associated with numerous diseases including neurotransmitter disease Autism spectrum disorder (ASD). Enterocyte cells play a pivotal role in the first line of defense against harmful bacteria. The integrity of the enterocyte cell wall is essential in human health and is compromised in autism spectral disorder. Typically, elevated levels of reactive oxygen species ROS which includes superoxide SOX, hydrogen peroxide H_2O_2 have been identified and linked to epithelium tissue damage in the autistic gut. The comprehensive assessment of increased oxidative burden, cause of epithelial tissue damage requires the simultaneous consideration of both phenotypical and biochemical changes in the autistic and normal gut. This study presents a first-ever gut representative model by combining gut bacteria characterized in the autistic gut with the host intestinal model. Moreover, we also studied the interaction of gut microbes and their interaction with the intestinal host for host metabolic perturbations. Our analysis showed that beneficial and harmful bacteria interact with major host intestinal metabolic pathways and administration of a High fiber diet can significantly lower the ROS toxins. The effort of constructing integrated gut model gives a mechanistic understanding of gut dysbiosis in autism, identifying biomarkers, and demonstrating the possibility of dietary changes in reducing autistic symptoms in the host gut. These results can be employed to build a whole-body transport model elucidating the transport of gut-derived toxins through the gut-brain axis affecting normal brain function.

Keywords—Autism spectrum disorder, Constraint based reconstruction and anlysis, small intestine enterocyte cells, reactive oxygen species, Hydrogen peroxide, Superoxide, Leaky gut.

I. Introduction

AUTISM spectrum disorder (ASD) is categorized as a group of neurodevelopmental disabilities. Clinically the condition is characterized as persistent social impairment, reduced cognitive capability, restricted communication skills, and repetitive body behavior. However, ASD has traditionally been reported as genetic and environmental factors [1], [2], recent research emphasizes the pivotal role of inherent metabolic disturbances in host intestinal gut [3], [4]. Pathogenesis of autism shows co-morbid patterns with gastrointestinal defects and gut microbiome dysbiosis [3]. These defects induce metabolic disturbance that can cause oxidative burden consequently intestinal hyper-permeability. Together, these factors transport to the brain and affect normal neuronal functioning.

Studies on autistic gut microbiota show toxins producing bacteria Clostridium, Bacteroides, Desulfovibrio, Ruminicoccus, and shigella is significantly higher in abundance [5], [6], [7], However, the beneficial bacteria Bifidobacterium, Lactobacillus, Prevotella, and Akkermansia bacteria are either absent or present in reduced quantities [6], [8]. This links gut microbiome with ASD, through microbe-gut-brain-axis, and can be explained by leaky-gut hypothesis [5].

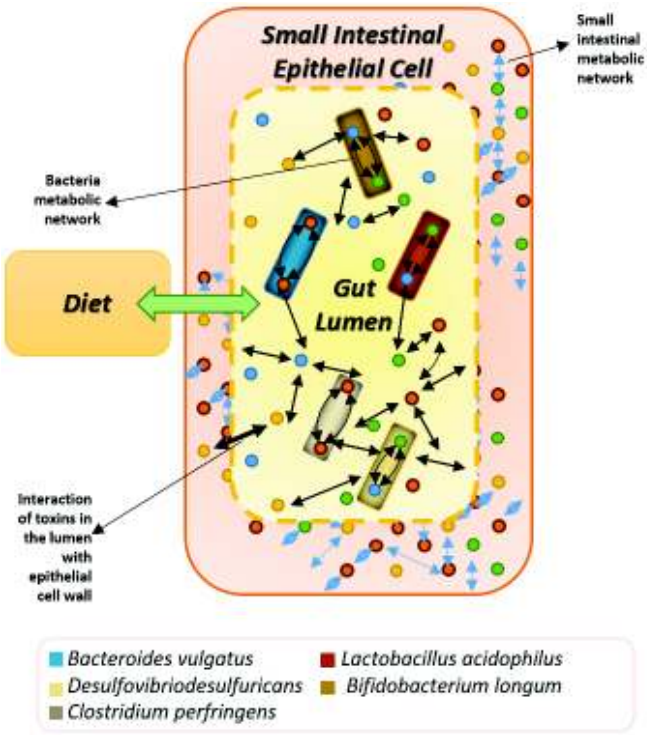

Fig. 1. Cross-talk of bacteria inside the SIEC

Intestinal hyper-permeability is also known as leaky gut, is the opening of small gaps in the tight junctions of the gut wall, consequently losing epithelial cell's ability to control the movement of molecules between gut and bloodstream. An increased oxidative burden has been identified to trigger the production of pro-inflammatory metabolites and is characterized by the level of ROS toxins. ROS that includes superoxide SOX, hydrogen peroxide H_2O_2, etc. are synthesized otherwise in a normal human gut. In an attempt to investi-

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TABLE I
GUT BACTERIAL ABUNDANCE IN AUTISTIC COMPARED TO NORMAL HUMAN GUT

Microbe	Abundance	Reference
Bacteroides vulgatus ATCC	Increased	[6], [7]
Desulfovibrio desulfuricans subsp desulfuricans DSM	Increased	[6], [7]
Clostridium perfringens ATCC	Increased	[5], [6]
Lactobacillus acidophilus ATCC	Decreased	[6], [7]
Bifidobacterium longum longum JDM301	Decreased	[6], [7]

gate ROS toxins-induced metabolic disturbances in the host intestine of the autistic gut, we here present a multi-cellular metabolic model of gut microbiota that helps investigate the metabolic perturbation in the intestinal host associated with the disease. Therefore, the first-ever integrated model comprising a metabolic model representing the human gut can describe the effect of increased oxidative stress. With the help of the proposed framework, the complex interactions between the gut microbiome and host intestinal model are simulated and investigated for the observable metabolic changes and propose potential intervention strategies to improve the condition of dysbiosis associated with autism.

II. MATERIAL AND METHODS

The human gut microbiome is a diverse and complex microenvironmental system, responds dynamically to any small change. This diverse and complex microsystem serves to define well being of the human host. Autistic gut shows a comorbid pattern with abnormal gut microbiome also known as gut dysbiosis. We here build a gut microbiome representative model as shown in Figure 1. This is achieved by following the Microbiome modeling toolbox [9] in which the microbial community is designed to cross-talk through transport reactions of each microbial reconstruction from the extracellular space of individual models in the community to the common lumen compartment.

At the cellular scale, the Integrated community (constraint-based COBRA) models were used to describe the alteration of metabolic pathways in small intestinal hosts and the impact of dietary and beneficial bacteria intervention upon the tissue-specific endogenous metabolism.

A. Construction of gut representative model

To construct the gut representative model we used COBRA reconstruction method. Constraint-based reconstruction and analysis (COBRA) [12] methods to study biological cell systems is one of the most preferred systems biology approaches. The gut metabolic model reconstruction representing autism symptoms was constructed by combining gut bacteria implicated in autism as shown in Table I and individual constraint-based genome-scale metabolic models of sIEC [11].

TABLE II
SPECIFICATION OF MICROBE METABOLIC MODEL USED

Model	Reactions	Metabolites	Reference
Bacteroides vulgatus ATCC 8482	1302	1110	[10]
Desulfovibrio desulfuricans subsp desulfuricans DSM 642	1279	1148	[10]
Clostridium perfringens ATCC 13124	1307	1115	[10]
Lactobacillus acidophilus ATCC 4796	756	728	[10]
Bifidobacterium longum longum JDM301	1054	959	[10]
Small Intestine Enterocyte Cell	1282	844	[11]

TABLE III
SPECIFICATION OF DIET USED

Diet	Metabolites
High Fiber	181
Western	176

The unconstrained gut bacteria models were obtained from the AGORA reconstructions [10].

The genome-scale metabolic models of five important bacteria species shown in Table II (i.e., Bacteroides vulgatus, Clostridium perfringens, Desulfovibrio desulfuricans, Lactobacillus acidophilus and Bifidobacterium longum) [10] were coupled with the genome-scale model of the human small intestinal enterocyte model [11] following the method explained in Microbiome modeling toolbox [9]. Its Microbe-microbe interaction and host-microbe interactions in specific microbial community module support integration of bacteria interacting with other bacteria and with host intestine model inside the human gut. The metabolic reconstruction of the human gut with five bacteria models, which included 7137 reactions, 6056 metabolites and 4116 genes shown in Table III.

The reconstruction of small instestine model sIEC [11] was expanded with new pathways to capture the metabolism of bacteria-derived toxin metabolites. Interaction of gut bacteria and the sIEC model happens through the exchange of metabolites in the common lumen compartment.

B. Gut representation with varying composition of harmful and beneficial bacteria

To understand the cross-talk between the gut microbiome and human host under different dietary constraints, for autistic v/s healthy case, three different integrated models were

TABLE IV
SPECIFICATION OF MICROBE METABOLIC MODEL USED

Model	Reactions	Metabolites
Gut microbiome – Beneficial	3177	2611
Gut microbiome – Harmful	5323	4365
Gut microbiome	7137	6056

constructed using different compositions of bacteria. The three integrated gut representative models are shown below and their model specifications are shown in Table III.

1) **Gut Microbiome**: All five including harmful and beneficial bacteria integrated with the sIEC model to represent autistic gut with beneficial bacteria intervention.
2) **Gut Microbiome Harmful**: Harmful bacteria integrated with SIEC model to represent typical autistic gut.
3) **Gut Microbiome Beneficial**: Beneficial bacteria integrated with SIEC model to represent Healthy gut.

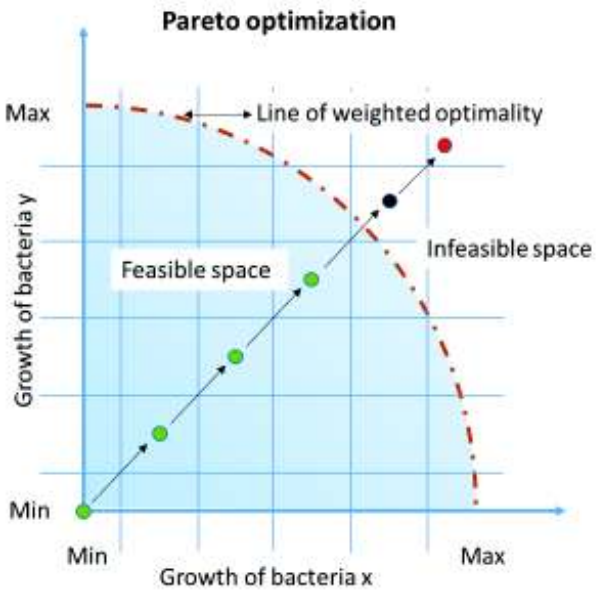

Fig. 2. Pareto optimization

C. Strategies for the dietary intervention

Interaction of microbiome inside the human gut depends majorly on the common environment. The environment can be defined as the diet administered by the subject. This dietary information can easily be translated to our integrated model by defining the constrained on the metabolite exchange in the lumen compartment. In this study, we have used two diets shown in Table IV. To add dietary constrain the model the combined gut model was opened with only those exchanges in the model that corresponds to nutrients in the diet for uptake.

Metabolic modulation of gut-brain-axis depends on the toxins depends primarily upon the complex interplay between bacterial virulence factors and host responses inside the human gut. Recently, however, it is reported that dietary intervention and the presence of beneficial bacteria might profoundly influence the outcome of bacterial infection. Thus, we also demonstrate that the administration of beneficial bacteria and diet, with the ability to modulate oxidative burden, can help us understand biochemical factors driving autism. Six separate models are constructed and were analyzed to analyze the effect of dietary intervention as shown in Table V.

TABLE V
MULTI-CELLULAR INTEGRATED GUT REPRESENTATIVE MODEL CONSTRAINT WITH DIET

Gut Microbiome	**High Fiber**	Bacterial community model constrained with High fiber diet.
	Western	Bacterial community model constrained with Western diet.
Gut Microbiome Harmful	**High Fiber**	Harmful bacteria community (only bacteria present in abundance in autistic gut) model constrained with High fiber diet.
	Western	Harmful bacteria community (only bacteria present in abundance in autistic gut) model constrained with Western diet.
Gut Microbiome Beneficial	**High Fiber**	Beneficial bacteria community (Gut bacteria present in very less percentage in autistic gut) model constrained with High fiber diet.
	Western	Beneficial bacteria community (Gut bacteria present in very less percentage in autistic gut) model constrained with Western diet.

D. Pareto search

For multi-objective optimization, a Pareto optimal solution [13] is required. A graphical representation of the working of the Pareto search technique is shown in figure 2. For instance, consider the case where the bacterium 1 and bacterium 2 are equally weighted to take the nutrient. The algorithm will equally weightage and will find the optimized growth rates at 45° line and will search otherwise at certain sloped line depending upon the abundance of bacteria in the community.

E. Metabolic pathway analysis

For metabolic pathway analysis, we used Flux variability analysis [14]. The Flux variability analysis module identifies

TABLE VI
PERTURBED METABOLIC PATHWAYS IN HIGH FIBER DIET AS COMPARED TO WESTERN DIET

Subsystem	Pathway score
beta-Alanine metabolism	1
Vitamin B6 metabolism	1
Vitamin A metabolism	1
Thiamine metabolism	1
Taurine and hypotaurine metabolism	1
Steroid metabolism	1
Squalene and cholesterol synthesis	1
ROS detoxification	1
Pyruvate metabolism	1
Pyrimidine synthesis	1
Purine synthesis	1
Propanoate metabolism	1
Oxidative phosphorylation	1
Nucleotide salvage pathway	1
Histidine metabolism	1
Heme synthesis	1
Heme degradation	1
Glutamate metabolism	1
Fructose and mannose metabolism	1
Folate metabolism	1
D-alanine metabolism	1
CoA synthesis	1
Transport, endoplasmic reticular	0.9524
Glycolysis/gluconeogenesis	0.9474
Cholesterol metabolism	0.9412
Glycerophospholipid metabolism	0.9231
Citric acid cycle	0.9231
Urea cycle	0.9167
Pentose phosphate pathway	0.9167
Purine catabolism	0.9
NAD metabolism	0.9
Transport, mitochondrial	0.8364
Miscellaneous	0.8
Alanine and aspartate metabolism	0.8
Transport, lumen	0.7914
Valine, leucine, and isoleucine metabolism	0.75
Unassigned	0.75
Triacylglycerol synthesis	0.75
Methionine and cysteine metabolism	0.75
Vitamin B2 metabolism	0.7143
Arginine and Proline Metabolism	0.7143
Transport, nuclear	0.6667
Glycine, serine, alanine and threonine metabolism	0.6667
Transport, peroxisomal	0.6538
Pyrimidine catabolism	0.625
Nucleotide interconversion	0.62
Galactose metabolism	0.5
Exchange/demand reaction	0.4577
Fatty acid oxidation	0.4065
Transport, extracellular	0.3908
Glutathione metabolism	0.3333
Starch and sucrose metabolism	0.1111
peptide metabolism	0
Vitamin D metabolism	0
Vitamin C metabolism	0
Dietary fiber binding	0
CoA metabolism	0

TABLE VII
PERTURBED METABOLIC PATHWAYS ON ADDITION OF BENEFICIAL BACTERIA IN AUTISTIC GUT

Subsystem	Pathway score
CoA metabolism	1
Dietary fiber binding	1
Vitamin A metabolism	1
Vitamin C metabolism	1
Vitamin D metabolism	1
peptide metabolism	1
Starch and sucrose metabolism	0.8889
Fatty acid oxidation	0.7398
Glutathione metabolism	0.6667
Transport, extracellular	0.6429
Exchange/demand reaction	0.6338
Galactose metabolism	0.5
Nucleotide interconversion	0.38
Pyrimidine catabolism	0.375
Transport, peroxisomal	0.3462
Glycine, serine, alanine and threonine metabolism	0.3333
Transport, nuclear	0.3333
Arginine and Proline Metabolism	0.2857
Vitamin B2 metabolism	0.2857
Methionine and cysteine metabolism	0.25
Triacylglycerol synthesis	0.25
Unassigned	0.25
Valine, leucine, and isoleucine metabolism	0.25
Transport, lumen	0.2393
Alanine and aspartate metabolism	0.2
Miscellaneous	0.2
Purine catabolism	0.2
Transport, mitochondrial	0.1636
NAD metabolism	0.1
Pentose phosphate pathway	0.0833
Urea cycle	0.0833
Citric acid cycle	0.0769
Glycerophospholipid metabolism	0.0769
Cholesterol metabolism	0.0588
Glycolysis/gluconeogenesis	0.0526
Transport, endoplasmic reticular	0.0476
CoA synthesis	0
D-alanine metabolism	0
Folate metabolism	0
Fructose and mannose metabolism	0
Glutamate metabolism	0
Heme degradation	0
Heme synthesis	0
Histidine metabolism	0
Nucleotide salvage pathway	0
Oxidative phosphorylation	0
Propanoate metabolism	0
Purine synthesis	0
Pyrimidine synthesis	0
Pyruvate metabolism	0
ROS detoxification	0
Squalene and cholesterol synthesis	0
Steroid metabolism	0
Taurine and hypotaurine metabolism	0
Thiamine metabolism	0
Vitamin B6 metabolism	0
beta-Alanine metabolism	0

metabolic pathways from the input lists that have perturbed feasible flux space and have significance to metabolic subsystems. The topological analysis, called Pathway Analysis, module measures the metabolic subsystems in a metabolic network that have a significant shift in the flux of the reactions associated with the subsystem. To measure the statistically significant subsystems having significant pathway shifts, we used pathway score as defined in equation 1. For subsystems with higher pathway score represents a high degree of shifts in the reaction.

$$\textbf{Pathway score} = \frac{\textbf{No. of shifted reactions}}{\textbf{Total no. of reactions in subsystem}} \quad (1)$$

TABLE VIII
OBJECTIVE REACTIONS IN THE INTEGRATED MODEL

Model	Net objective	Objective function reactions	
Gut	Toxin production	H_2O_2 output	O_2S output
Gut	Toxin consumption	H_2O_2 input	O_2S input

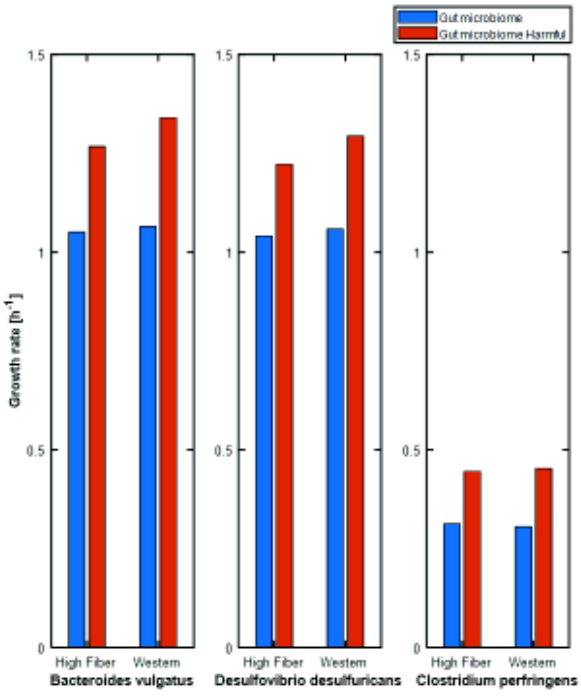

Fig. 3. Harmful bacteria growth rate

This suggests that a High fiber diet in comparison western diet helps to significantly lower the growth rates of harmful bacteria. Moreover, the perturbations on sIEC must also be kept in mind since high dosages may be harmful, we have also shown subsystems effected by the intervention of a High fiber diet in Table VII.

III. RESULTS

As mentioned earlier, the first major question of the present study was to calculate the effect of a potential dietary intervention strategy for autism. Two typical dietary patterns, favoring increased growth of beneficial bacteria were chosen, i.e., a western diet and a high-fiber diet. Each of the above

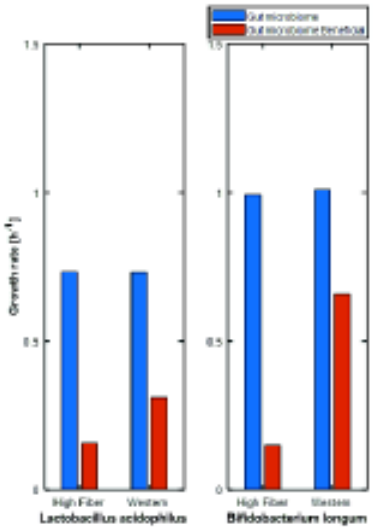

Fig. 4. Beneficial bacteria growth rate

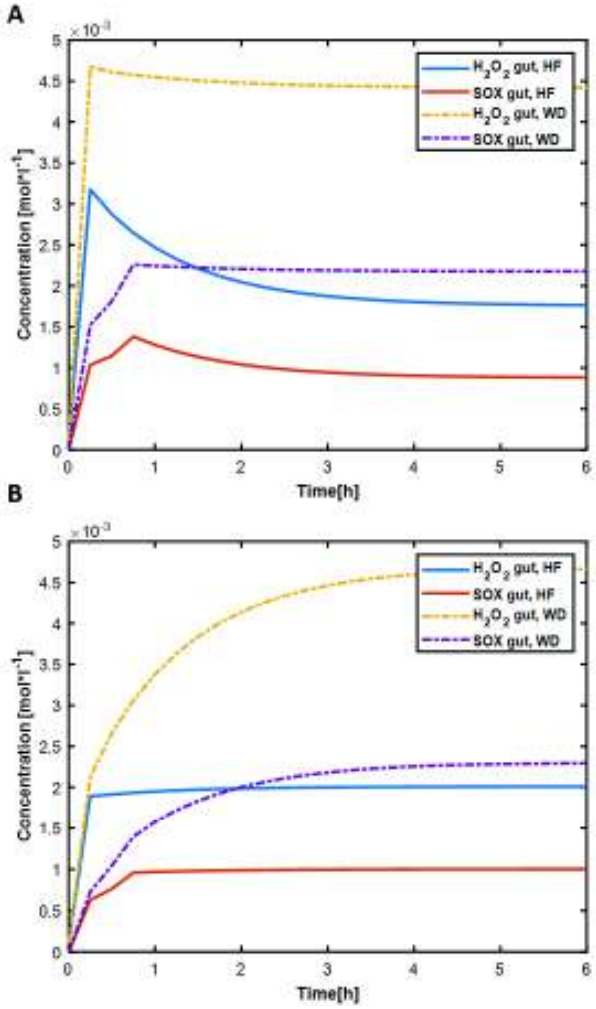

Fig. 5. Toxin produced inside the gut model

gut representative model autistic and healthy models were subjected for the dietary and beneficial bacteria intervention. We observed that the addition of High fiber diet to the purely autistic gut i.e., Gut microbiome Harmful decreased the growth rates of each of the harmful bacteria as compared to the Gut microbiome model, despite being in lesser quantity than the harmful bacteria as shown in figure 3. The other method of observing the effect of diet in improving the gut condition is observed by calculating the level of toxins produced inside the gut. Figure 5 shows the production of toxins inside the typical gut subjected to a different diet. Figure 5A, shows the production of toxins inside the gut microbiome harmful model i.e., gut with harmful bacteria inside. On the other hand, Figure 5B, shows that after adding beneficial bacteria into the microbial consortia the toxins level significantly reduced in the case of a High fiber diet. This concludes, the need for both beneficial and high fiber diets in improving the autistic symptoms inside the gut.

A. Microbiome and diet together alter intestinal and metabolism in autism

The other method of intervention for improving the autistic symptoms in gut is addition of beneficial bacteria. To assess the effect of beneficial bacteria, we added these to the purely autistic gut model i.e., microbiome gut harmful bacteria, and observed a higher growth rate of beneficial bacteria as shown in figure 4. Contrastingly, addition of beneficial bacteria, lead to reduced flux in the reactions linked to oxidative stress metabolism. Thereby, the concentration of ROS toxin is significantly reduced as shown in figure 5B. We propose that this could be another cellular protective mechanism to combat oxidative stress, a phenomenon also seen in cancer cells [15].

IV. Discussion

The Association of the human gut microbiome in various diseases has become a field of great focus for researchers. However, ASD is also been reported to be associated with gut dysbiosis. In silico metabolic analysis for the perturbations still lags. The presented model is the novel representation of the autistic gut, which integrates metabolomics data. The key challenge to simulate the dynamic changes using the COBRA integrated model. This was resolved by applying the static optimization approach of dynamic FBA [16], wherein, it was assumed that the entire concentration of a metabolite was consumed by a reaction.

Multi-cellular systems in a common nutrient medium pose several challenges. However, the growth of a single cell in an environment can be easily calculated using FBA, maximized growth of an individual cell giving no weight for the growth of other cells, making it unsuitable for optimizing multi-cellular systems. Hence, the Pareto search technique was implemented, to obtain collective growth of all the cells in the system .

Oxidative stress has been reported widely in autism [17]. To calculate the effect of oxidative stress on metabolic pathways affected in autism, we compared FVA analysis for the 'toxic' model and the 'non-toxic' model of the gut. The former allows high exchanges of toxins related to oxidative stress across membranes, due to the increased permeability observed in autistic conditions while the latter corresponds to low toxin exchange. The pathways affected by oxidative stress are given in Tables VII VIII. The majorly affected metabolic subsystems carrying more flux through its reactions in the toxic case were found to be ROS detoxification, oxidative phosphorylation, and glutamate metabolic pathways. To determine the effect of oxidative stress we modeled two representative ROS species, H_2O_2 and SOX. Oxidative stress was reduced under the administration of probiotics, significantly with high-fiber diet. Moreover, metabolic pathways that were found to be the most associated by gut bacterial imbalance seen in autism, overlap with the pathways affected by the change in oxidative stress . Therefore, a strong metabolic inter-relation is present between gut dysbiosis and cellular stress levels, that are significantly mediated via the amino acid, nucleotide, central carbon, and vitamin metabolisms.

V. Conclusion

Whilst our metabolic pathway analysis of novel integrated gut representative model provides understanding to disease driving factors in autism, dietary intervention in gut microbes was found to majorly influence host intestinal metabolism, typically via the central carbon, nucleotide, and vitamin metabolisms in the gut. Furthermore, characterization of bacterial secretomes in the community would enable the search for metabolic compounds that are aberrant in the autistic gut. The Pareto search technique, which was used to find microbiome-produced toxins fluxes via multi-objective optimization, can now be used to determine the growth profile of cells competing for nutrients in the microenvironment. The results of our microbial community study analyses and highlights the potential for gut dysbiosis that exists in autism and flag the need for a more sophisticated whole body transport model that can translate and analyze the autistic factor from the gut to the brain.

Acknowledgment

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The Curvature of Bending Analysis and Motion of Soft Robotic Fingers by Full 3D Printing with MC-Cells Technique for Hand Rehabilitation

C. Musikapan, R. Chancharoen, S. Bongsebandhu-phubhakdi

***Abstract*—** For many recent years, **s**oft robotic fingers were used for supporting the patients who had survived from the neurological diseases resulted in muscular disorders, neural network damages and inflammatory symptoms, such as stroke, Parkinson's disease, De Quervain and trigger finger. Generally, the major hand function assistance is essential and indispensable aid to support for patients in activities of daily living (ADL). In this work, we proposed the model of soft robotic fingers as soft actuators that produced by full 3D printing without the molding process, and one material used. Furthermore, we designed the model through multi cavitation cells (MC-Cells) technique and three air cavities. We demonstrated the curvature of bending, pneumatics-driven and force that generated to the model for assistive finger flexion and hand grasping. Also, the soft actuators were characterized in mathematical problem solutions by the length of chord equation and arc length equation. In addition, adaptive push button switch machine was used to measure the force in our experiment. Consequently, we evaluated biomechanics efficiency by the range of motion (ROM) that affected to metacarpophalangeal joint (MCP), proximal interphalangeal joint (PIP) and distal interphalangeal joint (DIP). Finally, the model achieved to exhibit the corresponding of air pressure in pneumatics-driven with force and ROM in biomechanics efficiency to assist the finger flexion and hand grasping.

***Keywords*—** Biomechanics efficiency, curvature of bending, hand functional assistance, multi cavitation cells (MC-Cells), range of motion (ROM).

I. INTRODUCTION

Soft robots have been developed continuously in numerous past researches, and innovated into wearable and mountable lightweight, safe and soften exoskeleton robots. [1] Soft actuators have become an important alternative for development of physical therapy equipment. [2], [3] So, soft actuators support function of hand and upper limbs. It has become essential and indispensable aid, and support for patients in their daily life (ADL). [4], [5] This treatment option through physical therapy has helped the patients with several hand impairments from neurological diseases and inflammatory symptoms [6]. For these reasons, the first 3 months after experiencing stroke or disease is an extremely period for restoration of finger flexion, hand grasping and hand gripping in rehabilitation and physiotherapy. The recovery rate from physiotherapy and treatment during this period is 80%. Meanwhile, recovery rates after 3 to 6 months after disease progressions are 33% to 66%. [7] In addition, soft robot has developed in term of shape, design of the structure and materials used for the application of medical aids for applying to medical support equipment. Similarly, mobility and at-home physiotherapy activities are also beneficial helpful for patients who required hand function restoration and hand assistive function. [8]-[10]

According to our study and design, our soft actuators were characterized by flexion and curvature of fingers bending via pneumatic-driven models. [3] The models utilize flexibility to allowed soft actuators to bend in a curved path that similar to our design. This feature is similarly technique to past design such as PneuNets, fabric-reinforcement and MC-Cells. [11]-[13] Furthermore, the illustration of soft actuator's bending behaviour can explain the resulting outcomes and relationship of finger joints in flexion, ROM and measurements of the force exerted by soft actuators on fingers. Many past studies indicated that soft actuators were created by the fabrication process, full silicone molding, 3D printing for some parts to support the silicone molding, bulk material use for molding, fabric-reinforcement and full 3D printing of silicone without the molding process. [13]

Therefore, in this study, we present soft actuators based on MC-cells technique with three air cavities. The study result showed that our models allowed bending movements similar to finger flexion, mathematical problem solutions, biomechanics efficiency and force measurements.

II. METHODOLOGY

A. Designing

In this study, we designed the internal structure of the models using MC-Cells which was a technique under our previous study. Nonetheless, we use a new internal structure, 3-cavity network, with load-bearing pole to support the load and the beam structure, all of which were above the base layer. In addition, the chamber wall, located at the top of soft actuators, would support bulging, inflating and expansion to support forward movement by pushing the next air block. As a result, the soft actuators would noticeably change its shape during

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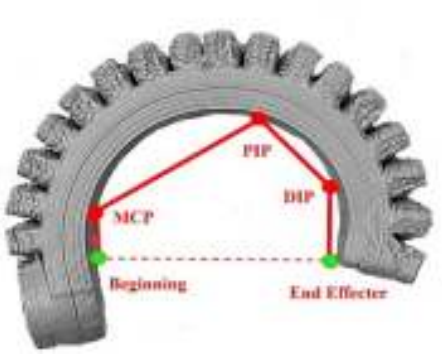
flexion together with the reaction to the base layer after we released air pressure from the system into the soft actuator through network of three cavities.

Thus, the basic of mechanical techniques herein demonstrated bending in curved path because movements of the soft actuators assimilated physical movement of the human fingers (Fig. 1).



(A)

(B) (C)

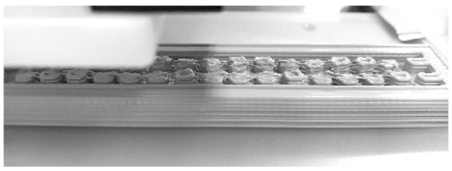
Fig. 1 Soft actuator when active with finger diagram in (A), and motion of finger flexor in (B) and (C).

B. Printing Process

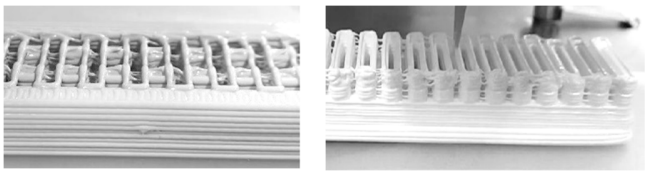
The models were created by 3D printing using liquid-like materials without molding process. There were non-other material support, non-fabrication and non-reinforcement to support or aid in shape retention. Based on our previous work, the models have length of 125 mm, width 21 mm and height 16 mm. Therefore, the weight of our unloaded models was 41 g per piece. In addition, silicone mixture was used as a liquid material for printing in our works. These materials would be available at low costs with commercially made products such as TOA sealants. The average printing costs of material was $0.96 per piece for our model printing. Meanwhile, the material has abled to stretch for 700% in elongation when it solidified (from the data sheet of TOA sealants).

Moreover, we used 3D Bio-plotter printer, sterile standard conical bioprinting nozzle type 18G with syringes in our process printing. The nozzle type 18G has length of 32 mm and 0.84 mm in diameter.

Therefore, the printing process started with printing base structure of soft actuator, followed by printing the 3 air cavities, parallel to the base part with trusses as the column structure is load-bearing pole to support the beam structure. Next, the process followed by printing the beam structure which require carefully control of the printing line thickness to prevent materials from flowing into the air cavities area. Next, air block structure would be printed with a chamber inside each air block to support inflation when pushing air blocks to allow soft actuators to be flexed together with the mechanical reaction layer on the base structure.



(A)



(B) (C)

Fig. 2 Soft actuator in full 3D printing process, (A), (B) Network of triple air cavitation with load-bearing pole and beam and (C) chamber in several air blocks.

C. Force Measurement

In our experiment, we used the adaptive push button switch machine through weight programming on MATLAB to measure the force from soft actuator (Fig. 3). The forces were measured when we released the air pressure into the model.

Fig. 3 Force measurement by adaptive push button switch machine.

III. MATHEMATICS

A. The Range of Motion

Initially, we proposed the length of chord to calculate the angle of end-effector when θ_{XZ} was the bending angle, as shown in (1) [14].

$$\theta_{XZ} = \sin^{-1}\left(L_{chord\,XZ}\left(R_X + R_Z\right)^{-1}\right) (2) \qquad (1)$$

Therefore, the bending angle was θ_Y which can be expressed in mathematical solutions, as shown in (2).

$$\theta_Y = \sin^{-1}\left((L_{chord\ XY} + L_{chord\ YZ})(R_X + R_Z)^{-1}\right) \quad (2)$$

We determined that L_{chord} was link between 2 joints, O was point of intersection between the two radii, and R was radius from the perpendicular from the 2 joints to the intersection at the additional O. In addition, O_n was any point of intersection that correlated with R_n. In Fig. 4, $L_{chord\ XY}$ was link of X to Y. Meanwhile, $L_{chord\ YZ}$ was link of Y to Z.

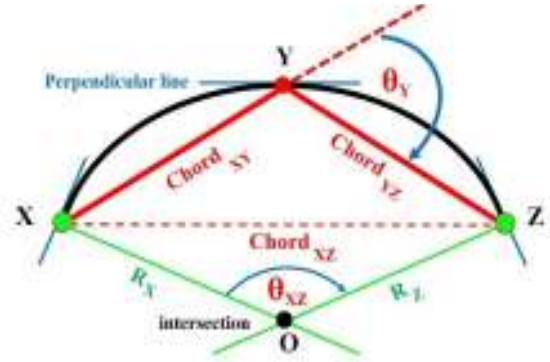


Fig. 4 Simple curving diagram of length of chord and arc length concepts.

In this study, we could calculate the joint flexion by applying the length of chord equation which could explain the correlation and trigonometry. Then, we determined that a point on the model to represent the location of the finger joints (Fig. 5). We assigned A to be beginning of the air cavity distance, B to D points were the joint points of MCP, PIP and DIP, E was the end of curve at EE (end-effector). Therefore, we could find R_C and R_E from the perpendicular line between the joint and soft actuator, and moment of bending to the point of intersection at O, R_C was radius from PIP joint to O, R_E was radius from end-effector to O.

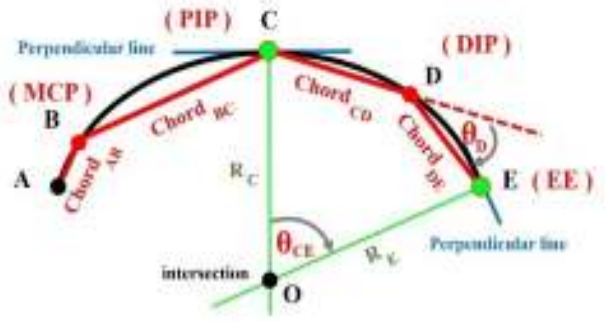


Fig. 5 Simulation of simple curving diagram on soft actuator with flexible joints.

So, MCP joint could be calculated the bending angle in (3).

$$\theta_{MCP} = \sin^{-1}\left((L_{chord\ AB} + L_{chord\ BC})(R_A + R_C)^{-1}\right) \quad (3)$$

Next, the bending angle of PIP joint could be calculated, as indicating in (4).

$$\theta_{PIP} = \sin^{-1}\left((L_{chord\ BC} + L_{chord\ CD})(R_B + R_D)^{-1}\right) \quad (4)$$

And, the bending angle of DIP joint could be calculated, as indicating in (5).

$$\theta_{DIP} = \sin^{-1}\left((L_{chord\ CD} + L_{chord\ DE})(R_C + R_E)^{-1}\right) \quad (5)$$

For the example of calculation, we tested the results of mathematical problem solutions based on our models which have a length of 125 mm. So, link of MCP joint to PIP joint have length of 17.5 mm, link of PIP joint to DIP joint was 52.5 mm, and link of DIP joint to end-effector was 20 mm. In our experiment, we released 100 kPa of air pressure into the model. In Fig. 4, the summation of $R_A + R_E$ was 115 mm which R_A was radius of A to O, R_E was radius of E to O. Therefore, we can calculate the bending angle of MCP joint as shown in (3), PIP joint as shown in (4) and DIP joint as shown in (5). As the results, $L_{chord\ AE}$ was 99 mm in length, $L_{chord\ AB}$ was 7 mm, $L_{chord\ BC}$ was 50 mm, $L_{chord\ CD}$ was 28 mm, $L_{chord\ DE}$ was 26 mm, R_A was 84 mm, R_B was 67 mm, R_C of PIP joint was 89 mm, R_C of DIP joint was 68 mm, R_D was 80 mm and R_E was 67.5 mm. Thus, the bending angle of θ_{MCP} joint was 19°, θ_{PIP} was 32° and θ_{DIP} was 24°.

B. Curvature of Bending

The arc length equation showed bending length of the base layer. We calculated the bending length of the sample curving example on soft actuators, as indicated in (6) [14].

$$Arc\ length = 2\pi R\ (\theta \cdot 360^{-1}) \quad (6)$$

Where R is radius which $2R$ was the summation between 2 radii from R_X and R_Y in Fig. 4, and this reason include the result in Fig. 5 that shows the correlation of R_A and R_E. For instance, we released 100 kPa of the air pressure for mathematical testing in our experiment. The summation of R_A and R_E was 149 mm, and the bending angle of θ_{AE} was 84.3°. As a result, the soft actuators were subjected to a bending reaction under calculation of mathematical problem solutions, as in (7).

$$Arc\ length = \pi\ (R_A + R_E)(\theta_{EE} \cdot 360^{-1}) \quad (7)$$

Thus, the soft actuators demonstrated bending reaction from the end-effector at E and entered the beginning point at A for distance of 109.6 mm.

C. Biomechanics Efficiency

The flexible bending capacity of the joint can be described by ROM, where the MCP joint was the flexion distance of the joint at 0° to 90°, 0° to 110° at PIP joint and DIP joint from 0°

to 80°. In addition, the movement of finger joints indicated flexion efficiency of the joints which biomechanics efficiency

could be calculated, as in (8). Thus, η is the percentage of joint flexion efficiency. [1], [13] The result shown in table 1.

$$\eta = (active\ angles \cdot ROM^{-1}) \times 100\ \% \quad (8)$$

IV. EXPERIMENTAL

In our experiment, we designed the soft actuators using MC-Cells technique in combination with three air cavities inside the model. So, the end-effector of the unloaded model would naturally bend at 180° after we released the air pressure at 100 kPa (Fig. 6).

Fig. 6 Soft actuator movements in several air pressure among 50 kPa to 100 kPa.

Meanwhile, the finger loaded model was 100 mm in length, the models would bended with air pressure range of 75 kPa to 200 kPa (Fig. 7). In this regard, we found the correlation of bending angle measurement and solved mathematical problem in biomechanics efficiency. When, soft actuators were installed on PALM packaging with fabric glove to perform the bending and the flexion tests under loading. We found some errors in the bending position of the MCP joint because of pulling and retraining limitation of the fabric glove due to fabric quality and sewing patterns of the glove. Thus, it was an impossible to demonstrate the full bending effects. The bending results from the biomechanics efficiency test were shown in table 1.

Fig. 7 Soft actuators on PALM packaging installation.

TABLE I
BIOMECHANICS EFFICIENCY OF JOINT FINGER

Pressure (kPa)	Biomechanics Efficiency		
	MCP	PIP	DIP
75	17 %	23 %	25 %
100	21 %	29 %	30 %
125	31 %	36 %	40 %
150	32 %	47 %	51 %
175	36 %	50 %	59 %
200	39 %	59 %	66 %

Furthermore, the force generated by the measurement after we released the air pressure into the models. We tested force measurement in our experiment by using the adaptive push button switch machine which operated by programming the weight measurement conversion through MATLAB. So, the results of force – air pressure stability testing at a range of 75 kPa to 200 kPa in time duration for 25 seconds that are shown in Fig. 8. Thus, the force produced by soft actuators in our experiment for 2.64 N at 75 kPa, 3.88 N at 100 kPa, 4.76 N at 125 kPa, 6.02 N at 150 kPa, 7.28 N at 175 kPa and 10.57 N at 200 kPa.

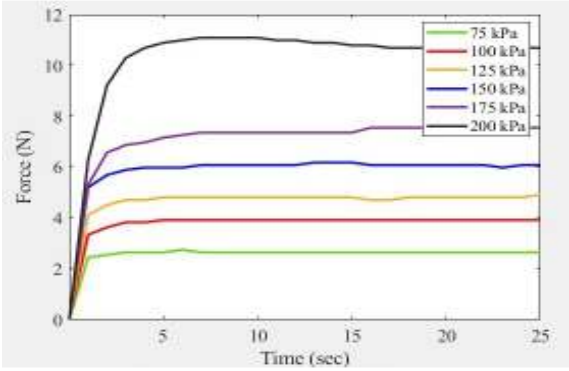


Fig. 8 The stability force testing in time duration for 25 seconds, fluidic pressure released between 75 kPa to 200 kPa.

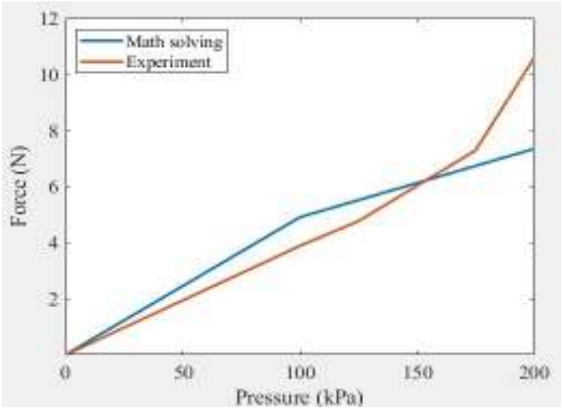


Fig. 9 Force measurement compared with the model ability in mathematics solving.

Consequently, the optimum air pressure volume applicable with our model was air pressure ranged between 125 kPa to 175 kPa. Therefore, the optimum applicable forces were between 4.76 N to 7.28 N. The correlations of our experiment with the model bending capacity was shown in the intersection area (Fig. 9). Thus, biomechanics efficiency of the ROM affects with air pressure at 125 kPa was MCP 31 %, PIP 36 % and DIP 40 %, 150 kPa was MCP 32 %, PIP 47 % and DIP 51 %, 175 kPa was MCP 36 %, PIP 50 % and DIP 59 %.

V. CONCLUSION

In this study, we demonstrated the functions of soft actuators designed based on MC-Cells technique, in conjunction with 3 air cavities that we called three air cavitation. That allowed soft actuators to bend in a curve path. The material could be replaced by high quality materials for better results. This technical model would create a force that enabling fingers to bend by mechanical reaction from air pressure released into the soft actuators through network of three air cavitation. This caused the base layer to be bend. The unloaded soft actuator would bend from the end-effector to the other end edge of the model for 180° when 100 kPa of air pressure was released. Meanwhile, for bending test of soft actuators with finger loading of 100 mm, the model required air pressure more than 100 kPa to allow the fingers to be bent in the treatment and recovery program.

Additionally, in our experiment, we found the optimum air pressure for driving the soft actuators to exert force on fingers for flexion effect. It was found that the forces generated by air pressure were 4.76 N at 125 kPa, 6.02 N at 150 kPa and 7.28 N at 175 kPa. Regarding the mathematical problem solutions, we found that the length of curve equation allowed us to calculate the flexion of finger joints and showed correlations of soft actuators' flexion with fingers in curvature of bending and biomechanics efficiency.

Finally, we found the optimum air pressure ranged between 125 kPa to 175 kPa to be used in the model to drive the soft actuators. After measuring the bending of joints at different air pressure, the biomechanics efficiency with air pressure of 125 kPa was MCP 31%, PIP 36% and DIP 40%, 150 kPa was MCP 32%, PIP 47% and DIP 51%, 175 kPa was MCP 36%, PIP 50% and DIP 59%. Unfortunately, we encountered some problems in the bending of MCP joint after installing soft actuators on PALM packaging with fabric glove because of pulling and retraining limitation of the fabric glove due to fabric quality. All problems encountered in this study would be improved and resolved in our future works.

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Additive Manufacturing of Ti6Al4V Scaffolds for Spinal Fusion Cages

Tuba Kizilirmak

***Abstract*—** While the different properties of porous materials are created by having a three-dimensional structure, their fine mechanical properties, biodegradability and biocompatibility have contributed to this difference. The main application areas of these materials have been dental implants and orthopedic implants, cancer drugs, sensors, drug delivery. There are basic features to consider when designing these materials. These properties are surface-to-volume ratio, pore size, and degree of adherence. In this study, porous titanium materials will be produced by selective melting method. It will benefit from the mechanical and biological properties of the materials produced. These porous structures will support cell proliferation and viability. Once it has been determined that the materials have an average modulus of elasticity, appropriate biological tests will be performed. In addition to the modulus of elasticity of the material, its hardness and strength are also important. Initially, the mechanical properties will be modeled with the finite element method, and then they will be supported by experiments. Materials with different pore structures and densities will be compared. The permeability coefficient of the designed materials will be measured by fluid dynamics modelling.

***Keywords*—** Additive Manufactruing,Spinal Fusion Cages,Stiffness,Biocompatibility.

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Smart Patient Provider, an AI Based Approach for Next-Gen Personalized Care Delivery

Abhay Shukla

Abstract—

Background: In the United States, CVD remains leading cause of death and by 2035, it is expected to cost the health systems $1.1 trillion. As per the Heart Disease and Stroke Statistics report of 2021, someone dies of CVD every 36 seconds in the US and it is estimated that about 2,380 deaths are attributed from CVD each day. At least 1 in 3 patients suffering from CVDs results in hospitalization within 30 days readmission, 25% land in emergencies from date of discharge and about $100 billion are accounted for the highest direct cost for inpatient stays. Currently, most of the approaches aimed at finding the BEST provider are based on patient conditions (index and comorbid etc.) as well as provider outcomes. Though it does a great job in finding an overall efficient provider, however it follows a '1-Size, Fits All' approach. Except risk of patients, there is no emphasis on 'Who' is the patient and thus lacks the ability to understand patient as an individual. It also assumes, that for same chief complaint, all patient needs are similar and does not consider patient variability while making the care delivery decision. This study proposes a novel approach to reduce inefficiencies in the current such approaches and aims at personalizing the experience for patients, affordable healthcare cost, gain better health outcomes, and paves a pathway for personalized treatment for patients and improve the patient satisfaction significantly.

Objective of the study: To understand patient needs better and recommend the provider who is not only BEST but also, MOST SUITABLE for the case in consideration. Thus, moving beyond traditional 'one-size-fits-all' care to a customized 'hyper-personalization' approach for care delivery decisions.

Methods: Patients history, demographics, and clinical measures will be assessed using claims and /or EMR data. This framework is based on unsupervised deep learning, which will be used to segment patients into pre-defined personas (based on demographics, behavior, and disease characteristics) and classify providers into provider classes (based on their treatment profile and prescribing behavior). This will help connecting the right set of patients with the right set of providers thus resulting in better clinical experience, exposure, and outcomes.

Result: This customized hyper-personalization approach holistically addresses the needs of 1) For patients by steering them to the Most Suitable and not necessarily, to the Best provider 2) For payers, driving affordability and access to care 3) Regarding Population Health, it acts as a catalyst between care delivery and patient population as well as gap identification 4) For regulators/admins, it provides new age mechanism for smart benchmarking different providers/physicians beyond just outcomes 5) Acts as an instrument for identifying the Key Opinion Leaders (KOL) who would be the right fit for targeting specific patient groups and a mix of different patient pool that can be used for recruitment and designing clinical trials. It also accelerates clinical trials with different groups with different drug combinations which will help in writing the Target Product Profile (TPP) and unique marketing attributes.

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Keywords— Artificial Intelligence, Quality of Care, Patient Steerage, Cost of Care, Economic Burden, Machine Learning, Deep Learning, Clinical Analytics, Clinical Trials, Population Health.

Use of Telemedicine and Health Outcomes in Hypertensive Patients in Pre- and Post-COVID-19 Periods in the United States

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***Abstract*—** Background: As per the Centre for Disease Control (CDC), hypertension contributes to 400,000 deaths per year in the United States, and economic burden costs the nation $48.6 billion each year. The Covid-19 pandemic further aggravated the situation as it led to limited access to health services and the physical distancing protocols created gaps in timely patient screening, lack of follow ups and clinical monitoring. Telemedicine, however, has been an effective tool for fighting against the Covid-19 pandemic and treating patients with existing diseases and comorbidities. Use of telemedicine services in bridging the gap in care of such patients has not been adequately examined. This study is an attempt to present findings related to prevention, control, diagnosis, and treatment for hypertension during Covid-19 era through tele medicine.

Objective: To examine and compare the of telemedicine services and health outcomes in hypertensive patients during 2018-19 and 2020-21 who were covered under Managed Medicare plans.

Method: This retrospective analysis used anonymized Optum health claims data, that included ~20 million covered lives from Managed Medicare plans during 2018-21. Eligible patients were ≥ 18 years old with medical and pharmacy benefits and minimum 30-days continuous enrollment in a calendar year. International Classification of Diseases, Tenth Revision (ICD-10) codes for primary hypertension were used to identify the hypertensive population (HTNP). HCPCS code G2012 and HCPCS code G2010 codes were used to identify telemedicine services. The analysis will look at and compare demographics, treatment adherence, follow-up consultations, and clinical outcomes in patients who accessed telemedicine services during 2018-19 and 2020-21.

Result: Hypertensive patients with Managed Medicare plans were included in the analysis. Significant changes were observed in use of teleconsultations for hypertension before and during Covid-19.

Discussion/ Recommendation: While tele consultations with providers continue to be effective tool and valued essential service, it cannot be substituted to physical visits. This large retrospective claim analysis will show if telemedicine is an effective tool for managing health of hypertensive patients in terms of adherence to treatment, control of disease, and complication rates.

***Keywords*—** telemedicine, COVID-19, hypertension, economic burden.

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Keratin Reconstruction: Evaluation of Green Peptides Technology on Hair Performance

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***Abstract*—** Hair surface properties affect hair texture and shine, whereas the healthy state of the hair cortex sways hair ends.

Even if cosmetic treatments are intrinsically safe, there is potentially damaging action on the hair fibers. Loss of luster, frizz, split ends, and other hair problems are particularly prevalent among people who repeatedly alter the natural style of their hair or among people with intrinsically weak hair.

Technological and scientific innovations in hair care thus become invaluable allies to preserve their natural well-being and shine.

The study evaluated restoring keratin-like ingredients that improve hair fibers' structural integrity, increase tensile strength, improve hair manageability and moisturizing.

The hair shaft is composed of 65 - 95% of keratin. It gives the hair resistance, elasticity, and plastic properties and also contributes to their waterproofing. Providing exogenous keratin is, therefore, a practical approach to protect and nourish the hair.

By analyzing the amino acid composition of keratin, we find a high frequency of hydrophobic amino acids. It confirms the critical role interactions, mainly hydrophobic, between cosmetic products and hair.

The active ingredient analyzed comes from vegetable proteins through an enzymatic cut process that selected only oligo- and polypeptides (> 3500 KDa) rich in amino acids with hydrocarbon side chains apolar or sulfur. These chemical components are the most expressed amino acids at the level of the capillary keratin structure, and it determines the most significant possible compatibility with the target substrate.

Given the biological variability of the sources, it isn't easy to define a constant and reproducible molecular formula of the product. Still, it consists of hydroxypropiltrimonium vegetable peptides with keratin-like performances.

20 natural hair tresses (30 cm in length and 0.50 g weight) were treated with the investigated products (5 % v/v aqueous solution) following a specific protocol and compared with non-treated (Control) and benchmark-keratin-treated strands (Benchmark). Their brightness, moisture content, cortical and surface integrity, and tensile strength were evaluated and statistically compared.

Keratin-like treated hair tresses showed better results than the other two groups (Control and Benchmark). The product improves the surface with significant regularization of the cuticle closure, improves the cortex and the peri-medullar area filling, gives a highly organized and tidy structure, delivers a significant amount of sulfur on the hair, and is more efficient moisturization and imbibition power, increases hair brightness.

The hydroxypropyltrimonium quaternized group added to the C-terminal end interacts with the negative charges that form on the hair after washing when disheveled and tangled.

The interactions anchor the product to the hair surface, keeping the cuticles adhered to the shaft. The small size allows the peptides to penetrate and give body to the hair, together with a conditioning effect that gives an image of healthy hair.

Results suggest that the product is a valid ally in numerous restructuring/conditioning, shaft protection, straightener/dryer-damage prevention hair care product.

***Keywords*—** conditioning, hair damage, hair, keratin, polarized light microscopy, scanning electron microscope, thermogravimetric analysis

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Pres Syndrome in Pregnancy: A Case Series of Five Cases

Dr. Vaibhavi Birle

***Abstract*—** Posterior reversible encephalopathy syndrome is a rare clinic-radiological syndrome associated with acute changes in blood pressure during pregnancy. It is characterized symptomatically by headache, seizures, altered mental status, and visual blurring with radiological changes of white matter (vasogenic oedema) affecting the posterior occipital and parietal lobes of the brain. It is being increasingly recognized due to increased institutional deliveries and advances in imaging particularly magnetic resonance imaging (MRI). In spite of the increasing diagnosis the prediction of PRES and patient factors affecting susceptibility is still not clear. Hence, we conducted the retrospective study to analyse the factors associated with PRES at our tertiary centre.

***Keywords*—** pres syndrome, eclampsia, maternal outcome, fetal outcome.

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The Missing Link in Holistic Health Care: Value-Based Medicine in Entrustable Professional Activities for Doctor-Patient Relationship

Ling-Lang Huang

***Abstract*—** Background: The holistic health care should ideally cover physical, mental, spiritual, and social aspects of a patient. With very constrained time in current clinical practice system, medical decisions often tip the balance in favor of evidence-based medicine (EBM) in comparison to patient's personal values. Even in the era of competence-based medical education (CBME), when scrutinizing the items of entrustable professional activities (EPAs), we found that EPAs of establishing doctor-patient relationship remained incomplete or even missing. This phenomenon prompted us to raise this project aiming at advocating value-based medicine (VBM), which emphasizes the importance of patient's values in medical decisions. A true and effective doctor-patient communication and relationship should be a well-balanced harmony of EBM and VBM. By constructing VBM into current EPAs, we can further promote genuine shared decision making (SDM) and fix the missing link in holistic health care. Methods: In this project, we are going to find out EPA elements crucial for establishing an ideal doctor-patient relationship through three distinct pairs of doctor-patient relationships: patients with pulmonary arterial hypertension (relatively young but with grave disease), patients undergoing surgery (facing critical medical decisions), and patients with terminal diseases (facing forthcoming death). We'll search for important EPA elements through the following steps: 1. Narrative approach to delineate patients' values among 2. distinct groups. 3.Hermeneutics-based interview: semi-structured interview will be conducted for both patients and physicians, followed by qualitative analysis of collected information by compiling, disassembling, reassembling, interpreting, and concluding. 4. Preliminarily construct those VBM elements into EPAs for doctor-patient relationships in 3 groups. Expected Outcomes: The results of this project are going to give us invaluable information regarding the impact of patients' values, while facing different medical situations, on the final medical decision. The competence of well-blending and -balanced both values from patients and evidence from clinical sciences is the missing link in holistic health care and should be established in future EPAs to enhance an effective SDM.

***Keywords*—** value-based medicine, shared decision making, entrustable professional activities, holistic health care.

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Using Health Literacy and Medico-Legal Guidance to Improve Restorative Dentistry Patient Information Leaflets

Hasneet K. Kalsi, Julie K. Kilgariff

***Abstract*—** Introduction: Within dentistry, the process for gaining informed consent has become more complex. To consent for treatment, patients must understand all reasonable treatment options and associated risks and benefits. Consenting is therefore deeply embedded in health literacy. Patients attending for dental consultation are often presented with an array of information and choices, yet studies show patients recall less than half of the information provided immediately after. Appropriate and comprehensible patient information leaflets (PILs) may be useful aid memories. In 2016 the World Health Organisation set improving health literacy as a global priority. Soon after, Scotland's 2017-2025 Making it Easier: A Health Literacy Action Plan followed. This project involved the review of Restorative PILs used within Dundee Dental Hospital to assess the Content and Readability. Method: The current PIL on Root Canal Treatment (RCT) was created in 2011. This predates the Montgomery vs. NHS Lanarkshire case, a ruling which significantly impacted dental consenting processes, as well as General Dental Council's (GDC's) Standards for the Dental Team and Faculty of General Dental Practice's Good Practice Guidance on Clinical Examination and Record-Keeping. Current evidence-based guidance, including that stipulated by the GDC, was reviewed. A 20-point Essential Content Checklist was designed to conform to best practice guidance for valid consenting processes. The RCT leaflet was scored against this to ascertain if the content was satisfactory. Having ensured the content satisfied medicolegal requirements, health literacy considerations were reviewed regarding readability. This was assessed using McLaughlin's Simple Measure of Gobbledygook (SMOG) formula, which identifies school stages that would have to be achieved to comprehend the PIL. The sensitivity of the results to alternative readability methods were assessed. Results: The PIL was not sufficient for modern consenting processes and reflected a suboptimal level of health literacy. Evaluation of the leaflet revealed key content was missing, including information pertaining to risks and benefits. Only five points out of the 20-point checklist were present. The readability score was 16, equivalent to a level 2 in National Adult Literacy Standards/Scottish Credit and Qualification Framework Level 5; 62% of Scottish adults are able to read to this standard. Discussion: Assessment of the leaflet showed it was no longer fit for purpose. Reasons include a lack of pertinent information, a text-heavy leaflet lacking flow, and content errors. The SMOG score indicates a high level of comprehension is required to understand this PIL, which many patients may not possess. A new PIL, compliant with medicolegal and health literacy guidance, was designed with patient-driven checklists, notes spaces for annotations/ questions and areas for clinicians to highlight important case-specific information. It has been tested using the SMOG formula. Conclusion: PILs can be extremely useful. Studies show that interactive use can enhance their effectiveness. PILs should reflect best practice guidance and be understood by patients. The 2020 leaflet designed and implemented aims to fulfill the needs of a modern healthcare system and its service users. It embraces and embeds Scotland's Health Literacy Action Plan within the consenting process. A review of further leaflets using this model is ongoing.

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***Keywords*—** consent, health literacy, patient information leaflet, restorative dentistry.

Health Communication and the Diabetes Narratives of Key Social Media influencers in the UK

Z. Sun

***Abstract*—**Health communication is essential in promoting healthy lifestyles, managing disease conditions and eventually reducing health disparities. The key elements of successful health communication always include the development of communication strategies to engage people in thinking about their health, inform them about healthy choices, persuade them to adopt safe and healthy behaviours, and eventually achieve public health objectives. The use of 'Narrative' is recognised as a kind of health communication strategy to enhance personal and public health due to its potential persuasive effect in motivating and supporting individuals change their beliefs and behaviours by inviting them into a narrative world, breaking down their cognitive and emotional resistance and enhance their acceptance of the ideas portrayed in narratives. Meanwhile, the popularity of social media has provided a novel means of communication for both healthcare stakeholders, and a special group of active social media users (influencers) have started playing a pivotal role in providing health 'solutions'. Such individuals are often referred to as 'influencers' because of their central position in the online communication system and the persuasive effect their actions may have on audiences. They may have established a positive rapport with their audience, earned trust and credibility in a specific area, and thus, their audience considers the information they delivered to be authentic and influential. To our best knowledge, to date, there is no published research that examines the effect of diabetes narratives presented by social media influencers and their impacts on health-related outcomes.

The primary aim of this study is to investigate the diabetes narratives presented by social media influencers in the UK because of the new dimension they bring to health communication and the potential impact they may have on audiences' health outcomes.

This study is situated within the interpretivist and narrative paradigms. A mixed methodology combining both quantitative and qualitative approaches has been adopted. Qualitative data has been derived to provide a better understanding of influencers' personal experiences and how they construct meanings and make sense of their world while quantitative data has been accumulated to identify key social media influencers in the UK and measure the impact of diabetes narratives on audiences. Twitter has been chosen as the social media platform to initially identify key influencers. Two groups of participants are the top 10 key social media influencers in the UK and 100 audiences of each influencer, which means a total of 1000 audiences have been invited.

This paper is going to discuss, first of all, the background of the research under the context of health communication; Secondly, the necessity and contribution of this research; then, the major research questions being explored; and finally, the methods to be used.

***Keywords*—**diabetes, health communication, narratives, social media influencers

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The Impact of the Macro-Level: Organizational Communication in Undergraduate Medical Education

Julie M. Novak, Simone K. Brennan, Lacey Brim

***Abstract*—** Undergraduate medical education (UME) curriculum notably addresses micro-level communications (e.g., patient-provider, intercultural, inter-professional), yet frequently under-examines the role and impact of organizational communication, a more macro-level. Organizational communication, however, functions as foundation and through systemic structures of an organization and thereby serves as hidden curriculum and influences learning experiences and outcomes. Yet, little available research exists fully examining how students experience organizational communication while in medical school. Extant literature and best practices provide insufficient guidance for UME programs, in particular. The purpose of this study was to map and examine current organizational communication systems and processes in a UME program. Employing a phenomenology-grounded and participatory approach, this study sought to understand the organizational communication system from medical students' perspective. The research team consisted of a core team and 13 medical student co-investigators. This research employed multiple methods, including focus groups, individual interviews, and two surveys (one reflective of focus group questions, the other requesting students to submit 'examples' of communications). To provide context for student responses, nonstudent participants (faculty, administrators, and staff) were sampled, as they too express concerns about communication. Over 400 students across all cohorts and 17 nonstudents participated. Data were iteratively analyzed and checked for triangulation. Findings reveal the complex nature of organizational communication and student-oriented communications. They reveal program-impactful strengths, weaknesses, gaps, and tensions and speak to the role of organizational communication practices influencing both climate and culture. With regard to communications, students receive multiple, simultaneous communications from multiple sources/channels, both formal (e.g., official email) and informal (e.g., social media). Students identified organizational strengths including the desire to improve student voice, and message frequency. They also identified weaknesses related to over-reliance on emails, numerous platforms with inconsistent utilization, incorrect information, insufficient transparency, assessment/input fatigue, tacit expectations, scheduling/deadlines, responsiveness, and mental health confidentiality concerns. Moreover, they noted gaps related to lack of coordination/organization, ambiguous point-persons, student 'voice-only', open communication loops, lack of core centralization and consistency, and mental health bridges. Findings also revealed organizational identity and cultural characteristics as impactful on the medical school experience. Cultural characteristics included program size, diversity, urban setting, student organizations, community-engagement, crisis framing, learning for exams, inefficient bureaucracy, and professionalism. Moreover, they identified system structures that do not always leverage cultural strengths or reduce cultural problematics. Based on the results, opportunities for productive change are identified. These include leadership visibly supporting and enacting overall organizational narratives, making greater efforts in consistently 'closing the loop', regularly sharing how student input effects change, employing strategies of crisis communication more often, strengthening communication infrastructure, ensuring structures facilitate effective operations and change efforts, and highlighting change efforts in informational communication. Organizational communication and communications are not soft-skills, or of secondary concern within organizations, rather they are foundational in nature and serve to educate/inform all stakeholders. As primary stakeholders, students and their success directly affect the accomplishment of organizational goals. This study demonstrates how inquiries about how students navigate their educational experience extends research-based knowledge and provides actionable knowledge for the improvement of organizational operations in UME.

***Keywords*—** medical education programs, organizational communication, participatory research, qualitative mixed methods.

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Self-Assessment Tool to Promote Organizational Health Literacy in Primary Care Settings in Switzerland

Saskia M. De Gani, Daniela Nowak-Flück, Dunja Nicca, Dominique Vogt

***Abstract*—**Besides a certain level of motivation and knowledge, specific skills are required to be able to take care of one's own health and to make informed health-related decisions. These skills include accessing, understanding and appraising oral and written health information. These aspects have been conceptualized as health literacy. Health literacy encompasses not only a functional level as for example understanding a doctor's advice. It also includes skills on an interactive level, like communicating with health care professionals. Thus, sufficient health literacy is a key element of effective health communication. Low health literacy is linked to poorer understanding and interpreting of health messages. In consequence, individuals with low health literacy often have poorer health outcomes and health behaviors. In contrast, better health literacy increases outcomes of disease treatment and reduces the need of health care. Health literacy can be improved effectively on two levels: 1) Strengthening health literacy skills and abilities of individuals and 2) reducing demands and complexities of the health system including health providers and professionals. Accordingly, health care organizations play an important role in improving population's health literacy by empowering patients in asking questions, reporting needs and uncertainties and therewith taking an active role in coping with disease and promoting health and wellbeing. So-called health literate health care organizations facilitate access, understanding and use of oral and written health information and decrease the demands and complexities of the health care system. However, few efforts have been taken so far to promote organizational health literacy (OHL), especially in German-speaking countries.

Therefore, this project aimed at developing a self-assessment tool, which enables primary care organizations to assess and improve their level of OHL. We performed a narrative literature review, considered existing tools and worked in a participative development process with several experts in this field as well as our primary care practice partners. This resulted in the "Organizational Health Literacy Self-Assessment-Tool for Primary Care" (OHL Self-AsseT) consisting of three modules: (1) manual with detailed introduction and instruction, (2) checklist for self-assessment of OHL and (3) handbook with measures for improvement. The aim of the OHL Self-AsseT is that organizations are able to identify their need for action, plan and implement improvement measures. It therewith adds to the development of health literate health care organizations by a comprehensive package of tools (manual, checklist and handbook), including assessment and interventions for primary care needs specifically. In order to scale the implementation of the OHL Self-AsseT up, an evaluation of its application in several pilot companies is currently conducted. The evaluated and refined self-assessment-tool could serve as a powerful instrument to improve OHL internationally. Nonetheless, a future systematic implementation of the concept is necessary to improve health literacy system-wide. Therefore, OHL needs to be included in the political agenda as well as in education and training of health care professionals.

***Keywords*—**Health Literacy, Organizational Health Literacy, Primary Care Settings, Self-Assessment-Tool

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Providing Polygenic Risk Scores Influences Providers' Responses Toward Black and White Virtual Patients with Obesity

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***Abstract*—** Individuals with obesity tend to be stigmatized by healthcare professionals, which contributes to suboptimal clinical care. In addition, racial bias in healthcare settings is particularly damaging for Black patients' health. To date, however, there has been limited research on how racial and weight stigma interact and whether obesity status may exacerbate racial disparities. Previous research has suggested that providing genetic information about disease risk may help alleviate obesity stigma and benefit patient-provider interactions. We explored whether risk information influences medical providers' perceptions of a virtual patient and their interaction style with the patient.

In a 2*2 randomized control trial a diverse sample of 84 physician trainees in their third or fourth year of medical school were randomly assigned to interact with a virtual patient with obesity. Virtual patients differed by apparent race (White or Black) and whether they brought to the clinic results from a direct-to-consumer genetic test indicating that they were at higher risk of obesity and other conditions. Participants' speech during the virtual clinic was recorded and afterwards they completed a questionnaire that assessed their perceptions of the patient.

Analyses indicated an interaction between the presence of genetic risk information and the virtual patient's race on providers' responses. However, the nature of this interaction was unexpected given the well-documented pro-white racial bias in healthcare settings. The virtual White patient prompted more negative responses than the virtual Black patient when no genetic risk information was presented. When this information was provided this racial difference was attenuated. On questionnaire measures, the virtual White patient was rated as lazier and more unpleasant than the virtual Black patient when no genetic risk information was provided, but was rated more similarly when this information was provided ($F_{lazy}(1, 45) = 8.00$, $p = .007$; $F_{unpleasant}(1, 58) = 7.89$, $p = .007$). Transcripts were analyzed to determine how similar the emotional tone of participant's speech was compared to the virtual patient. Mimicry is generally reduced when interacting with members of stigmatized and disliked groups, therefore we were again surprised to find that student physicians were more likely to match the emotional tone of the Black virtual patient. Again, however, this trend was reversed if genetic risk information was provided ($F(1,74) = 7.880$, $p = 0.006$).

Our surprising results may be a combination of demand characteristics and cognitive load. When presented with a Black virtual patient, participants may assume the research study is assessing racial bias and self-correct. However, when also presented with genetic risk information participants may be less able to self-correct as they are under higher cognitive load, leading to the re-emergence of this bias. An alternative explanation may be that within the context of obesity, White patients are judged more harshly at baseline that Black patients.

These surprising results require replication. Nevertheless, our results indicate that direct-to-consumer genetic testing influences provider's perceptions of patients with obesity and these effects interact with patient race. In particular, genetic risk information about obesity may not be as beneficial for Black patients as White patients.

***Keywords*—**Stigma, Obesity, Race, Polygenic Risk Information

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Screening for Women with Chorioamnionitis: An Integrative Literature Review

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***Abstract*—**

Introduction: Women die in pregnancy and childbirth for five main reasons—severe bleeding, infections, unsafe abortions, hypertensive disorders (pre-eclampsia and eclampsia), and medical complications including cardiac disease, diabetes, or HIV/AIDS complicated by pregnancy. In 2015, WHO classified sepsis as the third highest cause for maternal mortalities in the world. Chorioamnionitis is a clinical syndrome of intrauterine infection during any stage of the pregnancy and it refers to ascending bacteria from the vaginal canal up into the uterus, causing infection. While the incidence rates for chorioamnionitis are not well documented, complications related to chorioamnionitis are well documented and midwives still struggle to identify this condition in time due to its complex nature. Few diagnostic methods are available in public health services, due to escalated laboratory costs. Often the affordable biomarkers, such as C-reactive protein CRP, full blood count (FBC) and WBC, have low significance in diagnosing chorioamnionitis. A lack of screening impacts on effective and timeous management of chorioamnionitis, and early identification and management of risks could help to prevent neonatal complications and reduce the subsequent series of morbidities and healthcare costs of infants who are health foci of perinatal infections.

***Objective**:* This integrative literature review provides an overview of current best research evidence on the screening of women at risk for chorioamnionitis.

Design: An integrative literature review was conducted using a systematic electronic literature search through EBSCOhost, Cochrane Online, Wiley Online, PubMed, Scopus and Google. Guidelines, research studies, and reports in English related to chorioamnionitis from 2008 up until 2020 were included in the study.

***Findings**:* After critical appraisal, 31 articles were included. More than one third (67%) of the literature included ranked on the three highest levels of evidence (Level I, II and III). Data extracted regarding screening for chorioamnionitis was synthesized into four themes, namely: screening by clinical signs and symptoms, screening by causative factors of chorioamnionitis, screening of obstetric history, and essential biomarkers to diagnose chorioamnionitis.

Key conclusions: There are factors that can be used by midwives to identify women at risk for chorioamnionitis. However, there are a paucity of established sociological, epidemiological and behavioral factors to screen this population. Several biomarkers are available to diagnose chorioamnionitis. Increased Interleukin-6 in amniotic fluid is the better indicator and strongest predictor of histological chorioamnionitis, whereas the available rapid matrix-metalloproteinase-8 test requires further testing. Maternal white blood cells count (WBC) has shown poor selectivity and sensitivity, and C-reactive protein (CRP) thresholds varied among studies and are not ideal for conclusive diagnosis of subclinical chorioamnionitis.

Implications for practice: Screening of women at risk for chorioamnionitis by health care providers providing care for pregnant women, including midwives, is important for diagnosis and management before complications arise, particularly in resource-constraint settings.

***Keywors*—** chorioamnionitis, guidelines, best evidence, screening, diagnosis, pregnant women

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The Conceptualization of Patient-Centered Care in Latin America: A scoping review

Anne Klimesch, Alejandra Martinez, Martin HäRter, Isabelle Scholl, Paulina Bravo

***Abstract*—** Patient-centered care (PCC) is a key principle of high-quality healthcare. In Latin America, research on and promotion of PCC have taken place in the past. However, thorough implementation of PCC in practice is still missing. In Germany, an integrative model of patient-centeredness has been developed by synthesis of diverse concepts of PCC. The model could serve as a point of reference for further research on the implementation of PCC, however, it is predominantly based on research from Europe and North America. This scoping review therefore aims to accumulate research on PCC in Latin America in the past 15 years and analyse how PCC has been conceptualised. The resulting overview of PCC in Latin America will be a foundation for a subsequent study aiming at the adaptation of the integrative model of patient-centeredness to the Latin American health care context.

Scientific databases (MEDLINE, EMBASE, PsycINFO, CINAHL, Scopus, Web of Science, SCIELO, Redalyc.) will be searched, and reference and citation tracking will be performed. Studies will be included if they were carried out in Latin America, investigated PCC in any clinical and community setting (public and private), and were published in English, Spanish, French, or Portuguese since 2006. Furthermore, any theoretical framework or conceptual model to guide how PCC is conceptualized in Latin America will be included. Two reviewers will be responsible for the identification of articles, screening of records, and full-text assessment.

The results of the scoping review will be used in the development of a mixed methods study with the aim to understand the needs for PCC, as well as barriers and facilitators in Latin America. Based on the outcomes, the integrative model of PCC will be translated to Spanish and adapted to the Latin American context. The integrative model will enable the dissemination of the concept of PCC in Latin America and will provide a common ground for further research on the topic. The project will thereby make an important contribution to an evidence based implementation of PCC in Latin America.

***Keywords*—**Conceptual framework, integrative model of PCC, Latin America, Patient-centered care.

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"It Just Makes Me Feel a Little Less Alone": A Qualitative Exploration of the Podcast 'Menopause: Unmuted' on Women's Perceptions of Menopause

Amy Edwards, Philippa Shaw, Candida Halton, Stacy C. Bailey, Michael S. Wolf, Emma N. Andrews, Tina Cartwright

***Abstract*—** Introduction/objectives: Podcasts have been found to be an accessible method for increasing knowledge and challenging perceptions of stigmatized topics. The current research aimed to understand the impact of the podcast 'menopause: unmuted' on women's menopause-related knowledge, understanding, and communication practices. 'Menopause: unmuted', is a five-episode podcast series using immersive storytelling to share the experiences of US women. Alongside these first-hand accounts, a women's health professional provides a medical perspective to contextualize the women's stories, offer evidence-based lifestyle advice and address menopause myths. The podcast was funded by Pfizer Inc Women's Health Team.

Methods: A diverse sample of 30 women in the United States, aged 40-60 years listened to the podcast series, which focused on menopause stories, before taking part in semi-structured interviews to discuss the impact of the podcast on how they understood and communicated about menopause. The interviews were analyzed thematically.

Results: Two overarching themes were identified in the data. A 'journey of knowledge gain' explores participants' understanding of menopause before listening to the podcast and reflects on how this is deepened by hearing and connecting with women's stories. 'Reframing menopause' describes the impact of the podcast. Participants spoke about how their understanding increased, and their perceptions of menopause were challenged. They also highlighted the value of sharing personal experiences in addressing the taboo surrounding menopause. Participants reflected on the value of communication amongst women, and discuss ways to make positive behavioral changes in their lives.

Discussion/implications: To our knowledge, this is the first study to explore the impact of listening to a podcast about menopause. Results suggest that the podcast was well received and seen as a valuable resource to develop individuals' knowledge and understanding around menopause. The sense of support and community that women experienced from listening to the podcast was a notable finding. The podcast operated as a platform for women to openly and honestly share their experiences of menopause. The sharing of experiences in a story-telling format enabled participants to feel part of the conversation and make an intimate connection with the women featured in the series. This aligns with broader research into the effects of storytelling, where the stories of others who have been through similar experiences provided emotional support, promoted feelings of empowerment, and reduced feelings of loneliness

The podcast 'menopause: unmuted' helped women to learn about the menopause experience, have a greater sense of belonging to a community of women, and feel empowered to make changes in their own lives. Sharing stories via podcasts has potential as an accessible and impactful medium to educate women and reduce the widespread stigma associated with menopause.

***Keywords*—** Podcasts, Women's Health, Patient Empowerment, Qualitative Research.

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Antagonistic Activity of Bacteriocin-Producing Strain Streptococcus salivarius K12

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***Abstract*—** Introduction: Due to incremental increase and spread of antimicrobial resistance the use of probiotics in clinical practice is becoming one of the most promising trends in bacterial infections prevention.

Goals: To evaluate the antagonistic activity of bacteriocin-producing strain Streptococcus salivarius K12 (SsK12) against ENT and oral cavity infections pathogens (S. pneumoniae, S. pyogenes, S. aureus), gram-negative bacteria (E. coli, P. aeruginosa) and C. albicans.

Materials and methods: The probiotic strain SsK12 was isolated from dietary supplement, containing at least 1 × 109 CFU per tablet. The tablet was dissolved in the enrichment broth. The resulting suspension was seeded on 5% blood agar and incubated at 35°C in 4-6% CO2 for 48 hours. The raised culture was identified as Streptococcus salivarius with MALDI-TOF mass spectrometry method. The evaluation of SsK12 antagonistic activity was carried out using a perpendicular streak technique. The daily SsK12 culture was inoculated as heavy streaks with

a loop at one side of Petri dish with the Muller-Hinton agar (MHA) and incubated for 24 hours at 350 C in anaerobic conditions. It was supposed that bacteriocins A & B would diffuse over the whole area of the agar media. On the next day S. pneumoniae, S. pyogenes, S. aureus, E. coli,

P. aeruginosa and C. albicans clinical isolates were streaked at the clear side of MHA Petri dish.

MHA Petri dish inoculated with SsK12 (one part) and with the respective clinical isolates (another part) streaked perpendicularly on the same day was used as the control.

Results: There was no growth of S. pyogenes on the Petri dish with SsK12 daily culture; the growth of a few colonies of S. pneumonia was noted. The growth of S. aureus, E. coli,

P. aeruginosa and C. albicans was noted along the inoculated streak. On the control Petri dish with simultaneous inoculating of the SsK12 strain and the test cultures, the growth of all the testes isolates was noted.

Conclusions:

1. SsK12 possesses perfect antagonistic activity against S. pyogenes and good activity against S. pneumoniae.

2. There was no antagonistic activity of SsK12 against S. aureus, E. coli, P. aeruginosa and C. albicans.

3. SsK12 antagonistic properties make it possible to use this probiotic strain for prophylaxis of recurrent ENT infections.

***Keywords*—** probiotics, ENT infections, bacteriocin, Streptococcus salivarius.

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Mixed-Methods Analysis of a Student-Developed, Personalized Multi-Specialty Career Exploration Elective in Medical Student Specialty Selection

Arulita Gupta*, Rachel Chang*, Catherine Zivanov*, Amy Fleming

Abstract

Introduction: Choosing a specialty is of critical importance during medical school. While the Association of American Medical Colleges recognizes over 120 subspecialties, exposure to medical specialties during clerkship rotations is often limited to broad specialties such as internal medicine, pediatrics, and surgery. Moreover, the clerkship clinical experience in 2020 was drastically impacted by the COVID-19 pandemic, limiting opportunities for students to explore medical specialties. First-hand exposure to multiple specialties is a key component in specialty decision-making. The Careers in Medicine (CiM) Career Exploration Advanced Elective is a novel, student-developed, four-week elective at Vanderbilt University School of Medicine (VUSM) that offers post-clerkship medical students, personalized, multi-specialty clinical exposure along with one-on-one career advising by core physician administrators. The purpose of this study was to assess motivating factors for taking this elective, insights gained from the course, and outcomes related to career exploration.

Methods: We conducted a cross-sectional, mixed-methods study of 3rd and 4th year medical students enrolled in this elective using voluntary, anonymous end-of-course evaluation surveys and de-identified student reflections. Descriptive statistics were utilized to analyze survey responses. De-identified reflections were qualitatively analyzed using inductive thematic analysis. The study was considered exempt by the Vanderbilt Institutional Review Board.

Results: Twenty-three students (24% of the typical class size at VUSM) enrolled in the CiM Advanced Elective from August 2020 to July 2021, and 22/23 students (96%) completed end-of-course evaluation surveys. Student reflections identified nuanced themes about reasons students took the course, impact of the course, and specialty decision making. The most commonly cited reasons for taking the course were to try a new specialty (77.3%), to decide between different specialties of interest (77.3%), and to increase breadth of exposure to different specialties (77.3%). Common themes included desire for direct comparison of specialties of interest, heightened understanding of fundamental variables differentiating specialties (e.g., scope of practice, settings of care, variability of practice), and increased insight into personal values and career

preferences (e.g., nature of patient interaction, work life balance, finding fulfillment within specialties). The course guided 86.4% of students in ruling out and 86.4% of students in ruling in specialties. Students agreed or strongly agreed that the COVID-19 pandemic increased their interest in taking the course (63.6%). Many students would retake the CiM Advanced Elective instead of a focused specialty course if this were allowed in the curriculum (72.7%).

Conclusion: The CiM Advanced Elective fostered specialty decision-making from a multifactorial approach. Exploring various subspecialties head-to-head gave students an opportunity to think critically about their values, reflect on their experiences, develop professional skills, and ultimately helped students finalize their specialty of interest. A strong student interest in retaking the course indicates a need for the CiM Advanced Elective in the post-clerkship medical curriculum.

Keywords—careers in medicine, COVID-19, medical student specialty selection, professional development

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Health Advocacy in Medical School: An American Survey on Attitudes and Engagement in Clerkships

Rachel S. Chang, Samuel P. Massion, Alan Z. Grusky, Heather A. Ridinger

***Abstract*—**

Introduction

Health advocacy is defined as activities that improve access to care, utilize resources, address health disparities and influence health policy. Advocacy is increasingly being recognized as a critical component of a physician's role, as understanding social determinants of health and improving patient care are important aspects within the American Medical Association's Health Systems Science framework. However, despite this growing prominence, educational interventions that address advocacy topics are limited and variable across medical school curricula. Furthermore, few recent studies have evaluated attitudes toward health advocacy among physicians-in-training in the United States.

This study examines medical student attitudes towards health advocacy, along with perceived knowledge, ability and current level of engagement with health advocacy during their clerkships.

Methods

This study employed a cross-sectional survey design using a single anonymous, self-report questionnaire to all second-year medical students at Vanderbilt University School of Medicine (n=96) in December 2020 during clerkship rotations. The survey had 27 items with 5-point Likert scale (15), multiple choice (11), and free response questions (1). Descriptive statistics and thematic analysis were utilized to analyze responses. The study was approved by the Vanderbilt University Institutional Review Board.

Results

There was an 88% response rate among second-year clerkship medical students. A majority (83%) agreed that formal training in health advocacy should be a mandatory part of the medical student curriculum Likewise, 83% of respondents felt that acting as a health advocate or patients should be part of their role as a clerkship student. However, a minority (25%) felt adequately prepared. While 72% of respondents felt able to identify a psychosocial need, 18% felt confident navigating the healthcare system and only 9% felt able to connect a patient to a psychosocial resource to fill that gap. 44% of respondents regularly contributed to conversations with their medical teams when discussing patients' social needs, such as housing insecurity, financial insecurity, or legal needs. On average, respondents reported successfully connecting patients to psychosocial resources 1-2 times per 8-week clerkship block. Barriers to participating in health advocacy included perceived time constraints, lack of awareness of resources, lower emphasis among medical teams, and scarce involvement with social work teams.

Conclusions

In this single-institutional study, second-year medical students on clerkships recognize the importance of advocating for patients and support advocacy training within their medical school curriculum. However, their perceived lack of ability to navigate the healthcare system and connect patients to psychosocial resources, result in students feeling unprepared to advocate as effectively as they hoped during their clerkship rotations. Our results support the ongoing need to equip medical students with training and resources necessary for them to effectively act as advocates for patients.

***Keywords*—** clerkships, medical students, patient advocacy, social medicine

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Preparation of Papers - Paper Title the Lived Experiences of Paramedical Students Engaged in Virtual Hands-on Learning

Zyra Cheska Hidalgo, Joehiza Mae Renon, Kzarina Buen, Girlie Mitrado

***Abstract*—** ABSTRACT: The global coronavirus disease (COVID-19) has dramatically impacted the lives of many, including education and our economy. Thus, it presents a massive challenge for medical education as instructors are mandated to deliver their lectures virtually to ensure the continuity of the medical education process and ensure students' safety. The purpose of this research paper is to determine the lived experiences of paramedical students who are engaged in virtual hands-on learning and to determine the different coping strategies they used to deal with virtual hands-on learning. The researchers used the survey method of descriptive research design to determine the lived experiences and coping strategies of twenty (20) paramedical students from Lorma Colleges (particularly the College of Medicine Department). The data were collected through online questionnaires, particularly with the use of google forms. This study shows technical issues, difficulty in adapting styles, distractions and time management issues, mental and physical health issues, and lack of interest and motivation are the most common problems and challenges experienced by paramedical students. On the other hand, the coping strategies used by paramedical students to deal with those challenges include time management, engagement in leisure activities, acceptance of responsibilities, studying, and adapting. With the data gathered, the researchers concluded that virtual hands-on learning effectively increases the knowledge of paramedical students. However, teaching and learning barriers must have to be considered to implement virtual hands-on learning successfully.

***Keywords*—** virtual hands-on learning, E-learning, paramedical students, medical education.

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The Future of the Physicate Associate Program in the UK: Is Research Training Necessary?

Mohmmad Salhab

***Abstract*—** Introduction: The significance of research skills and experience among both physician associate (PA) educators and students had been the subject of recent research (Hoggins 2018, Roberts 2019). The important of research training as skills needed for future PAs has yet to be determined. However, it was evident that there are gaps in relation to developing the PA educational needs within the postgraduate medical education model; in addition to forging translational job roles amongst future PAs (Roberts 2019, Brown 2020). Interestingly, although the PA course is a postgraduate course, there is no clear entry pathways highlighting research skills within the course.

Objectives: To determine whether current working PAs think that research skills are relevant to their current job role and research their views on how these skills can positively impact developing the PA role model.

Methodology: Questionnaire based survey. A survey of 10 questions was sent to 17 PAs. The response rate was 70% (n=12).

Results: 90% of PAs agreed that research skills are needed for their current job model. 100% PAs agreed that this will be beneficial for their future role development. 90% of PAs agreed that they were asked about research related topic in their interview. 80% of PAs admitted that they did not receive research training during their course.

Conclusion: These results highlight the need for developing research training material as part of the PA course on a national scale. There is lack of research into this area and future studies are warranted.

***Keywords*—** research, job role, physician associate, medical education.

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Narrative as a Tool to Reflect Around Caring and the Future Profession for Physical Therapy Students: A Curricular Course

Carla Benaglio, Maria Jesus Mena, Catherine Sanhueza, Loreto Durcudoy, Camila Pavez

***Abstract*—**

Background

The COVID-19 pandemic imposed challenges for health career students. A student support program in our institution aimed to give learning and coping strategies to students to confront better the current situation. Narrative medicine emerged as a motivational strategy for student's reflection about caring and their future profession.

PURPOSE:

Observe how students visualize care in the physical therapy profession and if narrative enriches their speech about caring.

SUMMARY OF WORK

We organized six distance learning 1-hour sessions for each group (10 students). The facilitator presented the activity's framework within a safe environment for the students. A test was done before and after the intervention, asking students the question: "What do you think is the most important aspect of your future profession?". Qualitative methodology was used to identify the expressions that they used to refer to their profession.

A second anonymous questionnaire asked about lessons learned and suggestions for future activities.

SUMMARY OF RESULTS

The pre-test was responded to by 32 students, referring to ideals and future hopes regarding their profession. In the post-test, they were more precise and focused on caring, adding reflections about the importance they felt in focusing on patient's quality of life and seeing them as *"complete persons*", not just seeking a cure for a *"diagnosis"* or *"disfunction",* as in the pre-test. Students reflect deeper using phrases like "*doing good for their patient and society*" and valued a protected space to reflect and discuss which they felt contributed to their wellbeing. They recognized a value in the narrative methodology used and suggested face to face learning and smaller groups (5 students) to facilitate interaction in future activities.

DISCUSSION/CONCLUSIONS

Students need protected space in their curricula to reflect around a narrative related with their future profession. Narrative is a creative and powerful model that contributes to student's reflexion and wellbeing.

TAKE HOME MESSAGES

Narrative can be a tool to motivate students and help them reflect about their future as health professionals.

***Keywords*—** caring, education, narrative, physical therapy, student.

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The Provision of a Safe Face-to-Face Teaching Program for Final Year Medical Students during the COVID-19 Pandemic

Rachel Byrne

***Abstract*—** Background: Due to patient and student safety concerns, combined with clinical teachers being redeployed to clinical practice, COVID-19 has resulted in a reduction in face-to-face teaching sessions for medical students. Traditionally such sessions are particularly important for final year medical students, especially in preparing for their final practical exams. A reduced student presence on the wards has also resulted in fewer opportunities for junior doctors to provide teaching sessions. This has implications for junior doctors achieving their own curriculum outcomes for teaching, as well as potentially hindering the development of a future interest in medical education. Aims: The aims of the study are 1) To create a safe face-to-face teaching environment during COVID-19 which focussed on exam preparation for final year medical students, 2) To provide a platform for doctors to gain teaching experience, 3) to enable doctors to gain feedback or assessments on their teaching, 4) To create beginners guide to designing a new teaching program for future junior doctors. Methods: We created a program of timed clinical stations consisting of four sessions every five weeks during the student's medicine attachment. Each session could be attended by 6 students and consisted of 6 stations ran by junior doctors, with each station following social distancing and personal protective equipment requirements. Junior doctors were asked to design their own stations. The sessions ran out-of-hours on weekday evenings and were optional for the students. Results: 95/95 students and 20/40 doctors involved in the programme completed feedback. 100% (n=95) of students strongly agreed/agreed that sessions were aimed at an appropriate level and provided constructive feedback. 100% (n=95) of students stated they felt more confident in their abilities and would recommend the session to peers. 90% (n=18) of the teachers strongly agreed/agreed that they felt more confident in their teaching abilities and that the sessions had improved their own medical knowledge. 85% (n=17) of doctors had a teaching assessment completed, and 83% (n=16) said the program had made them consider a career in medical education. The difficulties of creating such a program were highlighted throughout, and a beginner's guide was created with the hopes of helping future doctors who are interested in teaching address the common obstacles.

***Keywords*—** COVID-19, education, safety, medical.

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A Thematic Analysis of Factors which Impact how Medical Students Perceive Clinical Placements

Dr Rhea Bhagdev

Abstract—

Clinical hospital placements are a major component of the undergraduate medical curriculum. However, there is a large variability in student satisfaction and achievement from each placement. Student perception of the educational environment is a strong factor in determining student satisfaction. This work has been conducted to better understand the factors which impact how medical students positively and negatively perceive clinical placements. Thematic analsysis of student questionnaire responses at Blackpool Victoria Hospital demonstrated that the most important factors were the friendliness of the staff and environment, the availability of teaching and clinical opportunities. This will allow educators to design and organize placements with consistently high levels of student satisfaction.

Keywords— Hospital placement, student perception, student satisfaction, Undergraduate medical placements

Full Text:

Introduction:

Clinical placements are an integral component of medical school curricula in the U.K. (GMC, 2011). These placements provide students with the opportunity to learn and practice "outcomes for graduates" and become good doctors. (GMC, 2009) However, there is significant variation in student perceptions of placements between differing hospitals and departments.

Student perception of the educational environment heavily influences their satisfaction, (Genn, 2001) academic achievement (Genn, 2001) and professional development (Irby, et al., 2010).

This research aims to improve understanding of the factors which impact how medical students positively and negatively perceive clinical placements. This will allow educators in secondary care to alter the learning environment by designing and organizing placements with consistently high levels of student satisfaction.

Methods:

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A qualitative research approach was used to capture medical students' perceptions towards their placement at Blackpool Victoria Hospital. All Year 2 medical students undertook a mixed medical and surgical placement with time spent at surgical and medical clinics and wards. At the end of the placement, all students were asked to complete a feedback questionnaire with free text questions asking students to elaborate on which aspects of each of the 10 main areas they liked and which could be improved.

Thematic analysis of the free text responses was then conducted in order to identify overarching positive and negative themes. Each comment was labelled to a maximum of three themes. The percentage of positive and negative comments relating to each theme was calculated to understand which domains affect placement perception the most.

Results:
Year 2 Medical Students at Blackpool Victoria Hospital (BVH) rotate through a variety of medical and surgical areas. At the end of the placement, each Year 2 medical student at BVH was asked to fill out a feedback form asking for written comments about the main ten clinical areas. These were then thematically analysed in order to identify overarching themes in what students believed impacted their placements, spanning both the positive and negative comments. The percentage of positive and negative comments relating to each theme was calculated to understand which domains affect placement perception the most.

100% (n=20) of the year two medical students at BVH responded to the survey. Six major themes were identified; an opportunity to practice skills; environment and staff; teaching; relevance to the curriculum; feedback; and admin. Students overwhelmingly valued areas with supportive and approachable staff (34% of positive comments) and where staff provided teaching and were willing to answer questions (30% of positive comments). Additionally, students valued areas where there were good opportunities to practice skills such as history and examination. (24% of positive comments). The majority of negative comments also related to these same three domains, they commented on:

1. Unwillingness of staff to teach or answer questions (37% of negative comments);
2. Areas where staff were too busy to help or unapproachable (29% of negative comments)
3. Where clinical opportunities were limited, including when students were forced to take a passive role or were unable to perform histories and examinations (26% of negative comments).

Discussion:
This evidence suggests that student's value clinical placements in areas where staff are approachable and where there is adequate opportunity for teaching and to practice skills. In order to provide consistently high-quality clinical placements for medical students' educators should assess wards and clinics for these qualities to ensure that they are suitable.

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Creation of a Trust-wide, Cross-speciality, Virtual Teaching Programme for Doctors, Nurses and Allied Healthcare Professionals

Nelomi Anandagoda, Leanne J. Eveson

***Abstract*—** During the COVID-19 pandemic the surge in in-patient admissions across the medical directorate of a district general hospital necessitated the implementation of an incident rota. Conscious of the impact on training and professional development, the idea of developing a virtual teaching programme was conceived.

The programme initially aimed to provide junior doctors, specialist nurses, pharmacists and allied healthcare professionals from medical specialties and those re-deployed from other specialties (e.g. ophthalmology, GP, surgery, psychiatry) the knowledge and skills to manage the deteriorating patient with COVID-19. The programme was later developed to incorporate the general internal medicine curriculum.

To facilitate continuing medical education whilst maintaining social distancing during this period, a virtual platform was used to deliver teaching to junior doctors across two large district general hospitals and two community hospitals.

Teaching sessions were recorded and uploaded to a common platform, providing a resource for participants to catch-up on and re-watch teaching sessions, making strides towards reducing discrimination against the professional development of less than full time trainees. Thus, creating a learning environment, which is inclusive and accessible to adult learners in a self-directed manner.

The negative impact of the pandemic on the well-being of healthcare professionals is well documented. To support the multi-disciplinary team, the virtual teaching programme evolved to included sessions on well-being, resilience and work-life balance.

Providing teaching for learners across the multi-disciplinary team (MDT), has been an eye-opening experience. By challenging the concept that learners should only be taught within their own peer groups, the authors have fostered a greater appreciation of the strengths of the MDT and showcased the immense wealth of expertise available within the trust. The inclusive nature of the teaching and the ease of joining a virtual teaching session has facilitated dissemination of knowledge across the MDT, thus improving patient care on the frontline.

The weekly teaching programme has been running for over 8 months, with on-going engagement, interest and participation. As described above, the teaching programme has evolved to accommodate the needs of its learners. It has received excellent feedback with appreciation of its inclusive, multi-disciplinary and holistic nature.

The COVID-19 pandemic provided a catalyst to rapidly develop novels methods of working and training, and widened access/exposure to the virtual technologies available to large organisations. By merging pedagogical expertise and technology, the authors have created an effective online learning environment. Although, the authors do not propose to replace face to face teaching altogether, this model of virtual multidisciplinary team, cross-site teaching has proven to be a great leveler. It has made high quality teaching accessible to learners of different confidence levels, grades, specialties and working patterns.

***Keywords*—**Cross-site, Cross-speciality, Inter-disciplinary, Multidisciplinary, Virtual Teaching

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A Randomised Simulation Study to Assess the Impact of a Focussed Crew Resource Management Course on UK Medical Students

S. MacDougall-Davis, S. Wysling, R. Willmore

***Abstract*—**BACKGROUND: The application of good non-technical skills, also known as Crew Resource Management (CRM), is central to the delivery of safe, effective healthcare.
The authors have been running remote trauma courses for over 10 years, primarily focussing on developing participants' CRM in time-critical, high stress clinical situations.
The course has undergone an iterative process over the past 10 years. We employ a number of experiential learning techniques for improving CRM, including small group workshops, military command tasks, high fidelity simulations with reflective debriefs, and a 'flipped classroom', where participants are asked to create their own simulations and assess and debrief their colleagues' CRM.
We created a randomised simulation study to assess the impact of our course on UK medical students' CRM, both at an individual and a teams level.
METHODS: Sixteen students took part. Four clinical scenarios were devised, designed to be of similar urgency and complexity.
Professional moulage effects and experienced clinical actors were used to increase fidelity, and to further simulate high stress environments.
Participants were block randomised into teams of 4; each team was randomly assigned to one pre-course simulation.
They then underwent our 5 day remote trauma CRM course. Post-course, students were re-randomised into four new teams; each was randomly assigned to a post-course simulation.
All simulations were videoed. Footage was reviewed by two independent CRM-trained assessors, who were blinded to the before/after status of the simulations.
Assessors used the internationally validated Team Emergency Assessment Measure (TEAM) to evaluate key areas of team performance, as well as a global outcome rating.
Prior to the study, assessors had scored two unrelated scenarios using the same assessment tool, demonstrating 89% concordance.
Participants also completed pre- and post-course questionnaires. Likert scales were used to rate individuals' perceived NTS ability and their confidence to work in a team in time-critical, high stress situations.
RESULTS: Following participation in the course, a significant improvement in CRM was observed in all areas of team performance. Furthermore, the Global Outcome rating for team performance was markedly improved (40-70%; mean 55%), thus demonstrating an impact at Level 4 of Kirkpatrick's hierarchy.
At an individual level, participants' self-perceived CRM improved markedly after the course (35-70% absolute improvement; mean 55%), as did their confidence to work in a team in high-stress situations.
CONCLUSION: Our study demonstrates that with a short, cost-effective course, using easily reproducible teaching sessions, it is possible to significantly improve participants' CRM skills, both at an individual, and, perhaps more importantly, at a teams level.
The successful functioning of multi-disciplinary teams is vital in a healthcare setting, particularly in high-stress, time-critical situations. Good CRM is of paramount importance in these scenarios.
The authors believe that these concepts should be introduced from the earliest stages of a medical education, thus promoting a culture of effective CRM, and embedding an early appreciation of the importance of these skills in enabling safe and effective healthcare.

***Keywords*—**Crew Resource Managment, Non-technical Skills, training, simulation

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Mapping of Forest Cover Change in The Democratic Republic of the Congo: Case of The Territory of Bolobo

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Abstract:

Deforestation is a change in the structure and composition of flora and fauna, which leads to a loss of biodiversity, production of goods and services and an increase in fires. It concerns vast territories in tropical zones particularly, this is the case of the territory of Bolobo in the current province of Mai-Ndombe in the Democratic Republic Congo.

Indeed, through this study between 2001 and 2018, we believe that it was important to show and analyze quantitatively the important forests changes and analyze quantitatively. It's the overall objective of this study, because in this area we are witnessing significant deforestation.

Mapping and quantification are the methodological approaches that we have put forward to assess the deforestation or the forest changes through satellite images or raster layers. These satellites data from Global Forest Watch are integrated into the GIS software (GRASS GIS and Quantum GIS) to represent the loss of forest cover that has occurred, and the various changes recorded (e.g. forest gain) in the territory of Bolobo.

The results obtained show in terms of quantifying deforestation for the periods 2001-2006, 2007-2012 and 2013-2018, the loss of forest area in hectares each year. The different change maps produced during different study periods, mentioned above show that the loss of forest areas is gradually increasing.

With this study, knowledge of forest management and protection is a challenge to ensure good management of forest resources. To do this, it is wise to carry out more studies that would optimize the monitoring of forests to guarantee the ecological and economic functions they provide in the Congo Basin, particularly in the Democratic Republic of Congo.
In addition, the cartographic approach, coupled with the geographic information system and remote sensing, proposed by Global Forest Watch using raster layers provide interesting information to explain the loss of forest areas.

Keywords: Deforestation, Loss year, Forest change, Remote sensing, Drivers of deforestation.