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.

OSI provides an efficient and thorough discovery process to the open science research database and provides links and free access to full-text articles. There are 50 open access journal categories that are curated and refereed by international scientific committees, the in-house editorial team, and trusted partners. Since its inception in 2007, OSI has made more than thirty thousand peer-reviewed open access full-text journal articles (PDF versions) freely available online without cost, barriers, or restrictions.

Open Science Access

With the Open Science Index, researchers can discover and access trusted peer-reviewed open access full-text scientific research articles with confidence. OSI helps researchers find appropriate non-profit open access journals to publish their work.

OSI gives one-click access to online full-text PDFs and expands the reach to global society by giving users free access from anywhere around the globe. Through cutting-edge open science collaboration, in an innovative public partnership, the non-profit OSI is devoted to making science open and reusable.

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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.

Scholarly Research Review Traits:
• 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

• Scholarly Research Pre-review Manuscripts: Manuscripts are made immediately available in advance of any formal peer review procedures

• 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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Open Science Award

The International Research Conference (IRC) is an open science research organization dedicated to promoting advancement of science, engineering, and technology. The IRC's open science award program is pleased to announce research awards which are available to distinguished researchers who are currently based at or affiliated with a research university.

The purpose of this award is the recognition of open science research and publications. The award program coordinates and develops high impact scholarly research which seeks to promote multiscience approaches. The open science originates with the premise that universal scientific knowledge is a product of collective scholarly efforts. The social collaboration involves all stakeholders and knowledge belongs to the global society. Scientific outputs generated by public research are public good that should be available to all at no cost and without any barriers or restrictions.

The open science award is granted annually for outstanding achievements and excellence in scientific research. Any researcher who is interested in this award can submit their own and /or the colleagues' scholarly research articles for consideration for this honor. All respected researchers are warmly welcome to submit their research works for potential award consideration and evaluation. Qualitative and quantitative assessment of the open access articles submitted and published for consideration will be evaluation criteria for the award. The award emphasizes open science contributions, collaborations and communication, and the open publication of scholarly research knowledge.

This annual award will be given to one and up to three honorees (or research groups) in recognition of exceptional contributions to open science in the following three distinct research categories: Social Sciences, Life Sciences, and Physical Sciences. The selection committees (waset.org/Committees) are responsible for selecting the recipient(s) of the named award. The members of the open science award committee will promote excellence and transparency, allow broad input, recognition, diversity and commitment to equity so that the open science award is sufficiently representative of distinguished research groups.

Assignment of the open science award committee is performed primarily through the online submission and review system. The annual event is held to present awards and to celebrate distinguished researchers for their open science contributions.

Open Science Award Deadlines

Online Nomination Deadline: January 01, 2020 - December 31, 2020

Scoring Deadline: January 01, 2021 - March 31, 2021

Selection Deadline: April 30, 2021

Award Ceremony Date: June 30, 2021

Application Procedure

Applicants must submit the following to https://waset.org/profile/messages with the email subject line reading "OSA_surname_given name," e.g., OSA_Smith_John.

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Please include the following attachments to your email application:

1. Applicants should hold, at a minimum, a Ph.D. or its equivalent degree.

2. Cover letter to the Award Committee indicating interest in the award.

3. Curriculum vitae.

4. Research statement. Please include a description of your research accomplished (not more than two pages, single spaced), and published full text original research article in pdf format.

5. Two letters of recommendation. The applicant must request the letters (or the dossier service).

6. High-quality copies or scans of transcripts showing degrees (Bachelor, Masters, and Doctoral) and coursework.

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Open Science

Postdoctoral Fellowship Award

The International Research Conference (IRC) is an open science research organization dedicated to promoting the advancement of science, engineering, and technology. The IRC's postdoctoral fellowship award is pleased to announce Fellowships which are available for postdoctoral researchers who are currently based at or affiliated with a research university. The postdoctoral fellowship award coordinates and develops high impact scholarly open science research which seeks to promote multiscience approaches. In addition, the fellowship award presents a unique opportunity for researchers who want to influence the future of open science through collaboration, communication, publication and data sharing within the global science community.

This postdoctoral fellowship award is looking for researchers with a passion for open science, open sources, open publications and data sharing. Applicants should already be working to promote research practices in a more collaborative, iterative and open dimension. Fellows will spend four months starting in June of 2020 as community catalysts at their own institutions creating, disseminating, and mentoring the next generation of open scientists, open data practitioners and researchers. The goal is to build lasting changes in the global open science community. Throughout the fellowship term, Fellows will receive training and support from the open science postdoctoral Fellowship award to develop and hone their skills around open science, open sources, data sharing, open science policy and licensing. Fellows will also craft policies and codes, write curriculum, teach their institutional peers, and be engaged in helping their local open science communities learn about open sources and open data practices.

Expectations: The open science postdoctoral Fellowship award anticipates applicants who:

- Create change within their university or other institution throughout open science, research, data sharing, and article publications.
- Create knowledge, policies and codes, curriculum and educational resources to promote open science.
- Participate in open science research workshops, symposia, conferences, and other activities.
- Participate in and help to lead regular open science research community call for proposals or papers.
- Serve as open science mentors and leaders within their research communities.
- Serve as reviewers for submitted open science abstracts and research papers for scholarly journals and conferences.
- Promote open science by communicating, publishing and sharing their high impact peer-reviewed research on an ongoing basis.

Note: Fellows are encouraged to continue their personal research for up to 20% of their time during the course of their fellowship (i.e., one day a week). Fellowship applicants must have buy-in from their advisors in advance and include their advisors' contact information on the application. The applicant's advisors will be interviewed should the applicant move on to the second round, and their support will be a critical consideration for the awarding of Fellowships.

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Fellowship Terms and Conditions

Award Scholarship Description

Application Deadline: April 30, 2020

- Fellowships are awarded to enhance the concept of open science and are open to scholars from all fields of science, engineering, and technology.

- The selected Fellow will receive a monthly stipend of $500.00 for four months during 2020 (June, July, August, and September). Fellows are responsible for remitting all applicable taxes and other government charges as required by their country of residence and by law.

Nationality: Fellowships are available to postdoctoral researchers in any country.

Requirements:

Fellows must:

• At a minimum, hold a Ph.D. or its equivalent by June 1, 2020, and should not have received the degree before 2018.

• Applicants should have working proficiency in the English language and should demonstrate their ability to read, write, and speak English.

• Applicants should be full-time academics or affiliated with a research university or institute.

• Funding will be direct to the Fellow and not distributed through their institution.

• Be able to travel.

• Obtain support from their advisors. Fellows will be based at their home institutions. Please note that a letter of support from the advisor is mandatory for consideration.

• Have experience participating in open science research.

Application Procedure:

Applicants must submit the following to https://waset.org/profile/messages with the email subject line reading "Postdoc_surname_given name," e.g., Postdoc_Smith_John.

Please include the following attachments to your email application:

1. Cover letter to the Search Committee indicating interest in the position.

2. Curriculum vitae.

3. Dissertation abstract.

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4. Research statement. Please include a description of your proposed research that would be accomplished during the fellowship (not more than two pages, single spaced).

5. Two letters of recommendation. The applicant must request the letters (or the dossier service).

6. High-quality copies or scans of transcripts showing degrees (Bachelor, Masters, and Doctoral) and coursework.

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Perception and Attitudes of Medical Students towards Dermatology as a Future Specialty.

Rakan S. Alajmi 1, Rahaf A. Alnazzawi 1, Yara E. Aljefri 1 , Abdullah F. Alafif 1 , Ali A. Alraddadi 2
Awadh M. Alamri 2

***Abstract*— Background**: The distribution of physicians in different specialties across Saudi Arabia is determined by the career choices of medical students. Dermatology residency program is one of the highly competitive programs here in Saudi Arabia. Assessing and understanding the factors perceived to be attractive in choosing dermatology will aid the directors of the specialty programs to plan for a more balanced workforce distribution to better suit the needs of the specialties. **Aim**: The aim of our study is to determine and assess the factors perceived to be significantly attractive when choosing dermatology as a future specialty. **Methods**: The study is a cross-sectional study conducted in King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia. A validated questionnaire was sent electronically to clinical year medical students. In addition to the questionnaire, gender, grade point average, preferred specialty, and other socio-demographic data were assessed. **Results**: A total of 121 clinical years medical students completed the questionnaire, 8 (6.6%) preferred dermatology as a specialty. 76 (62.8%) of the participants score a grade point average of more than 4.5 and 83 students (68.6%) chose their specialty during clinical years. The appeal of being a dermatologist *(P= 0.047)*, the portrayal of different specialities in the media *(P= 0.005),* and the likelihood that dermatologists can influence patients' lives *(P=0.010)* were shown to be significantly attractive factors. **Conclusion**: There are many factors that are affecting students' choices when choosing a medical specialty. The appeal of being a dermatologist, the portrayal of different specialities in the media, and the likelihood that dermatologists can influence patients' lives were shown to be significantly attractive factors when choosing dermatology as a future specialty. Recognizing medical students' specialty perception will lead them to a proper specialty tailored to their needs.

***Keywords*—** Career choice, Dermatology, Medical specialties, Students' perception.

I. Introduction

DERMATOLOGY is a medical specialty involving the management of skin conditions [1]. In Saudi Arabia, Dermatology residency program consists of 4 years of intensive training [1]. Despite that some acute skin diseases or severe inflammatory, infections and immune skin disorder require inpatient facilities, Dermatology is mostly an outpatient-based practice within hospitals or offices [1]. Non-Saudi dermatologists number has been increased, yet Saudi dermatologist number has been relatively stable, making it even more competitive for newly graduated medical students [2].

When choosing a medical specialty, students tend to evaluate the financial rewards, patients-load, training years, and the number of on-call duties of the chosen specialty [3].

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Moreover, students' personalities and lifestyles have an apparent impact on choosing their future medical specialties [4-5]. In addition to the previous factors, the degree to which they can exert control to the working hours and being under the influence of a role model have been stated as possible influencing factors in choosing a future specialty [1]. Furthermore, treatment outcome and challenging specialty were shown to be important elements in choosing a medical specialty [1].

In regards to gender preferences, aptitude, peer pressure, income, and obstacles involved are key elements in choosing a future specialty [6]. In fact, and according to a national study, Saudi male medical students are more attracted to less competitive specialties, specialties with a shortage of physicians, and specialties that have a diversity of patients [7]. On the other hand, prestigious life style and academic opportunities had a greater impact on Saudi female medical student's specialty selections [7].

Unfortunately, there is only modest amount of dermatology teaching during undergraduate training. Here at King Saud bin Abdulaziz University for Health Sciences, Jeddah-Saudi Arabia, dermatology is introduced to the medical students as lectures during preclinical and clinical years, and as a clinical exposure only in the final clinical year, the 6th year.

There are a lot of studies in Saudi Arabia determining the factors affecting undergraduate medical students' preferences when choosing their specialties [1]. However, this study is considered to explore student's perception and attitudes towards Dermatology as a future specialty. Accordingly, studying the preferences of doctors and medical students will help in improving the educational programs of future career planning for a more balanced distribution of workforce and driving the healthcare system towards a better coverage of the specialties needs by the choices of medical students [1]. Specialty choice is difficult for applicants and risks wasting societies' resources and talents. Thus, it is crucial to recognize medical students' specialty perception to lead them to a proper specialty tailored to their needs.

II. Methodology

This study is a cross-sectional study conducted in King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) in Jeddah, Saudi Arabia. In this study, participants were elected using non-probability sampling technique. Only registered medical students at clinical years(year 5 and 6) during the academic year 2019 - 2020 were allowed to participate.

The instrument used is self-administrated questionnaire prepared by the authors. The development of the questionnaire was based on previous related research topics. The first section of the questionnaire is consisting of sociodemographic parameters such as age, gender, marital status, academic level, GPA, preferred specialty and when did they make their specialty choices. The other section is encompassing sixteen factors which the participants rank them to be less attractive, more attractive, or no influence when choosing dermatology as a future specialty. Participants were anonymous and privacy ensured.

Data obtained from the questionnaire were gathered and analyzed in IBM Statistical Package for the Social Sciences(SPSS), version 25.0. Qualitative variables presented using descriptive statistics in the form of categories and summarized as frequency and percentage. Data

comparison was interpreted using Chi-square test and Fisher's exact test. All tests were two-sided, and a p value that is less than 0.05 was considered to be significant.

III. Results

Of the total 121 participating medical students, 92 (76.0%) were males and 29 (24.0%) were females. The selected students were in their clinical years, 5th and 6th year, of medical school. 76 (62.8%) students were in their fifth year and 45 (37.2%) students were in their last (6th) year. Majority of the participants (97.5%) were not married, whereas only 3 (2.5%) were married. Regarding the grade point average, GPA, scores (out of 5.0), more than half of the students (62.8%) had a GPA greater than 4.5, whereas 34 (28.1%) students stated having a GPA between 4 and 4.49, and the remaining who had less than 4 were 11 (9.10%) students. Refer to Fig. 1 for a more detailed GPA scores distribution.

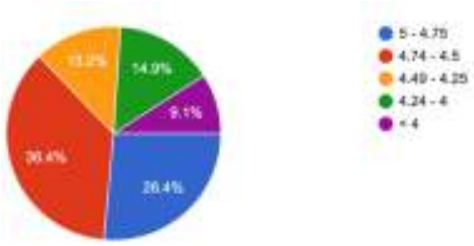

Fig. 1 GPA score distribution of the 121 participants.

Among the 121 respondents, only 8 (6.60%) reported a specialty preference toward Dermatology as a future career, a higher percentage of respondents (36.4%) selected surgical specialty, and medical specialty was the most preferred specialty by the participants (57.0%). More than half of the medical students (68.6%) had decided on their preferred medical specialty during the clinical years, whereas 27 (22.3%) chose their wanted specialty in the basic sciences' years, and the least number of the students (9.10%) made their specialty choice before getting into medical school. Sociodemographic features of all participants are shown in Table I.

Factors of particular significance to medical students in choosing Dermatology as a future specialty were the appeal of being dermatologist (P= 0.047), portrayal of different specialties in the media (P=0.005), and the likelihood that a dermatologist can influence a patient's lives (P=0.010). Table II shows all of the sixteen factors.

IV. Discussion

The main objective of this study is to evaluate medical students' perception and attitude towards dermatology as a future specialty. Dermatology, consisting of four years of training, is considered one of the highly competitive specialties here in Saudi Arabia [1]. Understanding the factors affecting students' choices will aid in having a more balanced workforce in the healthcare system [1].

There are many factors that are influencing medical students' specialty choices [5] Ranging from personal aspects like gender and lifestyle to more detailed aspects shown in table 2 [1,5].

As mentioned earlier in this study, financial rewards and job satisfaction cannot be overlooked when choosing dermatology as a specialty [8]. This might interpret why medical students chose the appeal of being a dermatologist to be an important factor. Moreover, a study published in Riyadh, Saudi Arabia, which used the same questionnaire used in our study, showed that the appeal of being a dermatologist is significantly important too [1]. Flexibility of training, low on-call commitments, and being mainly an outpatient based specialty make dermatology more appealing to medical students [9]. Opposingly, and a according to a research which assessed medical specialties' prestige level, dermatology was ranked low along with general practice, psychiatry, and geriatrics [10]. Self-image or self-acceptance are strongly associated with dermatology patients' lives [11]. As a result, quality of life and well-being of dermatology patients are highly affected [11]. This might explain why "the likelihood that dermatologist can influence patients' lives" factor was a significantly attractive in choosing dermatology as a future specialty.

The lack of research production in the field of dermatology was discussed in the same study in Riyadh, Saudi Arabia [1]. In fact, the opportunity to do researches was shown to be a significant factor in choosing dermatology as a specialty [1]. This result is supported by a Canadian study which concluded that the number of dermatologists were an important factor in the research production [12]. However, "the opportunity to do researches" factor was not shown to be significant *(P=0.084)* in our study.

TABLE I Socio-demographic Characteristics

Variable	Category	*n* (%)
Gender	Male	92 (76.0)
	Female	29 (24.0)
Academic Level	5th year	76 (62.8)
	6th year	45 (37.2)
Marital Status	Single	118 (97.5)
	Married	3 (2.5)
GPA /5	> 4.5	76 (62.8)
	4 -4.49	34 (28.1)
	< 4	11 (9.10)
Preferred Specialty	Dermatology	8 (6.60)
	Surgical Specialty	44 (36.4)
	Medical Specialty	69 (57.0)
When did you make your specialty choice	During clinical years	83 (68.6)
	During basic years	27 (22.3)
	Before medical school	11 (9.10)

Lifestyle has become an essential factor for medical students in choosing their medical specialty. Medical specialties like Radiology, Psychiatry, Ophthalmology, and Dermatology were perceived to have a controllable lifestyle [13]. A controllable lifestyle is strongly related to the amount of time that is independent of medical practices [5]. Furthermore, and a according to a study that assessed burnout level among the physicians, dermatologists were perceived to have low

burnout levels among other physicians [14]. In regards to gender preferences, and due to family commitments, specialties with controllable lifestyle had an apparent impact on female medical students' choices, a national study reported [7]. Similar interpretation was noted in Riyadh's study where most of the medical students who chose dermatology were females [1]. Moreover, a study conducted in the UK stated that the controllable lifestyle features of dermatology make it more popular among female medical students [9]. On the contrary, out of the students who chose dermatology in our study, 1 is a female.

TABLE II REASONS FOR CHOOSING DERMATOLOGY AS A FUTURE SPECIALTY.

Question	Answer	Specialty, *n* (%)		P
		Dermatology	Other	
The free time away from work	Less attractive	0	14 (12.4)	0.866
	No influence	2 (25.0)	29 (25.7)	
	More attractive	6 (75.0)	70 (61.9)	
The appeal of being a dermatologist	Less attractive	1 (12.5)	32 (28.3)	0.047
	No influence	2 (25.0)	56 (49.6)	
	More attractive	5 (62.5)	25 (22.1)	
How dermatologists role model a satisfying family life	Less attractive	1 (12.5)	12 (10.6)	0.406
	No influence	1 (12.5)	40 (35.4)	
	More attractive	6 (75.0)	61 (54.0)	
The difficulty of getting into dermatology residency	Less attractive	4 (50.0)	56 (49.5)	0.499
	No influence	1 (12.5)	32 (28.3)	
	More attractive	3 (37.5)	25 (22.1)	
Opportunities for part-time work in dermatology	Less attractive	1 (12.5)	14 (12.4)	0.149
	No influence	0	36 (31.9)	
	More attractive	7 (87.5)	63 (55.8)	
The variety of patients (all ages, both genders)	Less attractive	1 (12.5)	8 (7.08)	0.116
	No influence	2 (25.0)	68 (60.2)	
	More attractive	5 (62.5)	37 (32.7)	
The length of residency years	Less attractive	0	12 (10.6)	0.538
	No influence	4 (50.0)	66 (58.4)	
	More attractive	4 (50.0)	35 (31.0)	
The opportunity to perform procedures	Less attractive	0	23 (20.4)	0.500
	No influence	4 (50.0)	48 (42.5)	
	More attractive	4 (50.0)	42 (37.2)	
Relies on clinical diagnostic skills	Less attractive	0	19 (16.8)	0.274
	No influence	2 (25.0)	47 (41.6)	
	More attractive	6 (75.0)	47 (41.6)	
Portrayal of different specialities in the media	Less attractive	1 (12.5)	14 (12.4)	0.005
	No influence	2 (25.0)	81 (71.7)	
	More attractive	5 (62.5)	18 (15.9)	
The likelihood that a dermatologist can influence patient's lives	Less attractive	1 (12.5)	34 (30.1)	0.010
	No influence	1 (12.5)	53 (46.9)	
	More attractive	6 (75.0)	26 (23.0)	
Opportunities to do researches in dermatology	Less attractive	0	20 (17.7)	0.084
	No influence	3 (37.5)	65 (57.5)	
	More attractive	5 (62.5)	28 (24.8)	
The high income	Less attractive	0	6 (5.31)	1.000
	No influence	1 (12.5)	17 (15.0)	
	More attractive	7 (87.5)	90 (79.7)	
The degree of stress	Less attractive	3 (37.5)	17 (15.0)	0.266
	No influence	2 (25.0)	32 (28.3)	
	More attractive	3 (37.5)	64 (56.6)	
Unsatisfied patients	Less attractive	1 (12.5)	41 (36.3)	0.323
	No influence	6 (75.0)	58 (51.3)	
	More attractive	1 (12.5)	14 (12.4)	
Private sector opportunities	Less attractive	0	1 (0.9)	0.700
	No influence	1 (12.5)	27 (23.9)	
	More attractive	7 (87.5)	85 (75.2)	

As mentioned before, dermatology is one of the highly competitive programs both globally and in Saudi Arabia, hence the academic requirements are rationally also high [1]. In this study, 87.5 % of the students who preferred dermatology as a specialty score a GPA, grade point average, of more than 4.5. This also is mirrored in the same study conducted in Riyadh, Saudi Arabia [1].

A lot of studies in Saudi Arabia are concerned with determining the factors affecting undergraduate medical students' decisions when choosing their specialities [1]. The involvement of all medical students in the clinical phase gives another substantial point of this study. It is believable that there are several factors affecting medical students decision before, during, and after medical school. Since it was all a cross-sectional study, we have not had a comparison, one that determines reasons behind medical students opting for Dermatology between the same sample in the basic years and clinical years. Similar future studies should focus on identification of these factors' impact on graduates' career choices over many years to focus on them, and to know how to use these factors to guide medical students towards particular specialties, in order to develop a better healthcare system.

V. Conclusion

There are many factors that are affecting students' choices when choosing a medical specialty. Assessing the preferences of medical students will help in improving the educational programs of future career planning for a more balanced distribution of workforce, moreover, driving the healthcare system towards a better coverage of the specialties' needs by the choices of medical students. Specialty choice is difficult for applicants and might waste societies' resources and talents. As a result, it is crucial to recognize the attitudes of medical students as early as possible and lead them towards a proper career path suitable to their needs and talents. For that reasons, constant support from all workforce planners is required [1].

VI. Limitations

Some of the study participants have not yet been exposed to the clinical rotation of dermatology, hence, this might be a bias in our study. Moreover, a small sample size, and the lack of a standard definition in some of the variables like the portrayal of different speicalities in the media and other variables are also limitations in this study.

VII. Ethical Approval

The study was approved by the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (KAIMRC).

VIII. Financial Support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

IX. Conflicts Of Interest

There are no conflicts of interest.

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The Implication of Augmentation Cystoplasty with Mitrofanoff Channel on Reproduction Age Group and Outcome of Pregnancy

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***Abstract*—**The aim of this article is to share a rare clinical case of pregnancy and surgical delivery in a patient who has undergone augmentation cystoplasty with mitrofanoff channel in the past.
Methods: This case report is about a woman who conceived naturally at the age of 27, previously underwent augmentation cystoplasty at the age of 10 years with mitrofanoff procedure using self-clean intermittent catheterization. Furthermore, this pregnancy was complicated by the presence of preeclampsia diagnosed at term and PROM. Following failure of induction for intrapartum preeclampsia, the patient delivered a healthy baby via low transverse cesarean section at 38 weeks done at Latifa hospital, Dubai.
Conclusion: The procedure is done at a pediatric or young age after which most patients reach reproductive age. There is no contraindication to pregnancy vaginally or surgically however this case was complicated by preeclampsia due to which this patient was taken for a cesarean section. It is advisable to consult a urologist frequently along with taking regular bacteriological urine samples and blood samples with renal ultrasonography for the evaluation of kidney. Antibacterial treatment or prophylaxis should be used during pregnancy if necessary and intermittent self-catherization is mostly performed routinely. It is also important to have a urologist on standby during the surgery in order to avoid and/or fix any complications that might come forth

***Keywords*—**augmentation cystoplasty, cesarean section, delivery, mitrofanoff channel

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Instrumental Deliveries at Aneurin Bevan University Health Board, 2019

H. Kaur, S. Parveen

***Abstract*—** Aim: Analysis of instrumental deliveries in the year 2019 with an aim to find out indications, maternal and neonatal outcomes. Compare our practice with the National and RCOG recommendations. Methodology: Retrospective analysis of 332 instrumental vaginal deliveries from January 2019 to December 2019. Result: Instrumental deliveries accounted for 8.55% of total deliveries, 86% of the total patients were primigravida. Conclusion: To skill of operative vaginal deliver is essential to reduce the rates of caesarean sections.

***Keywords*—** forceps, ventouse, midcavity, perineal tear.

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Pregnancy Outcome in Pregnancy with Low PAPP- A in First Trimester

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***Abstract*—**
Aim: The aim of the study is to find out if low PAPP –A levels in the first trimester is associated with adverse obstetric outcome.

Methods: A retrospective study was carried out on 114 singleton pregnancies having undergone combined test screening.

Results: There is statistically significant increased incidence of low birth weight infants in the low PAPP-A group. However, significant association was not found in the incidence of pre eclampsia, miscarriage and placental abruption.

Conclusion: Low PAPP-A in the first trimester is associated with fetal growth restriction

Recommendation:
Women with low PAPP A level in first trimester pregnancy screening require consultant led care and serial growth scans.

***Keywords*—** pregnancy, pregnancy-associated plasma protein A, PAPP-A, fetal growth restriction, trimester

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Assessing the Competence of Oral Surgery Trainees: A Systematic Review

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***Abstract*—** Background: In more recent years in dentistry, a greater emphasis has been placed on competency-based education (CBE) programmes. Undergraduate and postgraduate curriculums have been reformed to reflect these changes, and adopting a CBE approach has shown to be beneficial to trainees and places an emphasis on continuous lifelong learning. The literature is vast; however, very little work has been done specifically to the assessment of competence in dentistry and even less so in oral surgery. The majority of the literature tends to opinion pieces. Some small-scale studies have been undertaken in this area researching assessment tools which can be used to assess competence in oral surgery. However, there is a lack of general consensus on the preferable assessment methods. The aim of this review is to identify the assessment methods available and their usefulness. Methods: Electronic databases (Medline, Embase, and the Cochrane Database of systematic reviews) were searched. PRISMA guidelines were followed to identify relevant papers. Abstracts of studies were reviewed, and if they met the inclusion criteria, they were included in the review. Papers were reviewed against the critical appraisal skills programme (CASP) checklist and medical education research quality instrument (MERQSI) to assess their quality and identify any bias in a systematic manner. The validity and reliability of each assessment method or tool were assessed. Results: A number of assessment methods were identified, including self-assessment, peer assessment, and direct observation of skills by someone senior. Senior assessment tended to be the preferred method, followed by self-assessment and, finally, peer assessment. The level of training was shown to affect the preferred assessment method, with one study finding peer assessment more useful in postgraduate trainees as opposed to undergraduate trainees. Numerous tools for assessment were identified, including a checklist scale and a global rating scale. Both had their strengths and weaknesses, but the evidence was more favourable for global rating scales in terms of reliability, applicability to more clinical situations, and easier to use for examiners. Studies also looked into trainees' opinions on assessment tools. Logbooks were not found to be significant in measuring the competence of trainees. Conclusion: There is limited literature exploring the methods and tools which assess the competence of oral surgery trainees. Current evidence shows that the most favourable assessment method and tool may differ depending on the stage of training. More research is required in this area to streamline assessment methods and tools.

***Keywords*—** competence, oral surgery, assessment, trainees, education.

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COVID-19 Impact on Medical Tourism: Case Study of Lebanon

Viana Hassan

***Abstract*—** The tourism and travel sector is a large and thriving industry, with almost 5 billion international tourist arrivals recorded in 2019, with an annual growth of 4% on the previous year (UNWTO, 2020).

However, Lately, the field of Medical tourism has been growing due the low cost treatment, Specialization of Medical agencies, hospitals and medical professionals in the host countries where was valued at USD 16.761 million in 2018, and it is expected to reach USD 27,247.6 million by 2024. But the appearance of COVID 19 has completely changed the tourism sector, were a loss of US910 $ billion to US 1.2 trillion from export revenues from tourism was reported.

Among the middle east countries, Lebanon appears to be attracting medical tourism the most; 10% of the tourists coming to Lebanon, identify receiving medical treatment as the main purpose of their visit

To better understand the impact of COVID 19 on Medical tourism mainly in Lebanon, the research was based on different sources (articles, papers, reports, statistics for UNWTO, WHO, etc…) together with a qualitative research through interviews with Plastic surgeons and employee in this sector.

The research aims to gather information on COVID 19 and its impact on the Medical tourism sector and to develop strategies about the future of medical tourism.

The main findings presented in the paper have shown that COVID19 had a devastating impact on the medical tourism sector due the restriction of travel and limitations of giving visas, beside the integrations of online consultation.

***Keywords*—** COVID 19, medical tourism, Lebanon, future.

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Effectiveness of the Lacey Assessment of Preterm Infants to Predict Neuromotor Outcomes of Premature Babies at 12 months Corrected Age

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Abstract

Background: The Lacey Assessment of Preterm Infants (LAPI) is used in clinical practice to identify premature babies at risk of neuromotor impairments, especially cerebral palsy. This study attempted to find the validity of the Lacey assessment of preterm infants to predict neuromotor outcomes of premature babies at 12 months corrected age and to compare its predictive ability with the brain ultrasound.

Methods: This prospective cohort study included 89 preterm infants (45 females & 44 males) born below 35 weeks gestation who were admitted in the neonatal intensive care unit of a government hospital in Dubai. Initial assessment was done using the Lacey Assessment after the babies reached 33 weeks postmenstrual age. Follow up assessment on neuromotor outcomes was done at 12 months (±1 week) corrected age using two standardized outcome measures, i.e., Infant Neurological International Battery and Alberta Infant Motor Scale. Brain ultrasound data were collected retrospectively. Data were statistically analyzed and the diagnostic accuracy of the Lacey Assessment of Preterm Infants (LAPI) was calculated - when used alone and in combination with the brain ultrasound.

Results: On comparison with brain ultrasound, the Lacey assessment showed superior specificity (96% vs. 77%), higher positive predictive value (57% vs. 22%), and higher positive likelihood ratio (18 vs. 3) to predict neuromotor outcomes at one year of age. The sensitivity of Lacey assessment was lower than brain ultrasound (66% vs. 83%) whereas specificity was similar (97% vs. 98%). A combination of Lacey assessment and brain ultrasound results showed higher sensitivity (80%), positive (66%) and negative (98%) predictive values, positive likelihood ratio(24) and test accuracy(95%) than Lacey assessment alone in predicting neurological outcomes. Negative predictive value of the Lacey assessment was similar to that of its combination with brain ultrasound (96%).

Conclusion: Results of this study suggest that the Lacey Assessment of Preterm Infants can be used as a supplementary assessment tool for premature babies in the neonatal intensive care unit. Due to its high specificity, Lacey assessment can be used to identify those babies at low risk of abnormal neuromotor outcomes at a later age. When used along with the findings of the brain ultrasound, Lacey assessment has better sensitivity to identify preterm babies at particular risk. These findings have applications in identifying premature babies who may benefit from early intervention services.

Keywords— Brain ultrasound, Lacey assessment of Preterm Infants, Neuromotor outcomes, Preterm.

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Estimated Cost-Effectiveness of the Pharmacist-Led Intervention in Glycated Hemoglobin Reduction in Type 2 Diabetes

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***Abstract*—** Background: Type 2 diabetes is a chronic condition accompanied with severe comorbidities and scary growing around the world. Also, imposes a radical economic excruciatingly burden on healthcare and society due to diabetes-related complications. Therefore, the pharmacist intervention documented as an essential key in cost reduction with diabetes care management [1].
Aim: The study aimed to evaluate the pharmacist intervention on diabetes outcomes and estimate the cost-effectiveness analysis when adding pharmacist into type 2 diabetes care using healthcare services.
Materials and methods: A randomized controlled trial was conducted for six months on 177 adults with type 2 diabetes at Military Hospital in Kuwait. Patients were assigned randomly into an intervention (n=88) that provided with pharmacist education or a control group (N=89) who received standard care. HbA1c as primary outcome were measured at the baseline and six months for both groups.
Results: During six months, the mean of HbA1c significantly decreased in the intervention group compared to control group ($p < 0.005$). In term of cost-effectiveness ICER, for the intervention group compared to the control group was $ -257.01 per capita to lower about 1% of HbA1c.
Conclusion and relevance: The randomized controlled trial study demonstrated that involved pharmacist in diabetes care management was cost-saving and reducing the risk of complications related to diabetes[2]. The results suggest that the benefit of integrating pharmacist in diabetes care is extensively recommended in order to diminish the direct cost of this condition on the health care team and society.

***Keywords*—** pharmacist intervention, Type 2 diabetes, cost-effectiveness, glycated hemoglobin.

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Towards Real-Time Classification of Finger Movement Direction Using Encephalography Independent Components

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***Abstract*—**This study explores the practicality of using electroencephalographic (EEG) independent components to predict eight-direction finger movements in pseudo-real-time. Six healthy participants with individual-head MRI images performed finger movements in eight directions with two different arm configurations. The analysis was performed in two stages. The first stage consisted of using independent component analysis (ICA) to separate the signals representing brain activity from non-brain activity signals and to obtain the unmixing matrix. The resulting independent components (ICs) were checked, and those reflecting brain-activity were selected. Finally, the time series of the selected ICs were used to predict eight finger-movement directions using Sparse Logistic Regression (SLR). The second stage consisted of using the previously obtained unmixing matrix, the selected ICs, and the model obtained by applying SLR to classify a different EEG dataset. This method was applied to two different settings, namely the single-participant level and the group-level. For the single-participant level, the EEG dataset used in the first stage and the EEG dataset used in the second stage originated from the same participant. For the group-level, the EEG datasets used in the first stage were constructed by temporally concatenating each combination without repetition of the EEG datasets of five participants out of six, whereas the EEG dataset used in the second stage originated from the remaining participants. The average test classification results across datasets (mean ± S.D.) were 38.62 ± 8.36% for the single-participant, which was significantly higher than the chance level (12.50 ± 0.01%), and 27.26 ± 4.39% for the group-level which was also significantly higher than the chance level (12.49% ± 0.01%). The classification accuracy within [–45°, 45°] of the true direction is 70.03 ± 8.14% for single-participant and 62.63 ± 6.07% for group-level which may be promising for some real-life applications. Clustering and contribution analyses further revealed the brain regions involved in finger movement and the temporal aspect of their contribution to the classification. These results showed the possibility of using the ICA-based method in combination with other methods to build a real-time system to control prostheses.

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***Keywords*—**Brain-computer interface, BCI, electroencephalography, EEG, finger motion decoding, independent component analysis, pseudo-real-time motion decoding.

I. Introduction

LOSING a limb can drastically alter one's life due to the inability to perform day to day tasks. Paralysis due to injuries in the spinal cord can also limit one's ability and in worse cases lose one's autonomy. Development in prostheses presents hope in regaining some sort of normal life. Brain-computer interfaces (BCI) are investigated as methods to control prostheses [1]. Invasive methods involve implanting electrodes in the brain or signal amplifiers at the nerve endings to acquire clear signals to achieve the desired control precision [2]. However, due to the complexity of surgical procedures and long-term instability, non-invasive methods are gaining more traction. Electromyography (EMG) is relatively easier to record and translate into control commands but can be limited to the number of available muscles to record from. It is also difficult to obtain reliable signals in cases of motor impairment, spinal cord injury, and locked-in syndrome. An alternative is EEG which can record brain activity at high temporal resolution from the surface of the head. Furthermore, EEG sensors are portable and commercially available. Many studies have used EEG for motion control [3],[4] ,[5] ,[6], and [7].

Since EEG electrodes are placed on the scalp, each electrode records the activity of a mixture of brain sources, which leads to a low spatial resolution. EEG signals also have low amplitude and are often contaminated with noise from eye movements, muscle artifacts, and so on. Another issue with EEG-based BCI is reusability and transferability from one person to the other. Placement of electrodes is likely to vary from one session to the next within the same participant. When dealing with multiple subject analysis, differences in the brain anatomy affect the conductance and therefore affect the recorded EEG. Solving these issues will lead to building a reliable BCI.

ICA is widely used to unmix brain-activity signals from artifacts [8],[9], and [10]. The scalp topographies of the ICs obtained from ICA can be represented by equivalent dipoles which will localize the ICs in the brain [11] and thus mitigate the issue of low spatial resolution. For the reusability issue, it has been shown that ICA decomposition is stable across sessions recorded at different periods within-subject [12]. Other studies validated the possibility of temporally concatenating EEG recordings of different participants for group-ICA [13], [14]. This suggests that a combination of ICA

and an appropriate machine learning algorithm can result in a modular system that can predict motion directions on newly recorded EEG data within-individual and across different individuals. However, to the extent of the authors' knowledge, this approach has not been fully investigated yet.

This study aims to investigate the possibility of using the ICA-based decoding method for real-time application. Using an eight-direction center-out finger movement task, movement directions were estimated from EEG data by applying the unmixing matrix obtained from ICA and a machine learning model obtained from a different dataset originating from either the same participant or a different participant. The brain regions involved in finger-movement were also localized and a classification contribution analysis was performed.

II. Materials and Methods

A. Participants

Six healthy participants performed the experiment (two females and four males). With a mean age of M = 40.67 years and SD = 7.23. The study protocol was approved by the ethics committee of the University of California, San Diego (Approval No. 14353) and carried out in accordance with the Declaration of Helsinki. Written informed consent was obtained from each participant before the experiment.

B. Experiment

The experiment was designed to separate the effect of the extrinsic and intrinsic coordinate frames. The extrinsic coordinate frame represents the position of an object in space while the intrinsic coordinate frame is a body-centered frame that is related to and moves with a specific body part such as a joint or muscle [15]. It has been shown that the extrinsic coordinate frame is transformed into the intrinsic coordinate frame in certain regions in the brain during motor control [16]. The experimental design referred to in this study was first applied in an invasive study on monkeys [15] and further validated in a human study [17].

Participants sat on a chair with their forearm and wrist supported and a PC screen was in front of them. They moved their index finger on a touchpad from the center of a circle to one of eight directions indicated on the screen. The eight targets are positioned on the circumference where the angle between every two consecutive targets is 45 degrees. Each participant performed a total of 1,280 trials divided into 40 sessions. The participants changed their elbow angle after every 10 sessions alternating between 0º and 90º. This elbow angle alternation dissociated the intrinsic and extrinsic coordinate frame in the classification analysis described later. Each trial consisted of two seconds of rest, then the target appears for two seconds. The participants were instructed to perform a single motion to the target regardless of whether the cursor reaches the target. Cursor position was recorded at a sampling rate of 30Hz.

C. Data Acquisition

EEG was recorded from 128 channels using Biosemi active two amplifier system (Biosemi, Amsterdam, Netherlands). Muscle activity onset was detected using EMG sensors placed over the right extensor indicis and flexor digitorum. EEG and EMG signals were recorded at a sampling rate of 2,048 Hz. The 3D positions of the EEG sensors, the nasion, left pre-auricular point and, right pre-auricular were measured using a posture functional capacity evaluation system. (zebris Medical GmbH, Isny, Germany).

D. MRI Image Acquisition and Preprocessing

MRI images were used to generate an accurate forward electric model to better localize the equivalent dipoles for each participant. The MRI images were acquired using a General Electric (GE) Discovery MR750 3.0 T equipped with a 32-channel receiver coil. A sagittal image was acquired using a T1-weighted spoiled gradient recalled sequence (TR = 8.132 s; TE = 3.192 ms; FA = 8°; FOV = 256 ×256 mm; matrix size = 256 × 256; 172 slices; slice thickness = 1.2 mm). The MRI images were used for DIPFIT as a custom MRI image. Images were normalized to the standard MNI brain template using SPM12 (https://www.fil.ion.ucl.ac.uk/spm/).

E. EEG Preprocessing

Raw EEG data were loaded into EEGLAB toolbox 2019.1, MATLAB R2017b for further processing. Data were filtered to eliminate baseline drift, line noise at 60 Hz, and frequencies of non-interest. Frequencies between 1 Hz and 40 Hz were kept. Data were then down-sampled to 512 Hz and channel signals were checked in a semi-automatic way and noisy channels - any channels that exceed [–500 μv 500 μv] for more than 20% of the time were removed. Channels were then re-referenced to the average. For better ICs decomposition, data were epoched to one second before the target appears and 2 seconds after as shown in Fig. 1 (a). For single-participant ICA (Fig. 1 (b)), datasets were divided into two sets with an equal number of trials in each set, and ICA was applied to each dataset separately using adaptive mixture ICA (AMICA) [18]. For group-level ICA (Fig. 1 (c)), datasets of all participants were down-sampled to 256 Hz and each unique combination of the datasets of five participants out of six was temporally concatenated. ICA was then applied to the concatenated sets.

F. ICs Localization and Selection

To localize the ICs in the brain we used EEGLAB plugin DIPFIT v3.3. The single-participant ICA used participant-specific channel locations as well as individual head MRI images for an accurate electric forward model. For group-level ICA, the standard MRI image provided with the toolbox was used. The ICs selection process was done in a semi-automated manner.

EEGLAB plugin ICLabel [19] predicts if the IC represents brain activity, eye or muscle artifacts, and so on. ICs were then manually checked in search of properties inherent to brain activity. In particular, event-related potential (ERP), relevant peaks in the power spectrum, the position of the equivalent dipole, and the residual variance that remains after the fitting. The threshold for residual variance was initially set to 30%. ICs with more than a 70% chance of representing brain activity

were kept regardless of the residual variance.

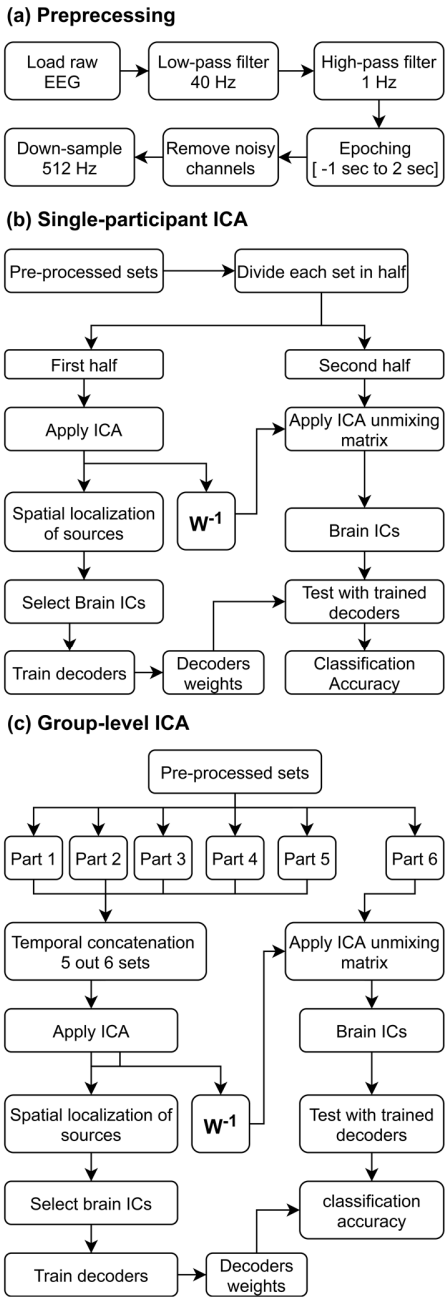

Fig. 1 Flowchart of the study. (a) preprocessing steps of raw EEG signals. (b) Single-participant ICA. (c) Group-level ICA

G.Eight-Directions Finger Movement Classification and Testing

SLR with Laplace approximation (SLR toolbox ver 1.51 https://bicr.atr.jp//~oyamashi/SLR_WEB.html) was used to predict eight-finger movement directions [20]. This algorithm was used in many studies [17],[20], and [21] for both fMRI and EEG data decoding mainly for its ability to automatically select the important features. The classifiers were trained using the concatenated time series of the ICs where zero to one second after the stimulus of each ICs was used. Due to the computational cost of SLR, the input was down-sampled to 64 Hz. To predict finger movement direction in the extrinsic coordinate frame, the trials where the finger moved to the same target were labeled with the same label regardless of the elbow angle resulting in trials where the finger performed different actions (extension vs adduction) being labeled the same. The training was performed using leave-one-out cross-validation. For each single-participant set, leave-one-out cross-validation consisted of 80 folds and for each of the temporally concatenated sets, leave-one-out cross-validation consisted of 800 folds. The performance of the classifiers was evaluated on the test sets. The trials were divided into bins where each bin contains a single trial of each direction without repeat. Each bin was then used once as a validation set and 79 times (799 times) in the training set for the single-participant sets (for the concatenated sets).

The test sets were constructed as follows: ICA relates EEG times series and ICs time series by a mixing matrix W such that $\mathrm{EEG} = \mathrm{W} \times \mathrm{IC}$. The unmixing matrix is then the inverse of W such that $\mathrm{IC} = \mathrm{W}^{-1} \times \mathrm{EEG}$ .For single-participant ICA, for every participant let Set_n be the EEG set for 'participant n' and Set_{1n} and Set_{2n} be the two halves of Set_n, $\mathrm{test}_{1n}$and test_{2n}be the test sets. $\mathrm{IC}_{1n} = {\mathrm{W}_{1n}}^{-1} \times \mathrm{Set}_{1n}$ and $\mathrm{IC}_{2n} = {\mathrm{W}_{2n}}^{-1} \times \mathrm{Set}_{2n}$. The test sets are then: $\mathrm{test}_{1n} = {\mathrm{W}_{1n}}^{-1} \times \mathrm{Set}_{2n}$ *and* $\mathrm{test}_{2n} = {\mathrm{W}_{2n}}^{-1} \times \mathrm{Set}_{1n}$.

For group-level ICA, let $\mathrm{GroupSet}_n$ be the EEG set constructed from temporally concatenating all participants' EEG except 'participant n'. $\mathrm{GroupSet}_n = \mathrm{GroupW}_n \times \mathrm{GroupIC}_n$ where $\mathrm{GroupW}_n$is the resulting mixing matrix. The test set is then $\mathrm{test}_n = {\mathrm{GroupW}_n}^{-1} \times \mathrm{Set}_n$

A non-parametric permutation test [22] was performed to evaluate the statistical significance of the classification results. Classifiers were trained with the same data using randomly generated labels to obtain accuracy distribution from the dataset, and p-values of the real-label dataset were calculated by evaluating the position of the real-label dataset in the distribution (Table I). Due to the computational cost, the permutation test was repeated 5000 times for the single-participant sets and 2500 times for the group-level temporally concatenated sets.

H.Clustering of ICs

The shape and size of the skull vary between individuals. Brains of different individuals also differ physiologically. This means that the same electrode may not record the same active brain regions across several individuals. To solve this issue, ICs were clustered based on the spatial properties of the equivalent dipoles using the EEGLAB study framework. The standard k-means algorithm was used [23]. Clustering was performed on the ICs obtained from the 12 single-participant sets, and on the ICs obtained from the 6 temporally concatenated group-level sets. The number of clusters is an open parameter and should be computed empirically. Each cluster should have at least 50% of unique sets in accordance with previous work [24]. This limited the maximum number of clusters to 15 for the temporally concatenated group-level sets and 23 for the single-participant

sets. The number of clusters was then varied to evaluate the stability of the results. The results were stable from 10 to 15 for the temporally concatenated sets and 12 to 18 for the single-participant sets. To balance the spatial resolution and the number of unique sets in each cluster, the number of clusters was 13 for the temporally concatenated sets and 16 for the single-participant sets. Each cluster contained 91.03% (SD = 0.97%) of the concatenated sets and 70.83% (SD = 2.13%) of the single-participant sets. The centroid of each cluster was located in the AAL atlas [25].

TABLE I
SINGLE-PARTICIPANT ICA RESULTS

Part1						
Participants	1	2	3	4	5	6
Second Set classification Acc%	47.21	38.62	39.94	46.14	37.78	27.66
Random Label Second Set %	12.51	12.48	12.48	12.49	12.51	12.49
Adjacent Error %	30.90	31.75	30.70	29.97	29.46	33.06
Accuracy Within [–45° 45°] %	78.10	70.37	70.64	76.11	67.24	60.71
P-value Second Set	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04
Part2						
Participants	1	2	3	4	5	6
First Set Classification Acc%	55.16	35.33	29.97	45.78	33.45	26.42
Random Label First Set %	12.5	12.52	12.5	12.5	12.51	12.51
Adjacent Error %	27.95	36.54	27.64	33.60	30.71	34.61
Accuracy Within [–45° 45°] %	83.11	71.87	57.61	79.38	64.16	61.03
P-value First Set	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04	p < 2.00e-04

TABLE II
GROUP-LEVEL ICA RESULTS

Set	12345	12346	12356	12456	13456	23456
6th participant's Acc %	28.58	32.24	26.30	19.08	25.74	31.62
Random Labels 6th participant's Acc %	12.48	12.49	12.50	12.49	12.51	12.49
Adjacent Error %	39.15	35.34	34.45	32.75	34.32	36.21
Accuracy Within [–45° 45°] %	70.77	61.08	53.53	59.06	66.56	64.80
P-value Unseen Data	p < 4.00e-04	p < 4.00e-04	p < 4.00e-04	p < 4.00e-04	p < 4.00e-04	p < 4.00e-04

I. Classification Weight-Matrices Analysis

SLR automatically selects the important features for the classification. By analyzing the weight matrices of the classifiers, the clusters most contributive to the classification can be defined and the time periods that were used for the classification can be localized. Each cluster $Clst(t)$ is composed of "n" ICs where $Clst(t) = \frac{1}{n}\sum_{i=1}^{n} IC_i(t)$ where $IC_n(t)$ is the time series of IC_n. Let $Imp_n(t_0)$ be the importance of a time point $IC_n(t_0)$ to the classification. The importance of a time point is defined by the number of classifiers that selected the time point averaged over the cross-validations ($Imp_n(t_0) = \frac{1}{m}\sum_{i=1}^{m} k$) where "m" is the number of cross-validation runs, "k" is the number of classifiers that chose $IC_n(t_0)$ for the classification in a single cross-validation run.

Let $cluster_k(t_0)$ be the importance of $cluster_k$ at time t_0 where $cluster_k(t_0) = \frac{1}{n}\sum_{i=1}^{n} Imp_i(t_0)$. The importance of $cluster_k$ is then the mean importance of its data points. The contribution of each cluster is the ratio of its importance over the total importance of all the clusters.

III. RESULTS

A. ICs Analysis

ICA decomposition for single-participant sets resulted in 128 ICs for each participant except for Participant 3 which had 127 ICs due to the removal of one noisy channel. Out of 1,790 ICs, only 261 were kept after rejecting ICs that represented non-brain signals and ICs where the noise was dominant. The number of accepted ICs ranged from 14 to 38 per dataset. For group-level ICA, the noisy channel of Participant 3 needed to be removed from all datasets due to temporal concatenation resulting in 127 ICs for each dataset. Out of 762 ICs, only 150 were kept. The number of ICs per dataset ranged from 20 to 28. The residual variance is a measure of how well the dipole fit models the data. It is the difference between the projected scalp map from the fitted dipole and the actual scalp map. All the selected ICs from the group-level ICA had a residual variance lower than 30%. For the single-participant ICA, some ICs exceeded the threshold of 30% but were included in the next step because they showed other properties that reflect brain activity such as peaks in the power spectrum at relevant frequencies between 5 Hz and 30 Hz and especially around 10 Hz, a clear ERP response and, ICLabel predicted with more than 70% certainty that they represent brain-activity.

B. Eight-Directions Finger Movement Classification

The classification accuracy of the test sets averaged over the cross-validation runs is shown in Table I for the single-participant ICA and Table II for the group-level ICA. The average classification accuracy of the permutation test is also shown along with the p-values of the null hypothesis that the observed classification accuracy is due to random chance. The

classification accuracy was significantly higher than the chance level ($p < 2.00e-04$ for single-participant ICA and $p < 4.00e-04$ for group-level ICA). Confusion matrix tables (supplementary Fig. 6 for single-participant sets part1, Fig. 7 for single-participant sets part2, and Fig. 8 for temporally concatenated sets) were analyzed to check if there was any pattern in the false-positives. The number of correctly classified trials and false-positives in each direction is shown in Fig. 2 for the single-participant ICA and Fig. 3 for the group-level ICA. The percentage of the adjacent false-positives and the classification accuracy within –45°, 45° of the intended direction is also shown in Table I.

C. Clustering and Contribution Results

The ICs of the 12 single-participant sets were clustered into 16 clusters and the ICs of the 6 temporally combined sets were clustered into 13 clusters. The contribution to the classification of each cluster was computed and the centroid of each cluster was located in the AAL atlas (Fig. 9 for single-participant ICA and Fig. 10 for group-level ICA). For the single-participant sets, the clusters were located in the left lingual, the right superior occipital gyrus, the left precuneus, the right middle temporal gyrus, the right cerebellum crus1, the left fusiform, the right precuneus, the right middle frontal gyrus orbital part, the right superior parietal gyrus, the left middle temporal gyrus, the left precentral gyrus, the left superior frontal gyrus dorsolateral, the right superior temporal gyrus, the left paracentral lobule, the right superior frontal gyrus dorsolateral, and the left median cingulate gyrus in descending order of contribution to the classification. For the group-level ICA, the clusters were in the left lingual, the left inferior occipital gyrus, the right inferior occipital gyrus, the right precuneus, the right postcentral gyrus, the left middle frontal gyrus, the left supramarginal gyrus, the right superior parietal gyrus, the left supplementary motor area (SMA), the left cuneus 1, the left cuneus 2, the right superior temporal gyrus, and the left superior parietal gyrus in descending order of contribution. The importance to the classification of each time point of the cluster is shown in Fig. 4 (a) for single-participant ICA and Fig. 5 (a) for group-level ICA. To further understand the temporal transition of the importance to the classification, the importance of each four consecutive time points was averaged. The time periods of interest are from the cue onset at t = 0 s to the EMG onset around t = 220 ms and from the EMG onset to the cursor onset around t = 450 ms. The results are shown in Fig. 4 (b) for the single-participant ICA and Fig. 5 (b) for the group-level ICA. Ten out of 16 clusters for the single-participant ICA and 11 out of 13 clusters for the group-level ICA were most contributive at t1 = [125 ms to 187.5 ms] before the EMG onset.

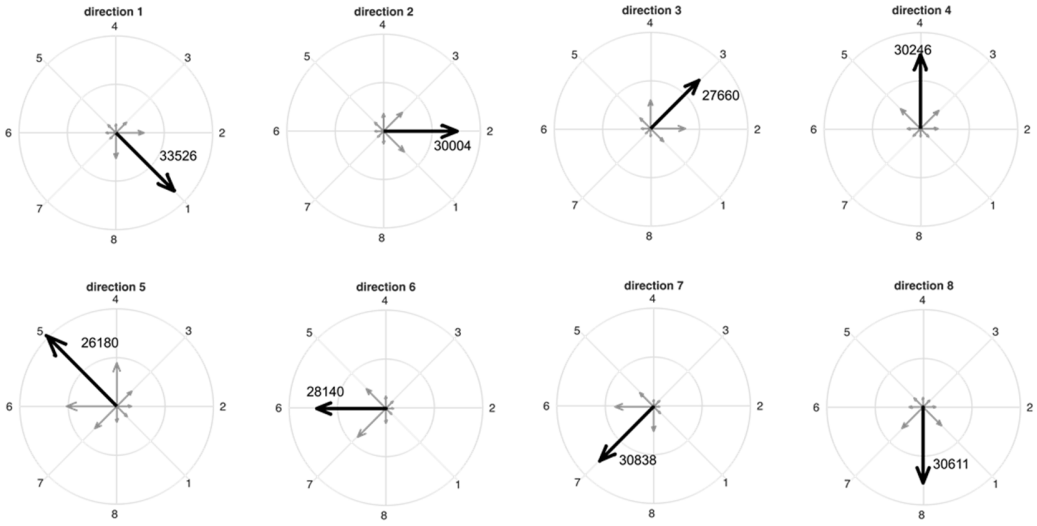

Fig. 2 The number of true-positives and false-positive for each direction for the single-participant ICA. The magnitude of the arrows reflects the number of trials. The dark arrow represents the true direction and the gray arrows represent the false-positives

IV. Discussion

This study aims to elucidate the possibility of using EEG-ICs to predict eight finger movement directions in a real-time prediction manner. In particular, the possibility of using the unmixing matrix W^{-1} that was obtained from applying ICA to an initial set to extract ICs from a different set and predict the finger movement direction of the latter set using classifiers trained using the ICs of the initial set. Single-participant ICA refers to when the set used for obtaining W^{-1} and training the classifiers and the set used for testing originated from the same participant while group-level ICA refers to when the set used for obtaining $W^{-1}$and training the classifier consisted of the temporal concatenation of five sets originating from five different participants while the test set originated from a different participant. Using ICA to unmix brain-signals from other signals of non-interest minimizes the effect of eye movement and other artifacts which allows the classifiers to utilize information related to motion from brain activity. Applying ICA and training a model every time to classify finger motion directions is computationally expensive which makes it not suitable for real-life applications. Therefore, there is value in exploring the possibility of predicting finger

movement direction from an EEG set using the ICA unmixing matrix and the machine learning model that has been trained on a different set. First, this method was applied to data originating from the same participant. The average test classification accuracy from 12 unique training datasets is 38.62 ± 8.36% which was significantly higher (p < 2.00e-04) than classification accuracy from models trained with random labels (12.50 ± 0.01%). In the second part of this study, ICA unmixing matrix and the classifiers were trained using temporally concatenated EEG sets originating from five participants and tested on the remaining sixth participant. The average test accuracy was 27.26 ± 4.39%. The results were lower than the single-participant results but still significantly higher (p < 4.00e-04) than the chance level (12.49 ± 0.01%). Further evaluation of the confusion tables showed that false-positives were concentrated on adjacent directions to the true direction which makes the accuracy of the classifiers within [–45°, 45°] of the true direction 70.03 ± 8.14% for single-participant ICA and 62.63 ± 6.07% for group-level ICA.

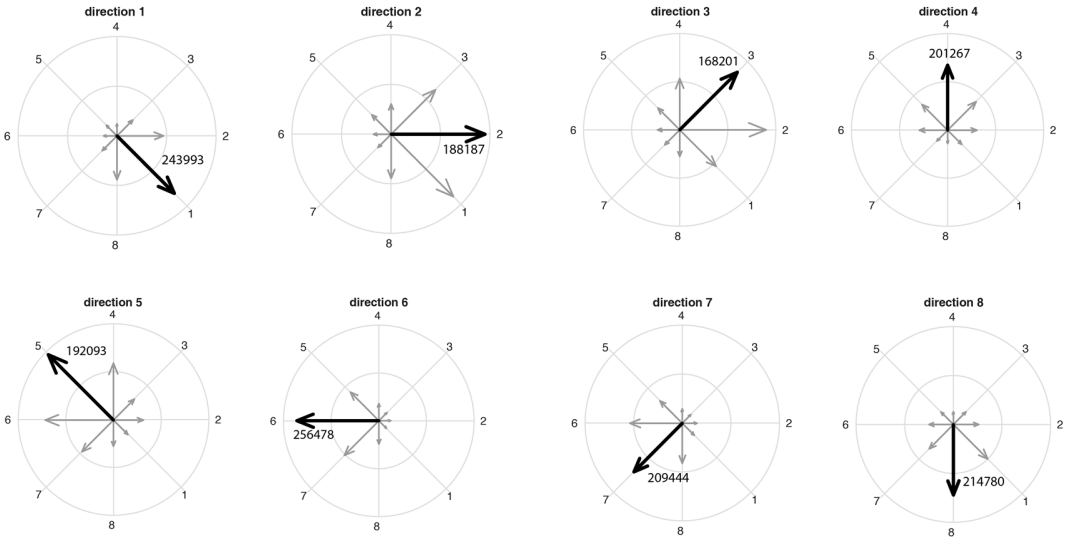

Fig. 3 The number of true-positives and false-positive for each direction for the group-level ICA. The magnitude of the arrows reflects the number of trials. The dark arrow represents the true direction and the gray arrows represent the false-positives

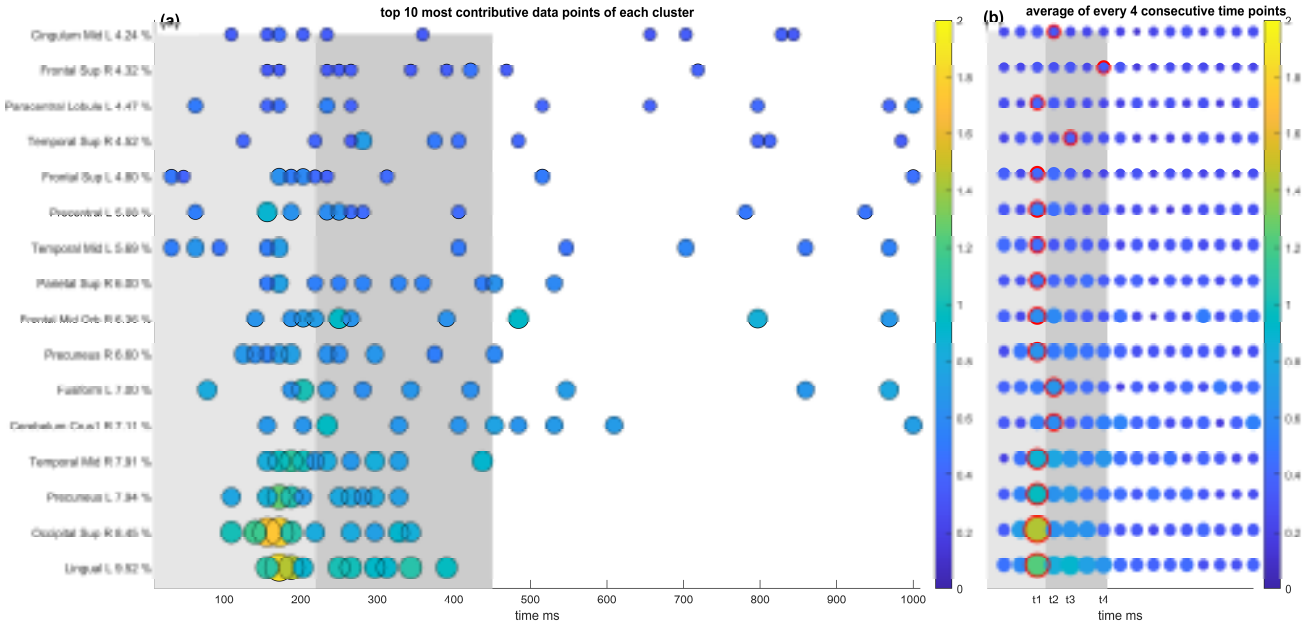

Fig. 4 The clusters of the single-participant ICA. (a) The importance of each data point of each cluster. (b) The average of each four consecutive data points of (a). The clusters are in descending order of contribution. The contribution of each cluster is indicated next to its name. The size and color of each point represent its importance. The unit of the color bar is the number of classifiers that selected the data point averaged over the number of ICs per cluster. The light-shaded area represents the time period between the cue onset at t = 0 ms and the EMG onset at t = 220 ms. The dark-shaded area represents the time period between the EMG onset at t = 220 ms and the cursor onset at t = 450 ms. t_1= [125 ms to 187.5 ms], t_2= [187.5 ms to 250 ms], t_3= [250 ms to 312.5 ms], t_4= [375 ms to 437.5 ms]

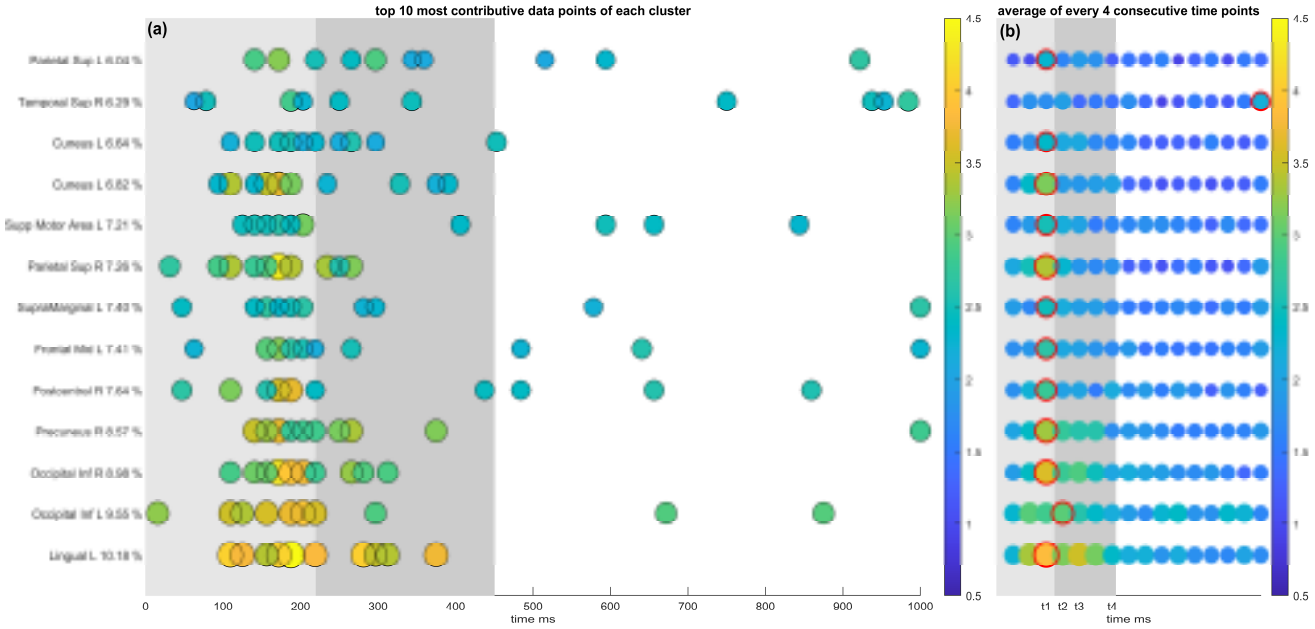

Fig. 5 The clusters of the group-level ICA. (a) The importance of each data point of each cluster. (b) The average of each four consecutive data points of (a). The clusters are in descending order of contribution. The contribution of each cluster is indicated next to its name. The size and color of each point represent its importance. The unit of the color bar is the number of classifiers that selected the data point averaged over the number of ICs per cluster. The light-shaded area represents the time period between the cue onset at t = 0s and the EMG onset at t = 220ms. The dark-shaded area represents the time period between the EMG onset at t = 220 ms and the cursor onset at t = 450 ms. t_1= [125 ms to 187.5 ms], t_2= [187.5 ms to 250 ms], t_3= [250 ms to 312.5 ms], t_4= [375 ms to 437.5 ms]

Most BCI studies focus on large body parts such as classifying simple hand movements [4] and binary reaching tasks [9]. The literature about finger movement classification is very limited and even more so for classifying 8 finger movements. Some studies focused on predicting which finger is moving like [26] where they decoded five finger motions with 54% accuracy while some other studies tried to decode single finger movements. Binary finger movement classification was achieved with 77.11% accuracy in [5] and left vs right index finger movement was classified with 62% accuracy in [27]. One study [28] dealt with classifying four thumb movements achieved an accuracy of 64.6± 3.6. All the previous studies were done offline and the performance in a real-time application was not assessed. For online studies, a cursor could be moved to the right or left with an average accuracy of 75% using invasive electrocorticogram (ECoG) signals [29]. Another study [30] achieved online discrimination between right vs left index finger movement to move a target in the screen to the left or the right with 80% accuracy in seven out of ten participants. Four motions (wrist flexion, extension, and all fingers open, close) were classified from the EEG signal with 78.44% classification accuracy [31]. This study realized the discrimination of eight classes of movement of the same finger where the classification accuracy at the single-participant level is comparable to the classification accuracy of fewer classes in the present literature. Furthermore, to the best of the authors' knowledge, the group-level ICA results are novel and have not been addressed before. The current accuracy may be suitable for some real-life BCI applications.

The clustering analysis revealed the brain regions that were involved in finger movement and the contribution analysis revealed the importance of each cluster and the temporal aspect of the contribution to the classification. 22 out of 29 clusters were most contributive at $t_1 = [125 \text{ ms to } 187.5 \text{ ms}]$ before the EMG onset. The most contributing clusters belonged to the left lingual, the right superior occipital gyrus, the left precuneus, and the right middle temporal gyrus for the single-participant ICA and the left lingual, left inferior occipital gyrus, the right inferior occipital gyrus, and the right precuneus for the group-level ICA. Some of these areas such as the lingual [32] are involved in visuospatial processing which is reasonable. The inferior occipital gyrus is a part of the dorsal visual pathway and the precuneus that is involved in motor coordination that requires shifting attention when making movements [33]. Areas that are involved in motor execution were also observed such as the precentral gyrus (M1) and SMA

This study is a first step towards building a real-time eight-finger movement classification system. Future work would be to evaluate the classification accuracy of real-time EEG.

V. SUPPLEMENTARY FIGURES

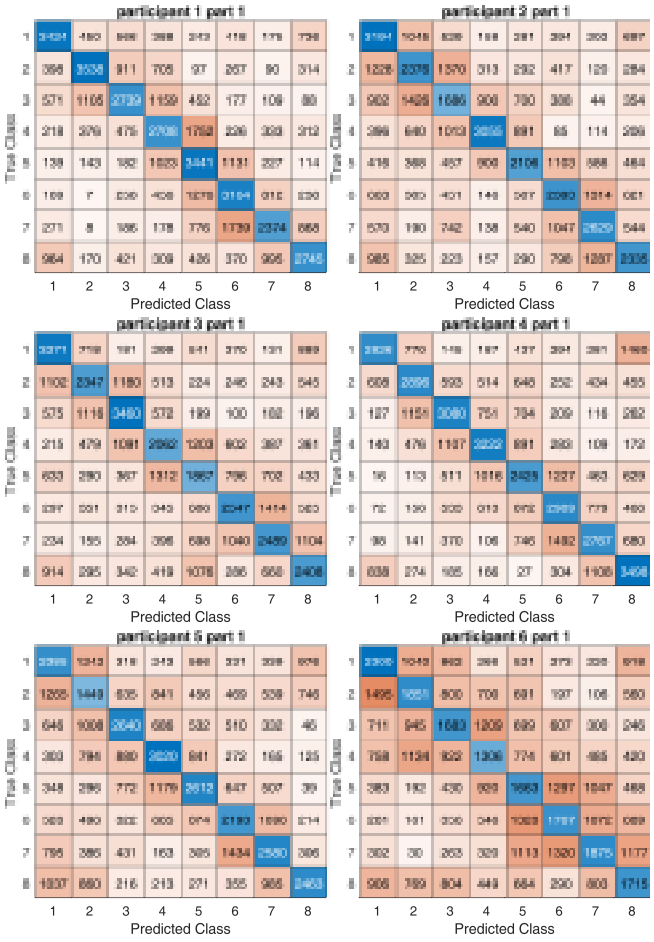

Fig. 6 Confusion tables of the single-participant ICA sets of all participants part 1

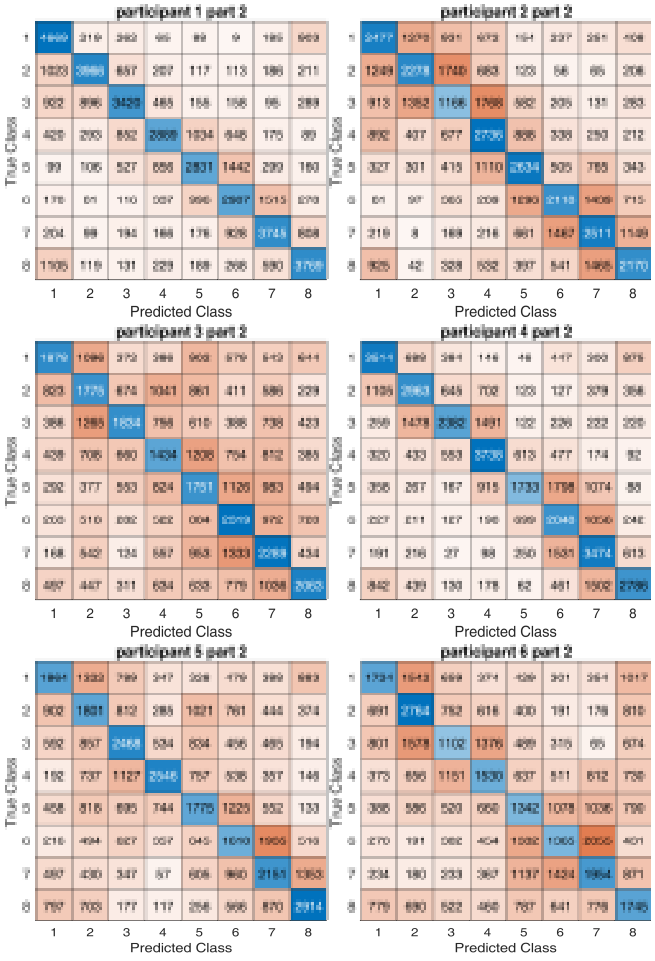

Fig. 7 Confusion tables of the single-participant ICA sets of all participants part 2

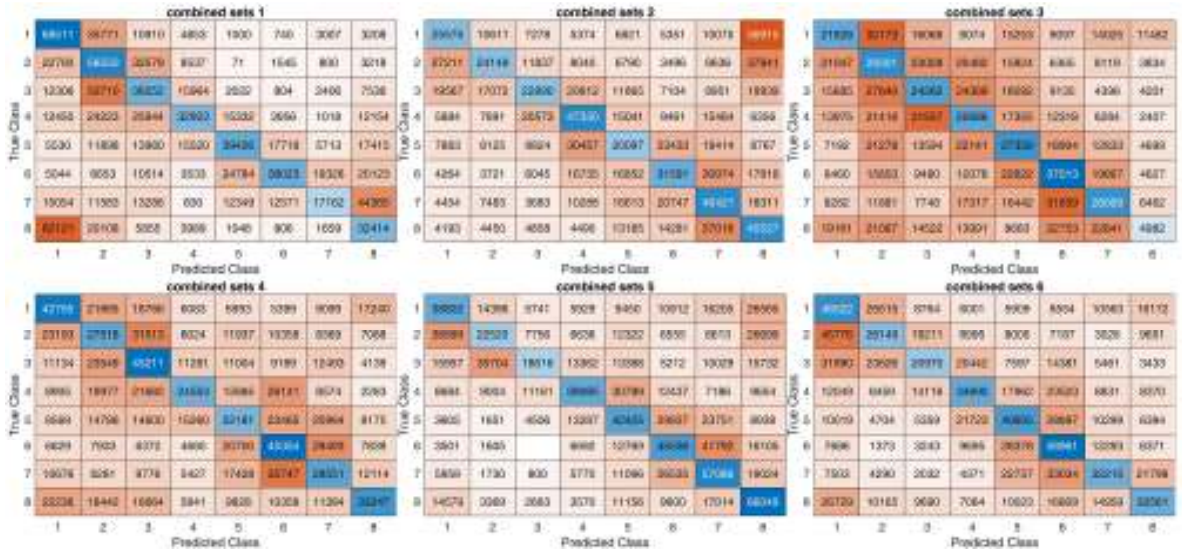

Fig. 8 Confusion tables of the group-level ICA sets

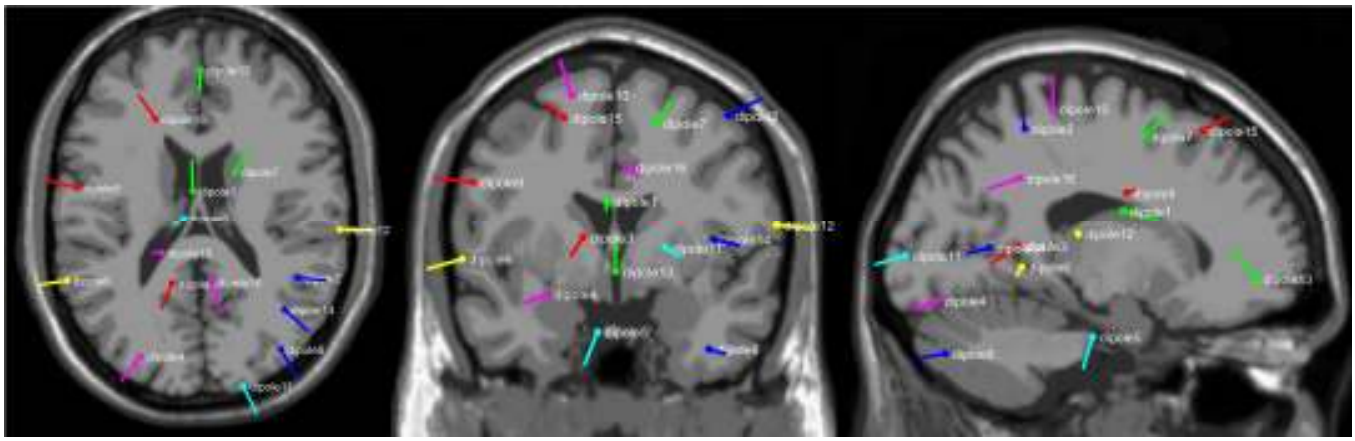

Fig. 9 Locations of the centroids of the single-participant ICA clusters

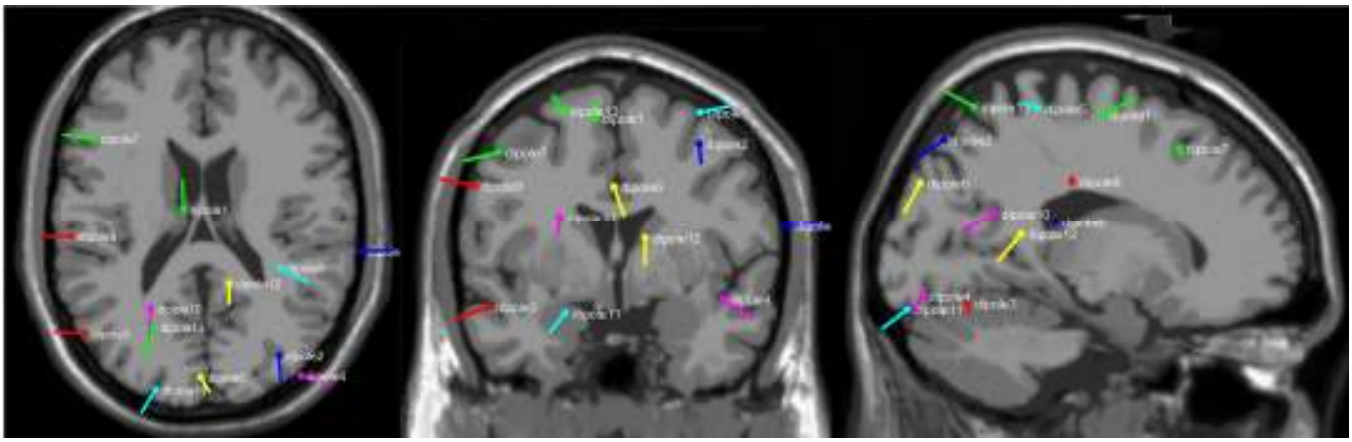

Fig. 10 Location of the centroids of the group-level ICA clusters

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Impact of Audit Committee on Earning Quality of Listed Consumer Goods Companies in Nigeria

Usman Yakubu, Muktar Haruna

***Abstract*—** The paper examines the impact of the audit committee on the earning quality of the listed consumer goods sector in Nigeria. The study used data collected from annual reports and accounts of the 13 sampled companies for the periods 2007 to 2018. Data were analyzed by means of descriptive statistics to provide summary statistics for the variables; also, correlation analysis was carried out using the Pearson correlation technique for the correlation between the dependent and independent variables. Regression was employed using the Generalized Least Square technique since the data has both time series and cross sectional attributes (panel data). It was found out that the audit committee had a positive and significant influence on the earning quality in the listed consumer goods companies in Nigeria. Thus, the study recommends that competency and personal integrity should be the worthwhile attributes to be considered while constituting the committee; this could enhance the quality of accounting information. In addition to that majority of the committee members should be independent directors in order to allow a high level of independency to be exercised.

***Keywords*—** earning quality, corporate governance, audit committee, financial reporting.

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International Financial Reporting Standard Adoption and Value Relevance of Earnings in Listed Consumer Goods Companies in Nigerian

Muktar Haruna

***Abstract*—** This research work examines the International Financial Reporting Standard (IFRS) adoption and value relevance of earnings of listed consumer goods companies in the Nigerian. The population of the study comprises 22 listed consumer goods companies, out of which 15 were selected as sample size of the study. The scope of the study is a 12-year period covering from 2006 to 2018. Secondary data from the annual report of sampled companies were used, which consists of earnings per share (EPS), the book value of equity per share (BVE) as independent variables; firm size (FSZ) as a control variable, and market share price of sampled companies from Nigerian stock exchange as dependent variable. Multiple regressions were used to analyze the data. The results of the study showed that IFRS did not improve the value relevance of earnings after the adoption, which translates to a decrease in value relevance of accounting numbers in the post-adoption period. The major recommendation is that the Nigerian Reporting Council should ensure full compliance to all provisions of IFRS and provide uniformity in the presentation of non-current assets in the statement of financial position, where some present only net current assets leaving individual figures for current assets and liabilities invisible.

***Keywords*—** IFRS, adoption, value relevance, earning per share, book value of equity per share.

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The Second Intifada and the Israeli-palestinian Conflict

Yilin Wang

***Abstract*—** In the following paper, I will examine the effects that the Second Intifada had upon the Israeli-Palestinian conflict by arguing that the intifada was caused by several different factors. After providing a brief overview of the Second Intifada, the present paper will contend that while Sharon's actions stood as the catalysts behind the outbreak of renewed violence, it was ultimately the failures of past peace attempts aimed at addressing the occupation that formed the most significant discontent leading to the intifada. The multiple failures of resolving the conflict through peace efforts placed the occupation of the West Bank at the center of the conflict and led to increased confidence that violence was a viable solution to end the conflict. Finally, I will argue that behind the significance of Sharon's actions stands the larger reality that a significant aspect of the conflict is the failure of both sides to decide how to share the holy city of Jerusalem. Ultimately, Sharon's actions only showed that the question of how to share religious space would need to play an important role in future attempts to resolve the conflict.

***Keywords*—** Israel, Palestine, Peace and conflict, Second Intifada.

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The Underlying Causes of the Second Intifada

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***Abstract*—** The Second Intifada is a period of intense conflict between Israel and the state of Palestine at the beginning of the 21st century. By the end of the Second Intifada many would ask about the exact causes of the new wave of conflict. While Sharon's visit to the Temple Mount formed an iconic moment and undoubtedly contributed to the break out of violence, the following paper will argue that there were three deeper interrelated causes that stood behind the eruption of the violence. Such causes include the failure of previous peace processes to resolve the occupation of the West Bank, the continuation of the policy of building Settlements in the occupied territories, and the religious role that Jerusalem has played in the question of how to share and administer the city politically. After providing a brief history of the Second Intifada, the following paper will analyze each of these factors with the goal of explaining how they contributed to the outbreak of violence during the Second Intifada. Understanding the real causes of this event will provide us with a clearer sense of what we need to do in the future to resolve and conflicts and achieve peace truly.

***Keywords*—** International Relations, Israeli-Palestinian Conflict, Middle East, The Second Intifada.

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Evidence From The Field: The Case Study Of *Golitos* As An Effective Soccer Program for ASD Children

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***Abstract*—**Physical activity can reduce symptomatology in children with autism spectrum disorder (ASD). The sport of soccer has been widely applied as a therapeutic method for ASD children. However, empirical results from soccer programs are not widely known. This paper presents the case study of *Golitos*, the only dedicated soccer program for children on the island of Puerto Rico and analyzes its results in the reduction of ASD social and emotional symptoms. The paper shows evidence that suggests that program approach, content and community-based elements can make a notable difference in the effectiveness of using soccer or sports as therapeutic methods for children with ASD.

***Keywords*—**sports, autism, soccer, community-based

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Comparison of Sedentary Behavior and Physical Activity between Children with Autism Spectrum Disorder and the Controls

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***Abstract*—** Background: A growing body of research has suggested that physical activities (PA) have important implications for improving the performance of ASD children. They revealed that the physiological, cognitive, psychological, and behavioral functioning had improved after performing some physical activities. Methods: We compared the sedentary behavior and physical activities between children with autism spectrum disorder (n=21) and age-matched control group (n=30), using the ActiGraph GT3X+ for the assessments. Results: Our results revealed that the total time spent in sedentary activity and the total sedentary activity counts were highly significant in the control group compared to the ASD group ($p < 0.001$, $p=0.001$, respectively). ASD spent a significantly longer time than the controls engaging on vigorous physical activity (VPA) ($p=0.017$). The results also indicated that there were no significant differences between both groups for the total counts and time spent in light physical activity (LPA) and moderate physical activity (MPA). Conclusion: The finding highlights the importance of physical activity intervention for ASD children, using accurate and precise measurement tools to record all activities.

***Keywords*—** Autism spectrum disorders, motor skills, physical activity, ActiGraph GT3X+, moderate-to vigorous-intensity physical activity.

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Drug Addiction: The Effects It Has on Pregnancy

Sharon Campbell-Phillips, Serlange Campbell, Daneil Phillips

***Abstract*—** Drug addiction is a global problem that is escalating, and it is negatively affecting families and society at large. For the purpose of this study, the focus is on alcohol, and it seeks to investigate if alcohol consumption affects fetal development. There are many types of drugs available to persons, both legal and illegal, and they affect the human body in various ways. Drug abuse usually leads to addiction, which involves the repeat and excessive use as a way of giving pleasure or a reason to escape reality despite its destructive effects, Environmental Health Perspectives (2005). Drug addicts believe that drugs are necessary for them to have a feeling of well-being, New Insight in to Drug Addiction, and Self-Control (2008). To acquire the data needed for this study, questionnaires was administered to pregnant women on the island of Tobago. The data was analyzed and will be used for future research.

***Keywords*—** drug addiction, alcohol, pregnancy, health.

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A Survey of Early Screen Exposure during Infancy and Autism

I. Mahmood

***Abstract*—**This survey was conducted to explore the hypothesis that excessive screen exposure combined with a subsequent decrease in parent-child interaction during infancy might be associated with autism. The main questions being asked are: Were children with autism exposed to long hours of screen time during the first 2 years of life? And what was the reason(s) for exposure at such an early age? Other variables were also addressed in this survey. An Arabic questionnaire was administered online (June 2019) via a Facebook page, relatively well-known in Arab countries. 1725 parents of children diagnosed with autism participated in this survey. Results show that 80.9% of children surveyed who were diagnosed with autism had been exposed to screens for long periods of time during the first 2 years of life. It can be inferred from the results of this survey that over-exposure to screens disrupt the parent-child interaction which is shown to be associated with ASD. The results of this survey highlight the harmful effects of screen exposure during infancy and the importance of parent-child interaction during the critical period of brain development. This paper attempts to further explore the connection between parent-child interaction and ASD, as well as serve as a call for further research and investigation of the relation between screens and parent-child interactions during infancy and Autism.

***Keywords*—**Attachment disorder, autism, screen exposure, virtual autism.

I. Introduction

AUTISM spectrum disorder (ASD) begins early in life and is characterized by deficits in social interaction, communication, and restricted and repetitive patterns of behavior [1]. Audiovisual stimulus (AV) refers to smartphones, tablets, television, video games, computers, and any type of screens.

A. Satellite TV, Children's Television Channels, AV Stimulation, and Autism

Many believe that the rise in autism cases correlates with the increased opportunities of very young children to watch TV and the increased popularity in children's TV programming, DVDs, VCRs, and video/computer games [2].

During the 1990s, Arabic satellite television broadcasting emerged, and it became the most powerful of all media instruments in Arab society. The pioneers of specialized Arabic children's channels were American companies involved in the children's television business. In 1996, Nickelodeon Arabia was first launched, followed by Disney Channel Middle East in 1997. In 2000, SpaceToon TV was launched as the first Arabic-owned children's television channel [3].

The first Arabic autism center was established in the Kingdom of Saudi Arabia in 1992 [4]. More autism centers began to open in other Arabic countries due to the increased demand for such services, which was especially prominent towards the end of the 1990s. Following this trend, it has been noted that the interest in ASD has increased in Arab society, especially in Saudi Arabia and Egypt. This is evident through the increase in research on ASD over recent years. Though the interest has increased, research on ASD in Arabic countries is still at its infancy and requires stronger support for it to be productive [5].

In 2002, a report from Saudi Arabia stated that there were 42,500 confirmed cases of autism with many remaining undiagnosed [6] whereas in 2010, a study published on the prevalence of autism in the Sultanate of Oman stated that the overall prevalence of ASD in children aged 0–14 years old was 1.4 cases per 10,000 children, but noted that the low prevalence was most likely due to under-reporting and under-diagnosing [7]. Following in suit, in 2014, a systematic review of the prevalence of Autism in Arab Gulf countries reported that the prevalence of ASD in Bahrain was 4.3 cases per 10,000 children, while in UAE (with the use of a random sample of 3-year-old UAE nationals) it was 29 cases per 10,000 children [8].

It was suggested that screen viewing during infancy is a dose-related environmental exposure factor that is contributing to the rise of autism in the last 25 years [9]. Excessive exposure to an AV (such as TV) in combination with lack of opportunities to socialize with peers, as well as inadequate interactive relationships with family during the developmental years of childhood, which includes speech development, were all found to be related to the development of autism [10].

B. Screen and Autism

Many studies have reported a correlation between screen consumption and autism [11]-[19]. A recent study conducted by Heffler and her colleagues from Drexel University in Philadelphia found that TV and/or video viewing at 12 months old was heavily associated with a greater display of ASD-like symptoms at 2 years of age [14]. This conclusion was also reached and confirmed by another study conducted in Indonesia [15].

A comparative study conducted by Cahid from Bezmialem University School of Medicine in Istanbul, Turkey, on the television viewing habits of children with ASD versus children who had no diagnosis, concluded that the sample of children with ASD had the highest percentage of children who consumed TV before the age of 12 months [16].

Chonchaiya from the Department of Pediatrics in Chulalongkorn University, Bangkok, Thailand, concluded in an article published in 2011 that there are earlier onset and higher frequency of television viewing in children with autism

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compared to neurotypical children [17].

Zamfir, a clinical psychologist from Spiru Haret University (Bucharest), found that excessive consumption of virtual environments between 0 and 3 years old, cumulative with a genetic predisposition, can produce a neuro-cognitive structure typically for children with ASD. This was dubbed virtual autism [18].

In 2012, a study was conducted in Qatar using a control group of children with no diagnosis and a group of children with autism. These authors concluded that the children in the autism group spent more time on TV prior to 3 years old compared to the control group [19].

C. Screen - Children's Health and Development

Childhood is a time of significant development in the brain's anatomical structure and connectivity [20]. Brain plasticity during the first 2 years of life is particularly sensitive to the social-affective environment [21].

Rapid brain development occurs during infancy, more specifically, during the first year of life. The total brain volume at 2–4 weeks is approximately 36% of the adult volume, and by the first year, it reaches 72% of adult volume [22].

The use of screens might have harmful effects on the health and development of children [23]-[32]. In 2004, a study by the department of pediatrics at the University of Washington concluded that the more TV watched by infants aged 1-3, the more likely they were to develop problems with attention [33]. It has been suggested by other studies that increased screen time in children is associated with negative health outcomes, for example, impairment in language development, decreased cognitive ability, autism-like symptoms, such as short attention span, and hyperactivity [34], [35].

A study in China on pre-school children concluded that the more exposure to screen time in combination with shorter sleep duration at night, the more likely they were to develop behavioral problems [36].

A recent study obtained brain scans of children aged 3 to 5 years found that children who consumed more than the recommended 1 h of screen time during the day had less development in their brain's white matter, which is an area that is key in the development of literacy, language, and cognitive skills [37].

D. Parents' Attitude toward Screen

Screen viewing now begins in infancy with new research finding that the prevalence of screen viewing in children aged under 2 years 'is high and appears to increase steadily across age groups', with TVs and mobile devices being the most commonly used [38]. Tomopoulos and his colleagues reported that screen viewing began in children as young as 6 months old [28].

In the US, media usage in children aged 2-4 years old increased from 39% to 80% between 2011 and 2013 [39]. A recent study in the UK noted that 51% of children aged 6 to 11 months old consumed touch-screen media every day [40].

There is a correlation between parental attitudes towards screens and the amount of screen exposure children receive. It has been reported by parents that the TV is viewed as a peacemaker in the household, and safe activity for their children while they are busy getting ready for the day, doing household chores, or preparing dinner [40].

A positive correlation has been found between screen time for children under 3 years of age, and the parental belief that the child enjoys TV [42], [43], the parental belief of the educational value of TV [42], [44] and the decreased duration of infant crying [45], in addition to shorter breastfeeding times [46].

E. Screen and Parental Sensitivity (Attachment Theory)

Parental sensitivity is the key to secure child-parent attachment relationships. Ainsworth defined parental sensitivity as the ability to perceive and interpret the child's signals accurately and respond to these signals in an adequate, prompt manner [47].

Secure children have experienced that their parents usually perceive and understand their distress, and that their needs are adequately met. Insecurely attached children tend to have less positive and supportive experience with their parents. Secure attachment is not only important for children's current well-being, but also for their later development [48].

Winnicott, a pediatrician and psychoanalyst, also described the importance of maternal caregiving behavior. Winnicott specifically described "holding" the child, both physically and within the mind, as an essential component of maternal care that serves to facilitate the development of early emotional capacities [49].

A study conducted by the Department of Pediatrics in Tohoku University concluded that attachment disorder and early exposure to media causes autism-like symptoms [50]. Audiovisual screen experiences take up time that could be used for social interaction; also, it cannot replace the quality of in-person social interaction [51], [52].

Parent-infant interactions are critical for child development. Children who spent ≥ 3 hours per day viewing screens had a language delay, short attention span, hyperactivity, and it negatively affects parent-child interaction during the exposure [53]. Lack of parental sensitivity has been shown to increase the possibility of developing psychopathology later in the child's life [54].

Screen exposure in early childhood, including background TV exposure, decreases the quantity and quality of interactions between parents and children, which has been shown to impact the development of the child [55]-[61].

F. Other Variables in the Survey

A comparative study on the prevalence of ASD links it according to feeding habits of infants at the time of birth (if they were breastfed, bottle-fed breast milk, or bottle-fed formula) concluded that there is an association between ASD and formula-fed children or those who were weaned off breastfeeding early. It was also revealed that increased duration of child breastfeeding decreased the prevalence of ASD [62].

II. Survey Result

This survey was undertaken to determine whether excessive screen exposure and lack of parent-child interaction in infancy could be associated with Autism disorder. In addition to that, some other variables were addressed in this survey.

An Arabic-language questionnaire was administered online via a relatively well-known autism community Facebook page in Arab countries. The survey was conducted in June 2019. Responses were received from 1725 parents of children that have been diagnosed with autism. Parents answered the questions of the survey using multiple choice answers and were also provided with the option to write custom answers if they felt that the standard answers provided were not sufficient or did not describe them accurately.

Seven questions were addressed:

1- Was your child exposed to any type of screen for long hours during the first 2 years of life (TV, iPad, Mobile, etc.)? If yes, what was the reason?
2- When did you notice that your child had a problem?
3- Was the mother suffering from general health, psychological or social problems during the first 2 years of the child's life?
4- Did the mother breastfeed the baby for the first 2 years?
5- Was the mother working or studying during the first 2 years of the child's life?
6- Who cared for the child during the first 2 years of their life?
7- Was the mother or father taking psychotropic drugs?

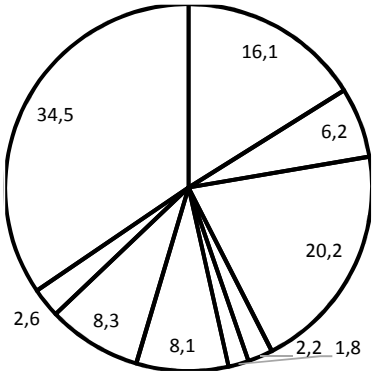

Fig. 1 Percentage breakdown of answers to the main question of whether the children are exposed to long hours of screen time during the first 2 years of life. Also shows the percentage breakdown for reasons (cited by parents) why the children of survey participants were subjected to screens for long hours during the first 2 years of life. 16.1% No, while 80.9% answered Yes.

The results indicated that 80.9% of the children diagnosed with autism had been exposed to long hours of screen time during the first 2 years of their life.

The main reasons cited by the parents were to keep the child occupied, avoid having them cry or move around too much, keeping them entertained and safe, or simply because the mother or caregiver was preoccupied [Fig. 1].

More than one-third (34.5%) of the parents thought that their children enjoyed their time watching TV. One-fifth (20.2%) were trying to keep them quiet, not moving around, and crying too much. Some (8.3%) got exposed to screens for long hours because mothers or caregivers were preoccupied with their other children and other responsibilities (babysitter). Some (8.1%) mentioned that the guardian that took care of children in the absence of the caregiver (housekeeper, grandparents, father) was keeping the child occupied by using TV to keep him or her quiet and safe (babysitter). Some (6.2%) believed that their children were learning from TV and Ipads and they would grow up smart because of this.

4% kept their child occupied with screens either because the child was physically ill or the mother was ill, and she could not take care of the child. Few mothers (2.6%) mentioned different reasons for early long hours of the screen including: older siblings who babysat the child were watching TV for long hours, and therefore the child got the same exposure; the mother was busy studying; because of war/country issues, families stayed at home all the time to be safe, and the TV was the only joy; the TV was on all day at home (background TV), and the baby was present; blind children enjoyed listening to the TV sound.

A. Other Variables Included in the Survey

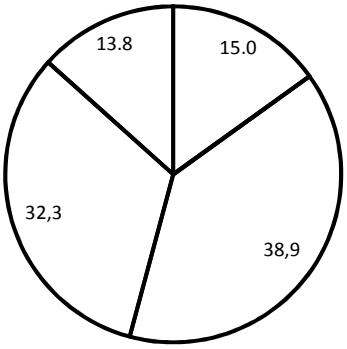

Fig. 2 The percentage breakdown of parents' responses to the question "when did you notice your child had difficulties?". 13.8% Before 1 year of age.38.9% Before 2 years of age. 32.3% After 2 years of age. 15.0% After 3 years of age

Among the mothers, 37.7% noticed their child had a problem before 2 years of age, 32.9% noticed the problem after 2 years of age, 15.1% noticed the problem after 3 years of age, and only 14.2% noticed their child had problems at an early age (less than 1 year of age) [Fig. 2].

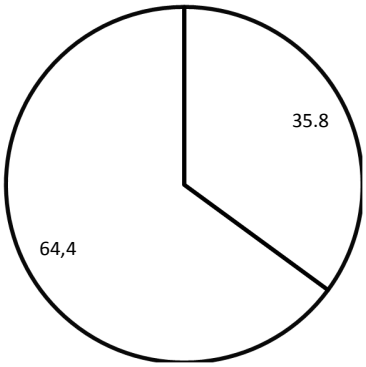

Fig. 3 The percentage of responses to the question of "Was the child's mother suffering from health, psychological, or social problems during the first two years of the child's life?". 35.8% Yes. 64.4% No

Among the respondents, 35.8% of the mothers were suffering from health, psychological, or social problems during the first 2 years of the child's life [Fig. 3].

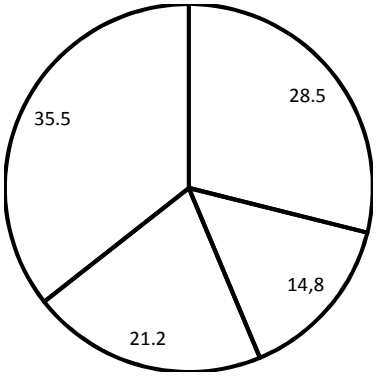

Fig. 4 Percentage breakdown of responses to the question of whether the mother completed breastfeeding and how long breastfeeding of the child lasted. 28.5% Yes. 14.8% Never been breast fed. 35.5% Less than one year. 21.2% One year only

35.6% of mothers breastfed their babies for less than 1 year, and 20.7% for 1 year, 14.8% of mothers never breastfed their child, while only 28.9% completed 2 years of breastfeeding [Fig. 4].

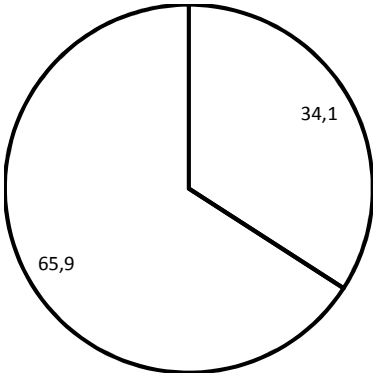

Fig. 5 Percentage breakdown of responses by parents to the question of whether the mother was busy with work or studies during the first 2 years of her child's life. 34.1% Yes. 65.9% No

35% percent of mothers were working or studying during the first 2 years of their child's life [Fig. 5].

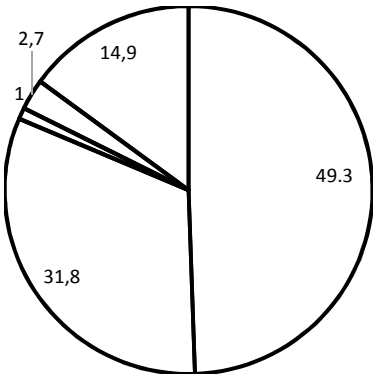

Fig. 6 Percentage breakdown of responses by parents to the question of "Who cared for the child during the first two years of life?". 49.3% Mother and Father. 31.8% Mother only. 1% Father only. 2.7% Other (mother is absent). 14.9% Mother with others (Grandparents, Nanny, Nursery, Other relatives)

Around half (49.3%) answered that both parents were responsible for taking care of the child, 31.8% answer that only the mother took responsibility, and 14.9% answered that guardians other than parents (Grandparents, Nanny, Nursery, Other relatives) took care of the child [Fig. 6].

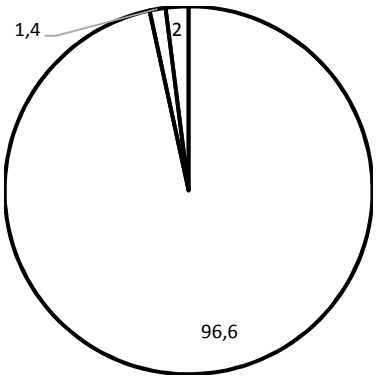

Fig. 7 Percentage breakdown of responses by parents to the question of whether either parent was taking psychotropic drugs. 96.6% No. 1.4 Yes, Mother. 2% Yes, Father

Only 3.4% answered yes to the question of whether either mother or father was taking psychotropic drugs. It is also important to address the context in which this question was asked, as this was addressed to audiences from Arab countries, where mental illnesses are viewed as taboo [Fig. 7].

III. Discussion

Our findings indicate that 80.9% of the children diagnosed with autism have been exposed to long hours of screen time during the first 2 years of their life. This is evidence supporting the hypothesis that exposing infants and toddlers to long hours on screens is associated with autism disorder/

autism-like symptoms. This is consistent with the findings of many research papers from multiple countries on this topic [9]-[19].

A. The Trap

Screen consumption for children in Arab societies began when it entered the mainstream media, after its prevalence increased in the West. At the beginning of the 1990s, satellite channels became more accessible to the masses, which was around the same time, cases of autism began to appear in children.

In 1991, the Middle East Broadcasting Channel, also known as MBC, was established by Saudi Arabia, making it the first privately owned Arabic satellite TV station. Its target audience was primarily the pan-Arab audience, and its launch paved the way for more satellite launches in the 1990s [63], [64]. However, the boom in children's Arabic TV programming took place in the mid-2000s when broadcasting companies began marketing to children as consumers to advertise children's toys, candy, cereal, and more. By the end of 2000, there were more than 20 Arabic television channels with a target audience of pre-school children and older [65].

A strong advertising campaign by broadcasting companies, as well as TV program creators marketing their shows and channels towards parents, claimed that they have the potential for educational value by introducing social values, and teaching academic and cognitive knowledge. Advertisers capitalized on families' desire to promote their children's cognitive development by presenting and citing non-specific brain research to convince them to buy their products (DVDs, T programs, apps) [66].

We believe that parents were deceived by these broadcasting/program companies into thinking that there is no real harm to screen exposure from a young age, resulting in the overexposure of infants to audiovisual stimulation in hopes of educational benefits as well as providing pleasure for their children [67]. When mothers were asked about the beliefs of TV and video consumption by infants and toddlers, most reported positive beliefs [68], illustrating the lack of hesitation by parents in exposing their children to screens.

In addition to false information on the effects of screens, the nature of life has changed progressively. Parents were busy with the demands of their jobs, or were engaging in overconsumption of screens and technological devices, such that they must find a way to occupy their child's time. This is in addition to the fact that during the first 2 years, children begin to move and explore their surroundings, expose themselves to risks, and have tantrums [69], [70]. Therefore, screens would be used to preoccupy them. One of the reasons cited by the parents who participated in the survey was that they used the TV as a way to occupy their child's attention in order to have them be less mobile around the house in order to ensure that they will be safe at all times without worrying about them.

Beyens and Eggermont's findings in 2014 [71] coincide with the results of our survey, where parents indicated that their children were exposed to screens during the first 2 years of life as they were using screens to occupy their child while they or other caregivers were preoccupied. In addition to that, the survey revealed that infants would receive the same amount of screen exposure as their older sibling that is consuming TV while babysitting them.

Parents have fallen so deep into the trap of screens to the point where it is hard to stop consuming them even if they had believed in the negative effects associated with screen consumption in the early years. This is illustrated in a study done by Cingel and Krcmar that concluded that although parents have reservations on the effects of TV on their young ones, they found it hard to refrain from using media as it was an integral part of their child-rearing routine [72].

B. The Phenomenon of "unintentionally emotionally absent parents!"

It has been suggested by attachment theorists that the quality of parent-child interaction is an important aspect of healthy development. Usually, a newborn baby would be the center of attention for the entire family. As such, those surrounding the baby would be the most influential and engaging in the environment [73].

A paper by Delmolino and Harris concluded that infants grow and learn through emotional interactions with the people in their environment and their surroundings [74]. The quality of parent-child interaction, as well as the child's experiences with their environment during the first 3 years of life, contribute greatly to the growth of the brain, including social and emotional growth, intellectual functioning, and language use [75].

Our survey revealed that 80.9% of the children diagnosed with autism had been exposed to long hours of screen time during the first 2 years of their life. Many studies have confirmed that screen exposure decreases the time available in the day for social interaction with the parents, thereby decreasing the quality of parent-child interaction [55]-[61].

In 2019, a study from Chulalongkorn University's Faculty of Medicine determined that positive mother-child interactions were associated with low screen consumption by children in early childhood [76], and we believe that this is the case with the 80.9% of the children diagnosed with autism, as mentioned above.

By looking at the reasons mentioned in this survey for screen exposure during infancy, it could be deduced that there was a lack of social communication with the infant during hours of screen exposure and attachment to screens disrupts the parent-child interaction. A decision was made to name this phenomenon, "unintentionally emotionally absent parent(s)".

The resulting phenomenon experienced by these children and their parents is an attachment disorder that occurs "unintentionally". A study in Tohoku University's Department of Pediatrics revealed that attachment disorders and media exposure are linked, causing Autism-like symptoms [50].

When toddlers and infants spend hours at screens, it deprives them of the time to experience their world and have continuous communication with their caregiver, leaving them with only the experience of sounds and images emanating

from the screen which do not engage in social communication with the child and is, therefore, of no use to the child's development. The child's senses of touch and smell are not engaged, and there is no direct eye contact occurring when sitting in front of a screen. This fact was further proven through research conducted by ophthalmologist Heffler from Drexel University College of Medicine, where she stated that the attention of the vulnerable infant is taken away from social interactions and instead put to focus on electric toys, TV, and other media screens [9].

C. Sensory Dysregulation

Sensory dysregulation during the early progression of ASD has an impact on social functioning, and this was concluded in a 2017 study describing the multiple mechanisms in which sensory dysregulation in ASD could trigger a cascade leading to social deficits throughout development [77]. We believe that sitting in front of screens for long hours during the first 2 years of life is one of the leading causes of sensory dysregulation. Studies also show that environmental enhancement results in increased dendritic branching in cortical neurons, among many other neurobiological changes [78], [79]. This was shown through a study displaying the overstimulation of newborn mice, which lead to deficits in cognitive performance and the behavioral difference compared to the negative control. This suggests that an excess of non-normative stimulation during critical times in the development of the brain demonstrates harmful effects on the subsequent neurocognitive function [80].

It is possible that an imbalance of age-appropriate sensory input in infants and toddlers in combination with lack of communication with caregivers leads to hindrance in brain development during a critical stage and that this is the main reason for autism.

D. Other Variables in the Survey

Our results show that there was a significant association between autism and breastfeeding, which is compatible with the findings of research conducted by Shafai and his colleagues, where they reported a strong correlation between ASD in children who were fed with formula from birth or weaned off breast milk early. Data from Shafai et al. revealed that increasing the duration of breastfeeding resulted in a decrease in the prevalence of ASD [62]. Only 28.8% of mothers that participated in our survey have completed 2 years of breastfeeding for their child, while 56.7% of mothers breastfeed their children for less than a year, and 14.9% never breastfed their child. Kangaroo bonding/attachment is affected.

There was no significant correlation found in our study between children with autism and if their mothers were working, studying, or their parents' general and mental health. About 34.1% of mothers were working/studying during the first two years of their child's life, and only 35.8% of mothers in the survey suffered from physiological, psychological, or social problems during the first two years of the child's life, and only 3.4% of them answered yes to the question of whether the mother or father were taking psychotropic drugs during the first 2 years of the child's life.

IV. Conclusion and Recommendation

The result of this survey indicates that the majority of children diagnosed with autism in Arab countries have been exposed to long hours of screen time during the first two years of their life. This is consistent with the findings of many research papers from multiple countries on the same topic. The exposure to screens was not only an imbalance of age-appropriate sensory input that leads to hindrance in brain development during this critical stage, but also the excessive screen time disrupts the parent-child interaction leading to an attachment disorder. Therefore, it can be inferred from these results that excessive screen exposure and the subsequent decrease in parent-child interaction might be associated with ASD.

V. Recommendation

Based on our findings, we recommend providing education to parents on the importance of parent-child interactions and brain development during the early years of child development, as well as the dangers of screen exposure on child development during this critical stage. This education should be part of programs offered by maternity and childhood care centers and should be distributed in the form of leaflets given to mothers during their periodic visits to gynecologists, pediatricians, and/or maternity and child care centers. Also, pediatricians and family physicians play a huge role in preventative healthcare, and should help warn mothers of the dangers of excessive screen exposure at a young age. How much and when this screen exposure occurred in early childhood should be one of the questions posed to parents during routine physicals of the child or in the event of the appearance of early signs of ASD in children.

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Gender Roles and Expectations of Romantic Partner in India: An Explorative Study

Diya Chacko

***Abstract*—** The current paper attempts to gain an understanding of the dynamics of dating and choosing partners which tends to focus one influence of factors such as the family environment (relationship with parents', marital issues in family), peer relationships, and cultural factors within an Indian context. India being a collectivistic society that is ingrained in patriarchy, the prevalent gender norms promotes expectations in relationships that perpetuate gender-specific behaviors, consequently allowing the exploitation and subordination of respective partner. Moreover, the literature also suggests that the prevalence of gender roles tend to have a larger impact on the female population as they are more vulnerable. Thus, the understanding of the influence of gender roles on expectations of romantic partner could challenge the patriarchal standards and allow the empowerment of women. Majority of studies related to gender and its influences have only utilize samples of Western youth to understand the dynamics and these understandings are not generalizable to other societies and this paper explores the same.

***Keywords*—** Gender Roles, India, Internalization, Patriarchy , Relationship.

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China and the Middle East in the 21st Century: From Political Mediation to Economic Expansionism

Ali Asghar Sotoudeh

***Abstract*—** Mediation Diplomacy has emerged as one of the main pillars of China's foreign policy goals and practices, and Beijing has established itself as a peacekeeping force in regional conflicts and crises such as Afghanistan, Syria, Sudan, Yemen, and the Arab-Israeli peace process. China is deepening and intensifying its diplomatic interventions in the Middle East and trying to shape the security and political developments in the Middle East. On the other hand, economically, China has become one of the most important trading partners with Middle Eastern governments. China is also seeking to expand its foreign policy and economic interests in the Middle East through the New Silk Road initiative and has signed cooperation agreements with 17 Arab countries. In this regard, due to the importance of the subject, this research focuses on answering this question; what is the basis of China's political mediation and economic expansionism in the Middle East? In parallel with this question, this study follows the hypothesis that the mediating role of peace is a legitimate way for China to intervene in Middle East political crises, Without causing China to deviate from its traditional guiding principles based on non-interference in the internal affairs of other actors in the international system. This policy also promotes the security of economic interests and increases the country's political influence in the Middle East. The research method is descriptive-analytical based on the qualitative method, and the data collection method is library and internet resources.

***Keywords*—** China, middle east, political mediation, economic expansionism.

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The Belt and Road Initiative : An Assessment of One of the Principal Chinese Economic and Foreign Policies Strategy in a Context of Power Competition between China and the United States of America

Napoleon Vigny Epansang Mbee

***Abstract*—** How can we understand the Chinese Belt Road Initiative (BRI) in the context of the US-China competition within the 21st century? Since its launch by Xi Jinping in 2013, the BRI appears to be an important tool to explain how, through the diffusion of alternative norms, values and pratices, China aims to resolve some of its domestic and external challenges including those imposed by its main competitor named the United States of America. The aim of this work is to inquire the BRI by situating it in the context of the ongoing competition with the USA. In facts, why there is a debate about the real objectives of such a huge project, our ambition is to go beyond clivages and present the One Belt one Road initiatives as an opportunity for cooperation than a source of more rivalries between the two great powers. Through the secondary sources data analysis, our preliminary results show that there are legitimate reasons for the US to have some concerns about the geopolitical advantages that the project may provide to China. However, instead of using a conflictual approach towards the BRI, the two countries should perceive it as a way to reinforce their cooperation and provide the world with public goods it needs. The immensity of the project and the potential impacts on the global world commend an appropriation of the project by the two in other to build an integrated world order given the fact in the current context none of them, alone, can solve the world problems.

***Keywords*—** Belt and Road Initiatives, China, Cooperation, Power Competition, USA.

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Seam Slippage of Light Woven Fabrics with Regards to Sewing Parameters

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***Abstract*—** Seams are the basic component in a structure of any apparel. The seam quality of garment is a term that indicates both aesthetic and functional performance of the garment. Seam slippage is one of the important properties that determine garment performance. Light weight fabrics are preferred for their aesthetic properties. Since seam slippage is one of the most occurable faults for woven garments. In this study a design of experiment of the following sewing parameters (three levels of needle size, three levels of stitch density, three levels of seam allowance, two levels of sewing thread count, and two fabric types) was used to obtain the effect of the interaction between different sewing parameters on seam slippage force. Two light weight polyester woven fabrics with different constructions were used with lock stitch 301 to perform this study. Regression equations which can predict seam slippage force in both warp and weft directions were concluded. It was found that fabric type has a significant positive effect on seam slippage force in warp direction, while it has a significant negative effect on seam slippage force on weft direction. Also the interaction between needle size and stitch density has a significant positive effect on seam slippage force on warp direction, while the interaction between stitch density and seam allowance has a negative effect on seam slippage force in weft direction.

***Keywords*—** needle size, regression equation, seam allowance, seam slippage, stitch density.

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Deposition of TiO2 and ZnO NPs onto the Manufactured Polyester Fabrics Designed for Multi-functional Purpose Focused on Medical Textiles

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***Abstract*—**Medical textiles required an essential properties to achieve its functional performance efficiency, nowadays nano particles plays an important role in textile applications to improve its properties. In this research four manufactured polyester fabrics were used with different specifications using plain 1/1 structure. Two nano particles (TiO2 and Zno NPs) were used for treating the manufactured samples, different properties (Self-cleaning, UV-resistance, hydrophobicity, and antibacterial) were measured, also some mechanical properties were performed to measure the performance for each type of nano particles for samples before and after treatment. Scanning electron microscope were done to show the effect of nano particles on samples.

***Keywords*—**Nano Particles, Medical Textiles, Polyester, Microfiber, Treatment.

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Prediction of Drapability of Cotton/Polyester Blend Fabrics from Fabric Low Stress Mechanical properties

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***Abstract*—** Drape is considered as one of the most important aesthetic properties of garments. It is the key factor for garment simulation soft wares. The drapability of a fabric indicates a manner of how the fabric falls, gathers, shapes or flows with gravity on a model form or on a human body when part of it is directly supported. Fabric drape behaviour is very important as it is the main contributory factor in designing and retailing garments. Since many factors affect fabric drape. The effect of fabric mechanical properties as measured by FAST (Fabric Assurance by Simple Testing) on fabric drape coefficient was studied for 52 fabric samples made from cotton, polyester fabrics and their blends. The drape coefficient of fabrics were measured on a drape tester designed and constructed by the author using image capturing system and image processing softwares. A multiple linear regression for the 52 fabric samples under study was applied. A significant regression equation with R^2=0.9 was obtained. It was found that the percentage cotton, bending length in both warp and weft directions, extensions at low loads in both warp and weft directions, extension at bias direction (which indicates fabric shear rigidity), fabric formability in both directions, and fabric weight are the factors affecting the drape coefficient. An ANN feed-forward back propagation was used to predict the drape coefficient from the 18 FAST mechanical properties and the percentage cotton. The ability of both regression analysis and artificial neural network (ANN) to predict the drape coefficient from FAST mechanical properties was investigated. It was found that both regression analysis and artificial neural network can predict the fabric drape coefficient from FAST mechanical properties with correlation coefficient 0.81 between observed and estimated values in case of regression analysis and correlation coefficient 0.79 between observed and estimated values in case of ANN. The percentage cotton has a major effect on the drape coefficient. The higher the percentage cotton the higher the drape coefficient therefore the lower the fabric drapability.

***Keywords*—** Artificial neural network (ANN), drape coefficient, FAST mechanical properties, multiple linear regression.

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Characterization the Properties of Blended Single Jersey Fabrics using Various Microfiber Yarn Cross-sections

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***Abstract*—** Due to increase in consumers' requirements, and achieving their satisfaction, the new types of fiber were developed to improve fabric properties in the last few decades. Generally, many manufactories attend to use cotton as a blended material to enhance the properties of the products. Now a day, several types of polyester microfiber have appeared with their novel properties, therefore it has become necessary to characterize these fabrics in order to meet customers' needs and remain market share. The main purpose of this article is to present the influence of microfiber cross sections and machine gauges on the functional properties of knitted samples. In this study two groups of single jersey knitted samples were manufactured, six samples were produced using gauge 24 while the other six samples were produced using gauge 20. Polyester microfiber with different cross-sections as well as polyester microfibers blended cotton used as materials for two groups. Some functional properties such as Air permeability, Spray test, Bursting strength, and roughness for face and backsides were carried out for all samples. The results values were statistically analyzed using ANOVA test to identify the significant effect of materials and machine gauges on the functional properties. Furthermore, the radar chart area was performed to declare samples rate.

***Keywords*—** Cross-section, Knitted fabric, Microfiber yarn, Polyester, Single Jersey.

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Improving the Protection of Architecture Textiles against Ultraviolet a Radiation on the Grab Tensile Strength Test Coated Polyurethane

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***Abstract*—**Ultraviolet rays had an influence on different tissues, especially those that was exposed to direct sunlight. It was demonstrated that the amount of the ultraviolet radiation (UVR) which reaches the Earth from the sun light was represented 95% of UVA. Architecture textiles were one of different types of technical textiles that were exposed to direct ultra violet radiation, as these textiles were used to shadow open places including stadiums, malls, car parking, building roofs, etc,,,. In this research two high performance fabrics were used with two different materials (Ballistic Nylon- Cordura) and yarn counts, the samples were treated with knife coating and fluorocarbon, the additional of fluorocarbon was to increase the water repellency, water proof and fire retardant of fabrics, after that polyurethane treatment were applied. The samples were exposed to artificial UVA radiation in UV exposure cabinet for 80.4 hours equivalent to one year outdoor exposure, grab tensile strength test was applied for samples before and after coating, also after exposure. Measurements results were statistically analysis using Independent-Samples T Test for all samples, the results values show that there is no significant difference between samples treated and exposed to UVA exposure due to the great effect of textile and treatment materials. Scanning electron microscope was conducted for all samples to show its surface morphology.

***Keywords*—** Architecture, Exposure, Grab Tensile Strength, Scanning Electron Microscope, UVA Radiation.

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Mechanical Characterization of Polymer-reinforced Glass Fibers Composites (PRGFs) and Nanocrystalline Titanium Dioxide

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***Abstract*—** Glass fibers considered as the most important reinforced composite material used in different polymer products in order to maintain light weight and strong materials. In this experiment nine types of synthetic polymers were used as a coating materials to provide a good dynamic load for the glass fabric mesh, Breaking load property was studied before and after coating (treatment). S-B5% represented the highest breaking load due to it is possess highest breaking load value in addition to the highest result of elongation comparable with other series of mixes. Anova One-way was used to study the difference between variables, the results show that there is a significant effect after applying different synthetic polymers.

***Keywords*—** Dynamic Loading, Glass Fiber, Nanocrystalline, Polymer-reinforced

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Increase In Reliability by SFR CT Analysis: Case Study

Yuvraj Singh Rajput

***Abstract*—** Mining Industries are known for their rouge and behavioral operation with the invertible mine condition and operation. Mining operation mainly sequence with drilling, mucking and Hauling cycle.

Hauling is the key activity to be regularizes and strengthen to achieve all time-based activity at all sub level which include production and development.

Further development is key for sustainable production and mine life.

However, Reliability of the equipment is major concern when equipment in operation. In underground mine working hours (Running Hours of equipment) are key factor to utilized to increase the shift productivity. Any breakdown at peak hour will derail the shift plan specially in Load Haul Dump (Scooptrams).

In underground mining equipment Scooptrams are key equipment which helps in Development of mine and production of Mine. This equipment provide position to drills and other service equipment to utilized. One scooptram breakdown make multiple LPDT (Low profile Dump trucks), Development drills etc.

On analysis three years of financial year starting from Commissioning of equipment with 12000 hours. it was revealed that significant Contribution of downtime in LHD is related to engine , hoses and failure in the Load frame breakdown by perato analysis .Further scrutiny through Comparison Matrix Analysis of the given factors revealed the average life of frame structure is 10000 Hours in similar condition in same class of equipment.

This analysis is beneficial to allow equipment owners and mine owners to articulate there strategy on the critical issues hampering the reliability of Scooptrams and re-design the equipment. Utilizing the scooptram analysis of all the downtime factors obtained, spares consumed, technical design changes in the Scooptram.

Reliability of the equipment is defined as frequency of breakdown in terms of operating hours i.e Mean Time Between Failure (MTBF)

Reliability of the equipment is also linked with Mean Time To Restore (MTTR) time which has been taken to rectify the breakdown

Breakdown is any unplanned shutdown of equipment which result in production loss.

***Keywords*—**About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

In past few year , Increase in the exponential growth of underground mine operation and technologies. Mine equipment are design with more complex strength and sophisticated equipment. To meet with the business requirement to escalate the tonnages plans. This in turns makes it extremely cost ineffective to move the other equipment which in turns disturb the planned operation. Making stand by equipment is also not viable considering the idling cost is very high.

As fall in prices of the metal have force the miners globally to undergo to reduction in the revenue cost to sustain .OEE of equipment is best tool to increase the revenue and decrease in production cost, for any mine HEMM maintenance cost is almost 15 % of mine production cost . 1. To enhance the reliability of LHD while in peak hours of operation to maintain the rhythm of operation. 2. To sustain the demand of the mine its difficult task for maintenance team to attend and reduce the MTTR for any breakdown as mine operate at various position spread over mRL in different blocks. 3.Unplanned stoppage (Breakdown) of equipment change the proactive schedule maintenance of fleet of equipment. 4. This paper include analysis of nature of same breakdown i.e breakdown at the cause level in particular object (subcomponent) on SFR CT concept. 5.Frequent breakdown of equipment for the same cause of object drive more focus on engineering team to re-design that cause of failure to eliminate the failure. 6. With analysis and force diagram this page include the strengthen the basic design of equipment to increase the reliability of equipment.

SFR CT concept is a systematic approach to analysis in any equipment to component which has been most time-consuming breakdown while equipment in operation.

S: Is subcomponent number of equipment which is predefine by divided into the subcomponent.

F: Is mode of failure or position of failure which is define with particular number

R: Rectification done like replace, repair, reseal etc. define with particular number

C: Count of breakdown for S F R chart

T: Average time taken for rectification for Number of counts for S F R chart

Engineering department have to check the Multiplication of C and T number for particular S F R chart to get the maximum down time for particular cause in same assembly at particular point and drive the attention towards the same .

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II. USE OF METHOD

A. Case study

The study has been carried out at Hindustan Zinc (A flagship company of Vedanata Resources plc) operated Rajpura Dariba Lead Zinc Mines (RDM) in Dariba, Rajasthan. RDM is an underground zinc and lead mine, while also producing silver as the by product. The mine has an annual ore production of roughly 1.08 Mt per annum. The mining method implemented for extraction in the mine is cut and fill mining. Simultaneous operations in the form of development of drives and galleries and the ore production from the mining stope take place in the mine. The material extracted after drilling and blasting is hauled from the draw points to the ore passes by the LHDs. The ore from the ore pass is filled into LPDTs, which further haul the ore to the surface-based stockpiles.

The equipment studied in the paper consists of Epiroc manufactured haulage machines. Eiroc made machines consisted of 7 ,10 and 15 tonnes capacity LHDs, 30 tonnes capacity LPDTs, 40 tonnes capacity LPDTs and 65 tonnes capacity LPDTs. All the equipment is maintained and inspected by the respective manufacturers (OEM) in their workshops at mine site.

The scheduled maintenance operations carried out by equipment manufacturers are pursued on the basis of regular time-based engine running hours of each machine which has been implemented by maintenance manual. After every week, 250, 500 ,1000, 1500 and 4000 engine running hours of the machine, there is a scheduled maintenance of 4, 6, 8, 24 ,36 and 48 hours for the respective machine. Apart from that before every shift 30 minutes of pre-shift checkup is carried for each machine.

B. Data Collection

The data collected from the mine consisted of shift wise downtime data for each of the haulage equipment operating in the mine over the course of 12 months i.e January 1, 2019 until December 31, 2019. The data depicted the time span and the occurrence date of each downtime event for each of the haulage equipment in the mine. The Daily shift reports maintained by equipment manufacturers for their daily shift wise equipment maintenance and inspection carried out in their respective workshops were studied for the given 12 months period. The alarm logs data depicting the alarm signals and warnings for different critical components in the machine were also analyzed for the given equipment.

Apart from that the equipment wise productivity, availability and utilization data were studied for last 12 months in addition to the daily price statistics of the zinc, lead and silver prices for the given time scale. Lastly the consumption statistics of the spares used by the equipment manufacturers during the events of downtime and scheduled maintenance operations of the machines.

C. SFR CT ANALYSIS

The downtime events in the equipment were segregated in SFR table by analysis of manual and breakdown event which is progressive in nature.

C: count i.e number of breakdowns
T: Average time if SFR breakdown
CT: C* T (Product of C AND T)

Table: I SFR code

Data has been collected over 4 no of fleet equipment i.e. ST1030 :1 ,2 3 and 6 running fleet and data are below as tabulated

Table: II

Data from Jan'19 to August '19:

Following are the criteria for collecting the data which will affect the shift planning.

1. NO breakdown more than 7 hours to be calculated as shift hour is 8.
2. Operation damage is not been consider in calculation the table
3. Failure or replacement of major component
4. Planned maintenance
5. Proactive maintenance
6. RCA,Backlog clearing ,SOS reports implementation.

III. HELPFUL HINTS

A. Table I

Name	Unique Code (S)
Engine	1000
Daily/Gen Checking	1010
Air Induction / Exhaust System	1050
Fuel System	1250
Engine Cooling System	1350
General Elec System	1400
Starting System	1450
Rod Changer	2701
Feed Assembly	2702
Drifter	2703
Drilling Hydr System	2705
Console Assembly	2706
Cable / Winch Control	2710
Power Extractor	2711
Feed Assembly	2712
Diesel Power Train	2713
Wire Rope	2714
Electrical Power Pack	2715
Canopy Module	2716
Transmission	3000
Water Pump	3004

Rock Tools	3010
Torque Converter	3100
Axle	3250
Drive Line	3500
Steering System/Articulation	4100
Wheel/Tyre	4200
Braking System	4250
Lubrication System	4500
Jack	4510
General Hydr System	5050
Hose Puncture/leakage	5060
Cylinder	5100
Air Conditioning	5600
Bucket Attachment/System	6000
Dump box/System	6300
Compressor	6500
Frame	7050
Cabin	7060
Fire Protection	7400

Name	Unique Code (F)
Power Pack or Cylinder Liner/Piston Group.	1
Flywheel Housing, Cylinder Head.	2
Front & Rear Covers, Crank Shaft.	3
Cam Shaft.	4
Air Cleaner / Precleaner.	5
Turbo Charge. Inlet Manifold, Exhaust Manifold / Pipe.	6
Muffler.After Cooler	7
Fuel Pumps, Fuel Injector Nozzles.	8
Fuel Transfer Pump / Priming Pump.	9
Fuel Shut Off Selenoid. Filter, Throttle. Fuel Tanks.	10
Engine Fuel Lines.	11
Radiator, Expansion Tank, Thermostat, Fan.	12
V-Belts, Belt Tightener, Fan Drive, Fan Guard.	13
Water Pump, Water Manifold, Aftercooler Water Pump	14
Hydraulic Oil Cooler, Engine Oil Cooler.	15
Engine Indicator Flash, Battery Cables.	16
Altenator, Wiring Harness, Disconnect Switch.	17
Altenator Pulley, Start Relay.	18
Lights, Strobe Light, Stop / Tail Lights, Flood Lights	19
Battery, Starting Motor, Ether Starting Aid.	20
Air Start Motor Tank, Start Selenoid.	21
Transfer Gears/Case, Trans. Oil Filter, Lines/Hoses.	22
Transmission (Control, Oil Pump, Control Valve).	23
Torque Conventer (Wiring Harness, Scavenge Pump).	24
Retarder, Torque Conventer Lines/Hoses.	25
Drive Shaft. U-Joint, Drive Chains.	26
Pin.Bushes.Valve.Line Hoses.Pressure Accumulator.	27
Adapter Assy	
Steering Pillar.	28
Rim, Tire, Wheel (Studs, Nuts, Bolts), Mud Guards.	29
Brake (Drum, Shoes, Linning, Disc).	30
Master Cylinder Brake, Wheel Cylinder.	31
Brake Slake Adapter, Brake Accumulator.Parking Brake.	32
Boom attachment	33
Brake Hoses/Lines.Grid Resistor, Spindle.	34
Hydraulic (Tank, Control Valves, Accumulator, Filter).	35
Vane Pump, Pilot Control Valve, Implement Control.	36
Main Relief Valves, Implement Pump, Flow Amplifier.	37
Hydraulic (Filter, Hoses/Lines, Motor).	38
Lift / Hoist Cylinder.	39
Tilt / Dump Cylinder.	40
Steering Cylinder.	41
Side Dump Cylinder.	42
Lift Kickout Control.	43
Hydraulic oil leaking. Hydr Hose Leaking	44
Adapter.Compressor.Protective Hoses	45
Bucket, Dump Body, Ripper, Blade, Push Arms.	46
Pin.Bushes	
Drawbar, Circle Assembly, Lift Fork, Ripper.	47

Filter.Motor	48
Main Frame, Loader Frame, Carbody, Bumper.	49
Hitch, Counterweight, Axle Box, Ripper Frame.	50
Glass, Door Lock, Hinge Door,Seat Operator,Suspension	51
Fire Suppression System	52
Differential, Axles (Shafts, Housing Assembly, Trunion).	53
Differential Lock. Oscillation cradle	54

Name	Unique code (R)
Worn Out	1
Leakage	2
Damage	3
Fail	4
Loose	5
broken	6
crack	7

Table II : Showing breakdown in each equipment Number

ST 1030 :1				
S	F	R	C	T
1000	0007	0004	1	6
3000	0023	0005	2	3
6000	0033	0006	12	7
3500	0026	0001	2	5
3500	0026	0005	1	8
1400	0016	0005	1	3
1400	0017	0005	2	5
1400	0018	0006	1	4

ST 1030 :2				
S	F	R	C	T
1450	0007	0004	2	2
1250	0023	0005	1	5
2706	0033	0006	3	3
4500	0035	0006	2	5
5060	0038	0005	1	2
5060	0038	0001	1	2
5060	0038	0002	2	5
5060	0038	0004	1	1
6000	0033	0006	6	6

ST 1030 :6				
S	F	R	C	T
4200	0029	0006	1	2
5060	0034	0005	2	1
5100	0041	0001	1	3
5060	0039	0004	3	4
6000	0033	0006	8	7
7400	0052	0002	1	6

ST 1030 :3				
S	F	R	C	T
1000	0005	0001	2	2
1350	0006	0007	1	7
1450	0011	0005	1	6
3500	0026	0006	1	4
6000	0033	0006	2	6

Above are the breakdown which has decrease the reliability of equipment and disturb the shift planning.

By putting all the breakdown on one table and calculating C* T for each SFR

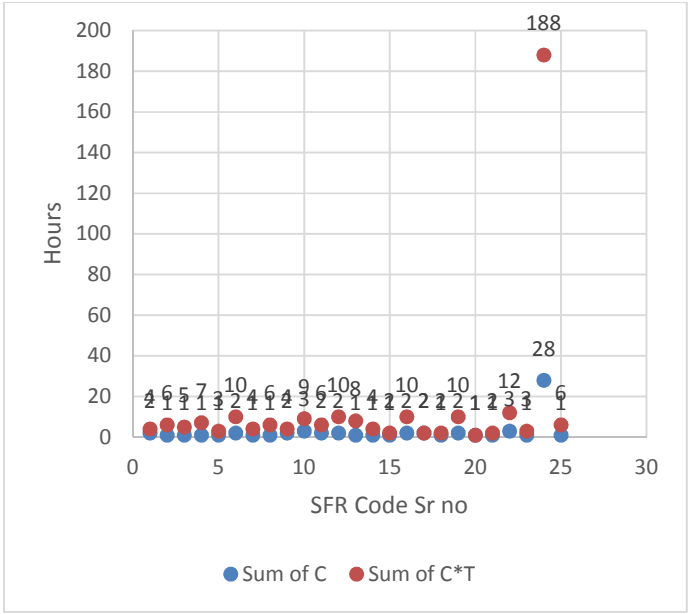
Table III: SRF code table calculation

ST 1030						
S	F	R	SFR Code	C	T	C*T
4200	29	6	4200296	1	2	2
1000	7	4	100074	1	6	6
1000	5	1	100051	2	2	4
1250	23	5	1250235	1	5	5
1350	6	7	135067	1	7	7
1400	16	5	1400165	1	3	3
1400	17	5	1400175	2	5	10
1400	18	6	1400186	1	4	4
1450	7	4	145074	2	2	4
1450	11	5	1450115	1	6	6
2706	33	6	2706336	3	3	9
3000	23	5	3000235	2	3	6
3500	26	1	3500261	2	5	10
3500	26	5	3500265	1	8	8
3500	26	6	3500266	1	4	4
4500	35	6	4500356	2	5	10
5060	34	5	5060345	2	1	2
5060	39	4	5060394	3	4	12
5060	38	5	5060385	1	2	2
5060	38	1	5060381	1	2	2
5060	38	2	5060382	2	5	10
5060	38	4	5060384	1	1	1
5100	41	1	5100411	1	3	3
6000	33	6	6000336	8	7	56
6000	33	6	6000336	12	7	84
6000	33	6	6000336	6	6	36
6000	33	6	6000336	2	6	12
7400	52	2	7400522	1	6	6

Table : IV Sum of breakdown against each SFR code

SFR Code	Sum of C	Sum of C*T
100051	2	4
100074	1	6
1250235	1	5
135067	1	7
1400165	1	3
1400175	2	10
1400186	1	4
1450115	1	6
145074	2	4
2706336	3	9
3000235	2	6
3500261	2	10
3500265	1	8
3500266	1	4
4200296	1	2
4500356	2	10
5060345	2	2
5060381	1	2
5060382	2	10
5060384	1	1
5060385	1	2
5060394	3	12
5100411	1	3
6000336	28	188
7400522	1	6

Chart: I Showing maximum count and hours of SFR number.



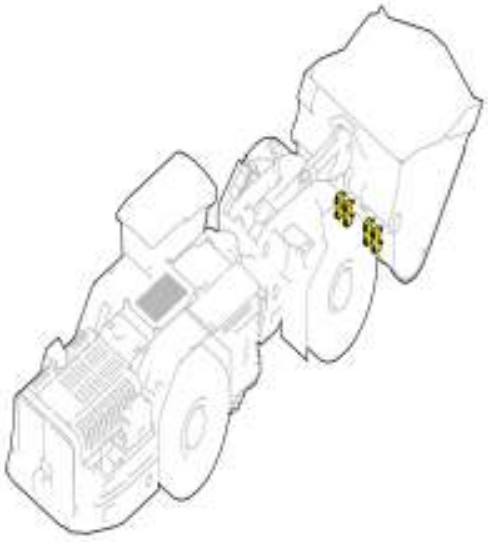
IV. DISCUSSION:

Ref to Chart: I

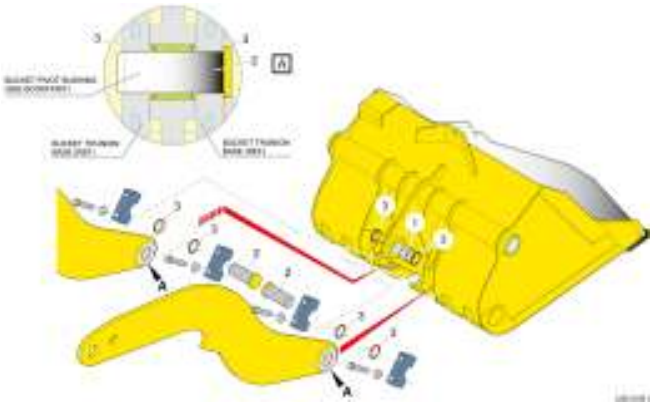
Sr No: 25 S: 6000 R: 0033 F: 0006 Contribute 44 % of total number of breakdown count and 58 % of total running breakdown.

Above ref will get the attention from the engineering team to drive elimination solution for SRF : 6000 0033 006 number

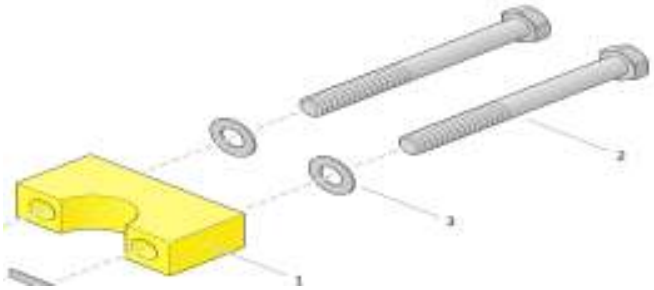
Pic: I Shows position of above SFR



Pic: II Shows the SFR 6000-0033-0006 parts details



PIC III: showing joints detail



Screw: 02 number fails while mucking and broken.

On checking found: These Screw are been checked every week in weekly maintenance but broke frequently.

On check design of the these while loading of bucket boom movement force direct outside and result in broken of bolts. As direct stress is applied on the screw which is weakest link of assembly. On new design to avoid the direct load on these bolts may result in avoiding or eliminating these failures by removing the bolts and casting complete new one frame.

Pic: IV Point from where bolt broken

Position from where screw broken and position of bolt

Pic: V Modified bucket to transfer the forces around the bucket:

Eliminate the screw from the design and converted into one piece avoid any joint to the load frame result in common distribution of forces over complete body

Above design change has been done in LHD: ST1030: 6 as it contributes the maximum breakdown for above SFR.

V CONCLUSION:

Below table shows the breakdown record for the all equipment for same SFR value from period of September'19 to December'19

Table: IV Breakdown details of SFR

SFR	S:6000	F:0033	R:0006
Machine	C	T	C*T
ST1030:1	3	6	18
ST1030:2	4	5	20
ST1030:3	3	7	21
ST1030:6	0	0	0

Breakdown of the screw broken are eliminated completely in ST1030 :6 equipment and provide addition hours of production .and shift planning.

Above study has pointed out the key area of engineering focus for all the loading equipment in the mine through step wise analysis of the critical downtimes impacting the equipment .The study has a potential to assist the mine engineering team to focus on specific critical area in the machine and look into design the particular point to eliminate the breakdown or device the preventive maintenance plan . The SFR CT procedure is advantageous for the maintenance engineering team to improve the productivity of shift.

VI ACKNOWLEDGMENT

I take this opportunity to be grateful toward the mine management and employees of Rajpura Dariba Mine for their immense efforts and patience to help collect the required filed data to pursue this study. This study would not have been possible without OEM and fabrication team with regular feedback

Analysis of Electromechanical Torsional Vibration in Large-power AC Drive System Based on Virtual Inertia Control

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Abstract — A method based on virtual inertia for suppressing electromechanical torsional vibration of a large-power AC drive system is presented in this paper. The main drive system of the rolling mill is the research object, and a two-inertia elastic model is established to study the mechanism of electromechanical torsional vibration. The improvement is made based on the control of the load observer. The virtual inertia control ratio K is added to the speed forward channel, and the feedback loop adds 1-K to design virtual inertia control. The control method combines the advantages of the positive and negative feedback control of the load observer, can achieve the purpose of controlling the moment of inertia of the motor from the perspective of electrical control, and effectively suppress oscillation.

Keywords—Electromechanical torsional vibration, large-power AC drive system , load observer, simulation design.

I. INTRODUCTION

The large-power AC drive system is wide. In the transportation field, it is the core equipment for high-speed train traction; in the energy industry, it is the technical key to energy saving and emission reduction. In the steel industry, the accuracy and dynamic response of the main drive system of the rolling mill directly affects the quality and production efficiency of the product. This paper takes the main transmission system of the rolling mill as the research object. In the literature [1], the two-inertia rigid model is used as an example to study: Based on the principle of disturbance invariance, the positive feedback control of the load observer is designed to reduce the dynamic speed drop caused by the disturbance greatly. But it cannot effectively suppress the oscillation; the negative feedback control of the load observer can effectively suppress the oscillation caused by external disturbance, but it exacerbates the dynamic speed drop of the system. On this basis, establish a two-inertia elastic model, study the electromechanical characteristics of the elastic model. To improve the control of the load observer, add the virtual inertia control ratio K, realize the change of the motor inertia through the control of K. Finally achieve the suppression of electromechanical torsional vibration purpose. The effectiveness of virtual inertia control is verified by simulation and experimental waveforms.

II. TWO-INERTIA SYSTEM MODEL

This paper takes the main transmission system of a rolling mill as an example. The actual main transmission system of a rolling mill is a "multi-inertia elastic system". For the convenience of analysis, the main transmission system of the rolling mill is simplified as a motor and load connected through an intermediate elastic shaft. The two-inertia mode[2], as shown in the figure 1:

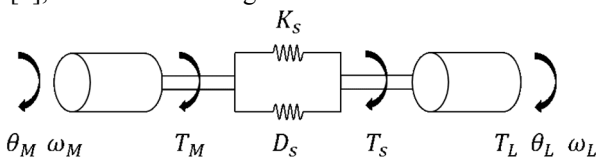


Fig. 1. Two- inertia Model

In figure 1, T_M is the motor torque, T_L is the load torque, T_S is the connecting shaft torque, K_S is the connecting shaft rigidity, D_S is the connecting shaft damping coefficient, ω_M and θ_M are the motor speed, ω_L and θ_L are the load speed.

The transfer function of the motor side is:

$$\frac{\omega_M}{T_M}=\frac{1}{(J_M+J_L)s}\frac{J_L s^2+D_S s+K_S}{\frac{J_M J_L}{J_M+J_L}s^2+D_S s+K_S} \quad (1)$$

J_M is the motor inertia, J_L is the load inertia.

The transfer function of the load side is:

$$\frac{\omega_L}{T_M}=\frac{1}{(J_M+J_L)s}\frac{D_S s+K_S}{\frac{J_M J_L}{J_M+J_L}s^2+D_S s+K_S} \quad (2)$$

The resonant frequency is $\omega_r=\sqrt{\frac{K_S(J_M+J_L)}{J_M J_L}}$,the anti-resonance frequency is $\omega_a=\sqrt{\frac{K_S}{J_L}}$,the resonance damping coefficient is $\zeta_r=\frac{1}{2}D_S\sqrt{\frac{J_M+J_L}{K_S J_M J_L}}$

In the two-inertia model, when the mechanical parameters change, the electromechanical performance of the system will change accordingly. When the moment of inertia of the motor increases or decreases, the anti-resonant frequency of the system remains unchanged according to the formula, but the resonant frequency and resonance damping coefficient of the system change. According to the transfer function of the two-inertia motor side, the bode diagram obtained by simulation is the figure 2:

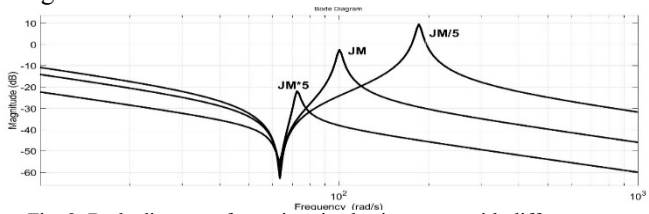


Fig. 2. Bode diagram of two- inertia elastic system with different

inertia of motor

The moments of inertia of the motor are selected as $J_M / 5$, J_M, and $J_M * 5$ respectively. It can be seen from figure 2 of bode that the anti-resonant frequency of the system does not change, but the resonant frequency of the system changes. When the motor moment of inertia increases, the resonant frequency of the system decreases and moves to the left in the bode diagram; when the motor moment of inertia decreases, the resonant frequency of the system increases and moves to the right in the bode diagram.

III. LOAD OBSERVER CONTROL

A. *Positive Feedback Control of Load Observer*

From the perspective of the principle of disturbance invariance, a load observer is designed for analysis. First, construct a load observer through the output ω_M to obtain the observation value of the external disturbance value, and then pass the observation value through the compensator G_b and add it to the current set value according to a certain rule to realize positive feedback control and external disturbance observation compensation feedforward control combined compound control. Among them, the controller G_b suppresses the influence of external disturbances according to the principle of disturbance invariance [1][3-4]. The structure diagram is:

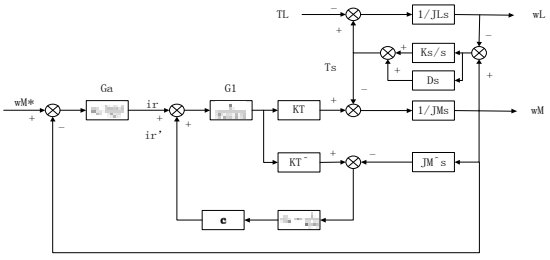


Fig. 3. Two- inertia elastic system model of positive feedback control of load observer

In figure 3, ω_M^* is the reference motor speed, G_a is the speed control inner loop, G_1 and K_T are the torque control inner loop, G_b is the compensator, i_r' is the observed current, $\hat{K}_T$ is the observed coefficient, $\hat{J}_M$ is the observed motor inertia, c is the feedback coefficient

According to the principle of disturbance invariance, design the load observer as: $J_M = \hat{J}_M, \hat{K}_T = K_T, G_b = \dfrac{1}{K_T G_1}$,

The resonant frequency is $\omega_r = \sqrt{\dfrac{K_S\left(J_M + J_L(1-c)\right)}{J_M J_L}}$,the anti-resonance frequency is $\omega_a = \sqrt{\dfrac{K_S}{J_L}}$,the resonance damping coefficient is $\zeta_r = \dfrac{1}{2} D_S \sqrt{\dfrac{J_M + J_L(1-c)}{K_S J_M J_L}}$ $(0 \le c \le 1)$

According to the transfer function of the two-inertia elastic system controlled by the positive feedback of load observer motor side, the bode diagram obtained by simulation in figure 4:

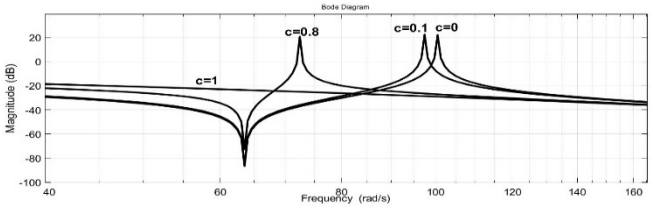


Fig. 4. Bode diagram of two- inertia elastic system controlled by positive feedback of load observer

In the bode diagram: the compensation coefficient c changes, the anti-resonant frequency of the system remains unchanged, and the resonant frequency of the design changes. When c is 1, the resonant frequency of the system is equal to the anti-resonant frequency, and the phase is opposite, just wholly cancelled out. The bode diagram of the transfer function becomes a straight line, completely suppressing the influence of external disturbance on the motor side; When changing c from 0 to 1, the anti-resonant frequency remains unchanged, the resonant frequency decreases, the distance between the two reductions. The dynamic speed drop caused by external disturbance decreases, but the vibration of the electromechanical system increases. Although the positive feedback control of the load observer can reduce the dynamic speed drop problem caused by external disturbance, it exacerbates the oscillation.

B. *Positive Feedback Control of Load Observer*

Using the same structure diagram, design G_b as $G_b = -\dfrac{1}{K_T G_1}$, analysis of the load observer negative feedback control.

The resonant frequency is $\omega_r = \sqrt{\dfrac{K_S\left(J_M + J_L(1+c)\right)}{J_M J_L}}$,the anti-resonance frequency is $\omega_a = \sqrt{\dfrac{K_S}{J_L}}$,the resonance damping coefficient is $\zeta_r = \dfrac{1}{2} D_S \sqrt{\dfrac{J_M + J_L(1+c)}{K_S J_M J_L}}$ $(0 \le c \le 1)$

According to the transfer function of the two-inertia elastic system controlled by the negative feedback of load observer motor side, the bode diagram obtained by simulation in figure 5:

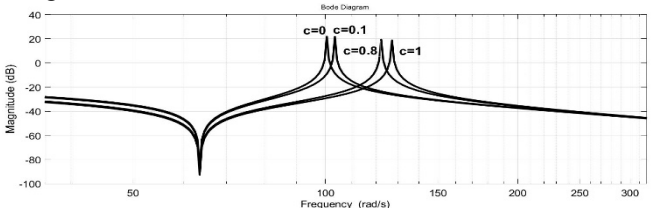


Fig. 5. Bode diagram of two- inertia elastic system controlled by negative feedback of load observer

In the bode diagram: the compensation coefficient c changes, the anti-resonant frequency of the system remains unchanged, and the resonant frequency of the design changes. The increase of c from 0 to 1, the anti-resonant frequency of the system remains intact, the resonant frequency increases, and the distance between the two expansions, which is beneficial to the stability of the system and suppresses the system oscillation caused by external disturbance. The negative feedback control of the load observer can effectively suppress the instability of the system, and cannot solve the problem of dynamic speed drop caused by external

disturbance.

IV. VIRTUAL INERTIA CONTROL

In the two- inertia model, it can obtain the influence of mechanical parameters on the system. Changing the motor moment of inertia of the system can not change the anti-resonant frequency of the system, but only the resonant frequency of the system. In practical engineering applications, the moment of inertia of the motor is basically cannot change any more. Through the research, it can achieve the purpose of changing the inertia of the system motor through the control method. The positive feedback control of the load observer is equivalent to increasing the motor inertia, the anti-resonant frequency remains unchanged, and the resonance frequency decreases and moves to the left in the bode diagram. Negative feedback control of the load observer is equivalent to reducing the moment of inertia of the motor, the anti-resonant frequency remains unchanged, and the resonant frequency increases and moves to the right in the bode diagram. Therefore, we propose virtual inertia control, which can achieve the effect of changing the inertia of the motor through the control method.

Based on the structure diagram of the positive feedback control of the load observer, it is easy to calculate then simplify the current loop to 1, and set the feedback channel to c(s)[5].

The resonant frequency is $\omega_r = \sqrt{\frac{K_S\left(J_M + J_L\left(1-c(s)\right)\right)}{J_M J_L}}$,the anti-resonance frequency is $\omega_a = \sqrt{\frac{K_S}{J_L}}$,the resonance damping coefficient is $\zeta_r = \frac{1}{2} D_S \sqrt{\frac{J_M + J_L\left(1-c(s)\right)}{K_S J_M J_L}}$.

Design $1-c(s)=K$,the resonant frequency is $\omega_r = \sqrt{\frac{K_S\left(\frac{J_M}{K} + J_L\right)}{\frac{J_M}{K} J_L}}$, compared with the original system, the moment of inertia of the motor becomes J'_M ,and $J'_M = \frac{J_M}{K}$. J'_M is the virtual motor inertia, K is the virtual inertia control ratio. The structure diagram is:

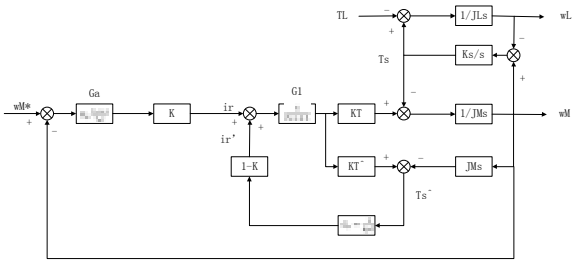


Fig. 6. Two- inertia elastic system model controlled by virtual inertia

Get the bode diagram through simulation:

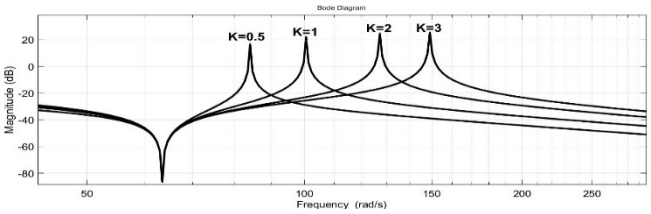


Fig. 7. Bode diagram of two- inertia elastic system model controlled by virtual inertia

The control ratio K of virtual inertia control is 0.5, 1, 2 and 3, respectively. As the control ratio K increases, the anti-resonant frequency of the system does not change, but the resonance frequency and resonance damping coefficient of the system increase, which is beneficial to the stability of the system. The resonant frequency moves to the right in the figure. The distance between the resonant frequency and the anti-resonant frequency increases is beneficial to suppress the system oscillation caused by external disturbance. When the value of K is 1, the feedback channel is 0, which is equivalent to no control. When the cost of K is less than 1, it is equal to the positive feedback control of the load observer, the anti-resonance frequency is unchanged, the resonance frequency reduces, and it moves to the left. When the value of K is greater than 1, it is equivalent to the negative feedback control of the load observer, the anti-resonant frequency remains unchanged, the resonant frequency increases, and it moves to the right. By controlling the value of K, the virtual inertia of the motor achieves the purpose of suppressing the electromechanical torsional vibration.

V. SIMULATION

Select the transmission system of the reversible medium plate rolling mill of a rough rolling mill of a steel mill for verification. The actual parameters are $J_M = 64300 kg \cdot m^2$, $J_L = 25116 kg \cdot m^2$, $D_S = 6.7566 \times 10^4$, $K_S = 1.5839 \times 10^8 N \cdot m / rad$ .When the system does not add any control, add load observer positive feedback control, load observer negative feedback control and virtual inertia control, show the system's resonance frequency and anti-resonance frequency in table 1:

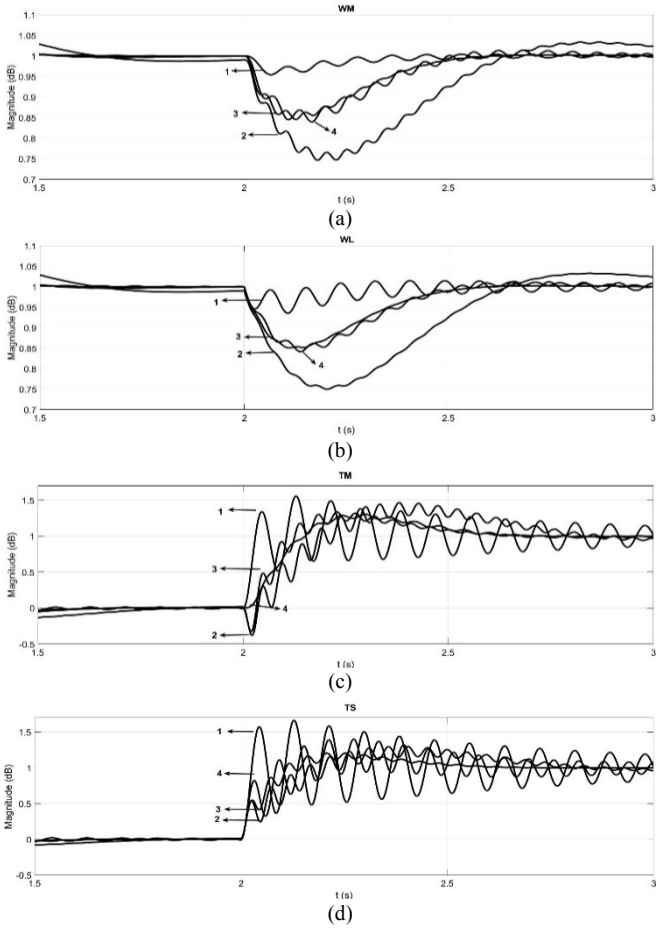
TABLE I
RESONANCE FREQUENCY AND ANTI-RESONANCE FREQUENCY OF SYSTEMS UNDER DIFFERENT CONTROL

Methods	Resonance frequency /Hz	Anti-resonance frequency /Hz
two- inertia	14.91	12.65
load observer positive feedback control	13.05	12.65
load observer negative feedback control	16.49	12.65
virtual inertia control	20.23	12.65

Obtained from the table, adding the above control does not affect the anti-resonant frequency of the system, only the resonant frequency of the system. The resonant frequency of the positive feedback control system of the load observer decreases. The resonant frequency of the negative feedback control of the load observer and the virtual inertia control system increase. The experimental data proves the correctness of the previous theoretical analysis.

In order to further verify the correctness of the theory and the effect of each control method on the system, perform a simulation experiment to obtain the waveforms of the system

motor speed, load speed, motor torque and load torque, as shown in figure 8:



(a) (b) (c) (d)

Fig. 8.Simulation results

In Figure 8, 1 represents the simulation waveform of the positive feedback control of the load observer, 2 represents the simulation waveform of the negative feedback control of the load observer, 3 represents the simulation waveform of the virtual inertia control, and 4 represents the simulation waveform without control. The abscissa represents time, in seconds, and the ordinate represents magnitude, in dB.

Figure 8 (a) is the motor speed waveform. The positive feedback control of the load observer reduces the dynamic speed drop caused by external disturbance but aggravates the system oscillation. The oscillations can be suppressed by the negative feedback control of the load observer, but the dynamic speed drops badly. Virtual inertia control does not affect dynamic speed drops but has a restraining effect on oscillations.

Figure 8 (b) is the load speed waveform. The positive feedback control of the load observer reduces the dynamic speed drop caused by external disturbance but intensifies the system oscillation. The negative feedback control of the load observer aggravates the dynamics speed drop obviously but reduces the oscillation. The virtual inertia control cannot solve the problem of dynamic speed drop, but it effectively solves the problem of oscillation.

Figure 8 (c) is the motor torque waveform. The positive feedback control of the load observer intensifies the system oscillation. The negative feedback control of the load observer and the virtual inertia control decrease the electromagnetic torque oscillation.

Figure 8 (d) is the load torque waveform. The positive feedback control of the load observer intensifies the system oscillation. The negative feedback control of the load observer and the virtual inertia control reduce the system oscillation, which is useful for suppressing the oscillation.

The positive feedback control of the load observer designed based on the principle of disturbance invariance can reduce the dynamic speed drop. However, it exacerbates the oscillation of the system. The negative feedback control of the load observer aggravates the dynamic speed drop, but can effectively suppress the system oscillation. The virtual inertia control does not affect the dynamic speed drop, but it can effectively suppress the oscillation of the motor and the load. The simulation experiment further proved the correctness of the above theoretical derivation.

VI. CONCLUSION

(1) In a two- inertia system, the change of motor inertia will affect the mechanical characteristics of the system. The motor inertia increases, the anti-resonant frequency of the system remains unchanged, but the resonance frequency decreases, which is not conducive to the stability of the system. The moment of inertia of the motor decreases, the anti-resonant frequency of the system remains unchanged, but the resonant frequency increases, which is beneficial to the stability of the system. The positive feedback control of the load observer does not change the anti-resonant frequency. It reduces the resonance frequency, which is equivalent to increasing the motor inertia. Although it can significantly reduce the dynamic speed drop, it intensifies the oscillation. The negative feedback control of the load observer does not change the anti-resonant frequency. It increases the resonance frequency, which is equivalent to reducing the motor inertia. Although it can effectively suppress the oscillation, it exacerbates the dynamic speed drop. The virtual inertia control can achieve the purpose of increasing or reducing the motor inertia by adjusting the control ratio K. It realizes the suppression of the electromechanical torsional vibration without affecting the dynamic speed drop.

(2) The virtual inertia control combines the advantages of the positive and negative feedback control of the load observer, which can effectively suppress the oscillation of the system without aggravating the dynamic speed drop. For systems where some mechanical parameters are determined, but the motor moment of inertia needs to be changed, virtual inertia control can meet the requirements. Virtual inertia control can be used not only in the drive system of the rolling mill, but also in other electrical drive control systems, such: wind power systems, ship traction control systems, and high-speed locomotive traction systems. It is of great significance for the control of large-power AC drive systems.

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Design and Simulation of 3-Transistor Active Pixel Sensor Using MATLAB Simulink

H. Alheeh, M. Alameri, A. Al Tarabsheh

***Abstract*—** There has been a growing interest in CMOS-based sensors technology in cameras as they afford low-power, small-size, and cost-effective imaging systems. This article describes the CMOS image sensor pixel categories and presents the design and the simulation of the 3-Transistor (3T) Active Pixel Sensor (APS) in MATLAB/Simulink tool. The analysis investigates the conversion of the light into an electrical signal for a single pixel sensing circuit, which consists of a photodiode and three NMOS transistors. The paper also proposes three modes for the pixel operation; reset, integration, and readout modes. The simulations of the electrical signals for each of the studied modes of operation show how the output electrical signals are correlated to the input light intensities. The charging/discharging speed for the photodiodes is also investigated. The output voltage for different light intensities, including in dark case, is calculated and showed its inverse proportionality with the light intensity.

***Keywords*—** APS, CMOS image sensor, light intensities photodiode, simulation

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Effects of Storage on the Physicochemical Parameters of Sachet Water Produced in Ado Ekiti Metropolis, Nigeria

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***Abstract*—** The effects of storage on the status of the Physico-chemical parameters of sachet water produced in the Ado-Ekiti metropolis had been carried out for a period of eight weeks. Twelve different brands of sachet water were sampled from different factories that produced the sachet water after 24 hours and stored at room temperature. Sub-samples were taken from the samples on a weekly basis and analyzed for some Physico-chemical parameters using APHA methods of analysis. The results showed that pH generally increased in all the samples while other parameters decreased with the time of storage and still conformed to Nigerian Industrial and World Health Organization standards. Both Total Dissolved Solids and Electrical Conductivity had the highest % coefficient of variation, and there is no significant difference between them at a 95% confidence level. The health effects of the various parameters determined are discussed.

***Keywords*—** physicochemical parameters, Sachet water, storage, water quality.

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Scalable Action Mining for Recommendations to Reduce Hospital Readmission

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Abstract—Hospital re-admission problem is one of the long-time issues of the healthcares in the USA. Unplanned re-admissions to hospitals not only increase costs for patients, but also for hospitals and taxpayers. Action mining is one of the data mining approaches to recommend actions to undertake for an organization or individual to achieve required condition or status. Undertaking such actionable recommendations incur some form of cost to users. The actionable recommendation system fails when the recommended actions are cost-wise unendurable or non-profitable and uninteresting to the end user. Finding low cost actionable patterns in larger datasets is time consuming and requires a scalable approach. In this work, we propose a scalable action mining method to recommend hospitals and taxpayers on what actions would potentially reduce patient readmission to hospitals at lowest costs. Most importantly we incorporated graph search methods to extract low cost actionable patterns. We use the Healthcare Cost and Utilization Project (HCUP) databases to evaluate our approach. All our proposed scalable approaches are cloud-based and use Apache Spark to handle data processing and to make recommendations.

Keywords—Hospital readmission reduction, action mining, scalable methods.

I. Introduction

Hospital readmissions are the most common risk factors that the real-world hospitals are trying to solve.US hospital expenditures rapidly increased for the past 2 decades,that constitute total spending of $3.3 trillion and 17.9% of US economy as of 2016, given by US health records [1]. Hospital expenditures are attributed due to various factors like inpatient care price, ambulatory prices, pharmaceutical prices, unnecessary visits, and emergency services apart from other social factors like population growth and aging [2]. Research shows that,out of these 31% of the expenditures are due to inpatient care [3] and 20%-30% of patients gets readmission within 30-90 days of discharge [4].Hospitals are trying to identify causes,enhancing transitional care, and engaging patients these are three ways that the hospitals can reduce the readmission rates and avoid penalties in this case.January 08, 2018- providers understand that high hospital readmission rates spell trouble for patient outcomes.

Data science focuses on various techniques to extract some unknown, surprising, and interesting knowledge patterns from massive data.These techniques adopt the relationship of data objects with other objects (Clustering) or classes (Classification) to uncover useful patterns in the data. The rule based learning is one of the simple data mining methods that identifies, learns,or evolves 'rules' to store, manipulate or apply. Association Rules and Decision are the few segments of rule-based methods that generates rules to associate patterns and classify data respectively. In general, we represent rules as given in Equation 1, where the *antecedent* is a conjunction of conditions and the *consequent* is the resulting pattern in the given data for the given conditions in antecedent.

$$condition(s) \rightarrow result(s) \tag{1}$$

Action rule is also a knowledge extraction technique developed in the context to recommend possible transitions for a person to move from one state to another. For example, recommending the business to improve customer satisfaction [5] and sentiment analysis on Twitter [6]. Action rules follow the representation, similar to Equation 1, as given in Equation 2, where Ψ represents a conjunction of stable features, $(\alpha \rightarrow \beta)$ represents a conjunction of changes in values of flexible features and $(\theta \rightarrow \phi)$ represents desired decision action.

$$[(\Psi) \wedge (\alpha \rightarrow \beta)] \rightarrow (\theta \rightarrow \phi) \tag{2}$$

Actionable patterns from Action Rules are prone to incur certain form of cost to the user [7], [8]. Cost for actions in Action Rules include money, time, energy or human resources. Recommended actions can cause both positive(*benefits*) and negative($loses$) effects for users.Thus, Action Rules recommendations system should incur low cost to the users to make them feasible actions. Existing approaches [9] - [10] do not consider cost effectiveness for recommendations. In [7] [11], the notion of cost of the Action Rules is introduced and refined. Searching for low cost Action Rules from a huge data can be very time consuming and requires a scalable and distributed approach for extracting them in a reasonable time frame.

Distributed Processing frameworks like Hadoop[12] and Spark[13] had been introduced to make big data processing and data mining faster and easier. These frameworks distribute the data among nodes in a cluster of computers. The data processing work is split among multiple nodes, each of which

performs computations on their part of the data. Once all the nodes finish executing their tasks, the results are merged to present the final result. In this work, we use Apache Spark [13] framework for implementing a scalable solution to the proposed Action Graph method, and make it suitable for big data. Spark provides APIs such as GraphX [14] for an efficient parallel processing in large graphs.

In this paper, we propose an extension to our previous work on distributed actionable pattern mining with Spark [15] and use the *Healthcare Cost and Utilization Project* (HCUP) databases [16], [17] as use cases for the proposed pattern extraction method. We also aim to extract actionable recommendations from the HCUP datasets, that help hospitals to give better care to its patients and reduce their overall costs for patients in the future.

II. Related Work

Unplanned hospital readmissions are expensive for both patients and healthcare, and they create unfortunate outcomes to everyone(patients, physicians, taxpayers, and healthcare systems) [3]. After the advent of Hospital Readmission Reduction Program in Affordable Care Act, the hospital readmission in the country has declined moderately, but still creating new challenges to hospitals [18]. Recently various domains like medicine [19], education [20], and business [21] started adopting data science research in their respective problems. Many research studies have focused on using the voluminous real-world datasets for healthcare applications and decision making using such data mining and knowledge extraction techniques [22]. For example, in particular to hospital readmission, researchers created a machine learning model to predict patient readmissions using just billing codes and basic patient admission characteristics [4]. Some focus on predicting the likelihood of patient readmitting to the hospital, modeled as risk prediction, using Support Vector Machines, Random Forests, and Neural Networks [23]. Similarly, there is a study on using logistic regression to measure the relationship between diabetes and early readmission [24], and a study on using a classic data mining technique like Support Vector Machine to predict readmission [25] using other features such as patient demographics, disease type, admission type, and clinical procedures undertaken. Recently, there is an interesting study on designing a personalized procedure graphs, which gives a probability on patient's future procedure and recommend hospitals in making decisions for a patient [26], [27].

In this work, we prefer to use rule based systems to recommend steps on reducing readmissions. Rule based systems are one of the most commonly used machine learning methods like classification, regression and association [28] because of its simplistic nature and ease of use. Action rules are such rule based systems that are designed to recommend actionable insights, for example recommendations for businesses to gain profit by finding interesting actionable patterns in the data [29]. In the literature, action rules are extracted using two methods. First method is a rule based approach, in which intermediate classification rules are extracted first using efficient rule generation algorithms such as LERS or ERID. From these extracted rules, action rules are generated with systems like DEAR [9], which extracts Action Rules from two classification rules, or ARAS [30], which extracts Action Rules using a single classification rule. Second method is object-based approach, in which the Action Rules are extracted directly from the decision table without any intermediary steps. Systems ARED [10] and Association Action Rules [31] work in the object-based approach. Algorithms, except association action rules, run much faster with the aim of extracting rules that benefits the user to the maximum and extracts only limited recommendations.

Ras and Tzacheva [7] in their work introduced the notion of cost and feasibility of Action Rules as an interesting measure. They proposed graph based method for extracting feasible and low cost Action Rules. Ras and Tzacheva [7] also proposed a heuristic search of new low cost Action Rules in which objects that support new set of rules also supports existing rule set but the cost of reclassifying them is much lower for new rules. Later,Tzacheva and Tsay [11] proposed tree based method for extracting low cost Action Rules.

There are also some research that has been done on extracting Actionable knowledge. For example, Yang, et.al [32] measured *Customer Attrition* in Customer Relationship Management (CRM) in telecommunication industry and the cost complexities involved in gaining profit to all the customers. They proposed a method to extract low cost Actionable patterns for converting undesired customers to loyal ones while improving the net profit of all customers. Karim and Rahman [33] proposed another method to extract cost effective actionable patterns for customer attrition problem in post processing steps of Decision Tree and Naive Bayes classifiers. Su, et.al [8] proposed a method to consider positive benefits that occurs by following an Action Rule apart from all costs that incur from the same rule. Cui, et.al [34] proposed to extract optimal actionable plans during post processes of Additive Tree Model (ATM) classifier. These actionable patterns can change the given input to a desired one with a minimum cost. Hu, et.al [35] proposed an integrated framework to gather cost minimal action sets to provide support for social project stakeholders to control risks involved in risk analysis and project planning phases. Lately, Hu, et.al [36] developed a cost sensitive and ensemble framework to predict software project risk predictions and conducted large scale analysis over 60 models, 327 real world project samples.

Recently, due to the advent of big data, some research [37], [15], [38] started applying distributed computing frameworks like MapReduce [12] and Spark [13] to extract actionable recommendation completely in a clustered setup. [37] proposed a method to distribute the data in random to multiple sites, combining results from all sites and take an average on parameters like Support and Confidence. [15] handle the load balancing by uniformly distributing the data into partitions based on the decision attribute. [38] introduces a new method of projecting the database into smaller chunks, for handling data with large number of attributes, and extracting action rules from them effectively.

TABLE I
EXAMPLE DECISION SYSTEM $\mathbb{T}$

X	A	B	C	D
x_1	Y	N	N	D_1
x_2	Y	H	Y	D_2
x_3	Y	H	Y	D_1
x_4	N	N	N	D_2
x_5	N	H	N	D_1
x_6	N	N	Y	D_2
x_7	N	H	Y	D_2
x_8	N	H	N	D_1

III. BACKGROUND

In this section, we give basic knowledge about Decision system, Action Rules, Spark and GraphX frameworks to understand our methodology.

A. Decision System

Consider a decision system given in Table I

Information System can be represented as $\mathbb{T} = (\mathbb{X}, \mathbb{A}, \mathbb{V})$ where,

X is a nonempty, finite set of objects: $\mathbb{X} = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8\}$

A is a nonempty, finite set of attributes: $\mathbb{A} = A, B, C, D$ and

V_i is the *domain* of attribute *a* which represents a set of values for attribute $i|i \in \mathbb{A}$. For example, $V_B = N, H$.

An information system becomes a Decision system, if $A = A_{St} \cup A_{Fl} \cup d$, where *D* is a *decision attribute*. The user chooses the attribute *d* if they want to extract desired action from $d_i : i \in V_d$. A_{St} is a set of *Stable Attributes* and A_{Fl} is a set of *Flexible Attributes*. For example, *ZIPCODE* is a Stable Attribute and *User Ratings* can be a Flexible Attribute.

Lets assume from Table I that *C* $\in A_{St}$. A, B $\in A_{Fl}$ and *D* $\in$ *d*. and the decision maker desires Action Rules that triggers the decision attribute change from D_1 to D_2 throughout this paper for examples.

B. Action Rules

In this subsection, we give definitions of action terms, action rules and properties of action rules [29]

Let $\mathbb{T} = (\mathbb{X}, \mathbb{A} \cup d, \mathbb{V})$ be a decision system, where *d* is a decision attribute and $\mathbb{V} = \cup V_i : i \in \mathbb{A}$. Action terms can be given by the expression of $(m, m_1 \rightarrow m_2)$, where $m \in A$ and $m_1, m_2 \in V_m$. $m_1 = m_2$ if $m \in A_{St}$. In that case, we can simplify the expression as (m, m_1) or $(m = m_1)$. Whereas, $m_1 \neq m_2$ if $m \in A_{Fl}$

Action Rules can take a form of $t_1 \cap t_2 \cap .... \cap t_n$, where t_i is an atomic action or action term and the Action Rule is a conjunction of action terms to achieve the desired action based on attribute *D*. Example Action Rule is given below: $(a, a_1 \rightarrow a_2).(b, b_1 \rightarrow b_2) \longrightarrow (D, D_1 \rightarrow D_2)$

1) Properties of Action Rules: Action Rules are considered interesting based on the metrics such as Support, Confidence, Utility and Coverage. Higher these values, more interesting they are to the end user.

Consider an action rule $\mathcal{R}$ of form:

$(Y_1 \rightarrow Y_2) \longrightarrow (Z_1 \rightarrow Z_2)$ where,

Y is the condition part of $\mathcal{R}$

Z is the decision part of $\mathcal{R}$

Y_1 is a set of all left side action terms in the condition part of $\mathcal{R}$

Y_2 is a set of all right side action terms in the condition part of $\mathcal{R}$

Z_1 is the decision attribute value on left side

Z_2 is the decision attribute value on right side

In [29], the support and confidence of an action rule $\mathcal{R}$ is given as

$Support(\mathcal{R}) = min\{card(Y_1 \cap Z_1), card(Y_2 \cap Z_2)\}$

$Confidence(\mathcal{R}) = [\frac{card(Y_1 \cap Z_1)}{card(Y_1)}] \cdot [\frac{card(Y_2 \cap Z_2)}{card(Y_2)}]$

Tzacheva et.al [11] later proposed new set of formulas for calculating Support and Confidence of Action Rules. The main idea is to reduce the complexities in searching the data several times for Support and Confidence of an Action Rule. The new formulas are given below.

$Support(\mathcal{R}) = \{card(Y_2 \cap Z_2)$

$Confidence(\mathcal{R}) = [\frac{card(Y_2 \cap Z_2)}{card(Y_2)}]$

Tzacheva et. al [11] also introduced a notion of utility for Action Rules. Utility of Action Rules takes a following form. For most of the cases Utility of Action Rules equals the Old Confidence of the same Action Rule.

$Utility(\mathcal{R}) = [\frac{card(Y_1 \cap Z_1)}{card(Y_1)}]$

Coverage of an Action Rule means how many decisions from values, from the entire decision system S, are being covered by all extracted Action Rules. In other words, using the extracted Action Rules, *Coverage* defines how many data records in the decision system can successfully transfer from Z_1 to Z_2

C. Cost of Action Rules

Typically, there is a cost associated with changing an attribute value from one class to another - more desirable one. The cost is a subjective measure, in a sense that domain knowledge from the user or experts in the field is necessary in order to determine the costs associated with taking the actions. Costs could be monetary, moral, or a combination of the two. For example, lowering the interest percent rate for a customer is a monetary cost for the bank; while, changing the marital status from 'married' to 'divorced' has a moral cost, in addition to any monetary costs which may be incurred in the process. Feasibility is an objective measure, i.e. domain independent.

According to the cost of actions associated with the classification part of action rules, a business user may be unable or unwilling to proceed with them.

The definition of cost was introduced by Tzacheva and Ras [7] as follows:

Assume that $S = (X, A, V)$ is an information system. Let $Y \subseteq X$, $b \in A$ is a *flexible* attribute in S and $v_1, v_2 \in V_b$ are its two values. By $\wp_S(b, v_1 \rightarrow v_2)$ we mean a number from $(0, \omega]$ which describes the average cost of changing the attribute value v_1 to v_2 for any of the qualifying objects in Y. These numbers are provided by experts. Object $x \in Y$ qualifies for the change from v_1 to v_2, if $b(x) = v_1$. If the above change is not feasible, then we write $\wp_S(b, v_1 \rightarrow v_2) =$

TABLE II
INTERESTING ATTRIBUTES IN THE DATASETS

Attribute Name	Attribute Description
Age	Patient's age during discharge
Died	Boolean indicator of whether a patient died during the hospital stay
DX, DXCCS	Diagnosis codes representing all diagnosis that a patient follows during their hospital visit
PR, PRCCS	Procedure codes representing all procedures that are followed on a patient during their hospital stay
LOS	Length of hospital stay
VisitLink	Identifier of a patient
Race	Race of a patient
DaysToEvent	Number of days before next admission

ω. Also, if $\wp_S(b, v_1 \rightarrow v_2) < \wp_S(b, v_3 \rightarrow v_4)$, then we say that the change of values from v_1 to v_2 is more feasible than the change from v_3 to v_4. Assume an action rule r of the form:

$$(b1, v_1 \rightarrow w_1) \wedge (b2, v_2 \rightarrow w_2) \wedge \ldots \wedge (bp, v_p \rightarrow w_p) \Rightarrow (d, k_1 \rightarrow k_2)$$

The rule r is *feasible* if the sum of the cost of the terms on the left hand side of the action rule is smaller than the cost on the right hand side.

D. Spark

Spark [13] is a framework that is similar to MapReduce [12] to process large quantity of data in a parallel fashion. Spark introduces a distributed memory abstraction strategy named Resilient Distributed Datasets(RDD) that can do in-memory computations on nodes distributed in a cluster. Results of each operation are stored in memory itself, which can be accessed for future processes and analyses, which in-turn creates another RDD. Thus, Spark cuts-off large number of disk accesses for storing intermediate outputs like in Hadoop MapReduce. Spark functions in two stages: 1. *Transformation*, 2. *Action*. During the *Transformation* stage, computations are made on data splits and results are stored in worker nodes memory as RDD. While the *Action* stage on RDD collects results from all workers and sends it to the driver node or saves the results to a storage unit. With RDDs Spark helps machine learning algorithms to skip innumerable disk access during the iterations.

IV. DATASET DESCRIPTION

The use case that we used for this research is the medical domain data: Healthcare Cost and Utilization Project (HCUP) data. HCUP offers multiple data for analysis such as *Inpatient databases*, *Emergency department databases*, and *Readmission databsaes* at both state level and national level. However, the national level data is a weighted sample of data collected from all state level datasets. For our analysis we use the *State Inpatient Data* (SID) of the state Florida of years 2011-2012 [17] and *Nationwide Readmission Data* (NRD) of the year 2011 [16]. All our data are organized as each data record representing a patient's hospital visit and each patient visit has 298 attributes. Table II give a brief description about interesting attributes that are available in our datasets and that we use in all our methods. In total, our SID dataset has 4,008,182 patient visits of 2,625,083 unique patients. Although, we do not have a separate boolean attribute called *Readmitted*, we measure this attribute for each patient visit using attributes *LOS* and *DaysToEvent*. Based on this measured *Readmitted*, attribute, we give a plot on number of patients with their corresponding number of hospital readmission in Figure 1. From this figure, we can note that the number of patients who have been readmitted to the hospitals at very low frequency decreases constantly and have sudden spikes between readmission frequencies 40 and 60, and becomes constant for higher frequencies. We also note that almost 72% patients in the data have been readmitted to the hospital atleast once.

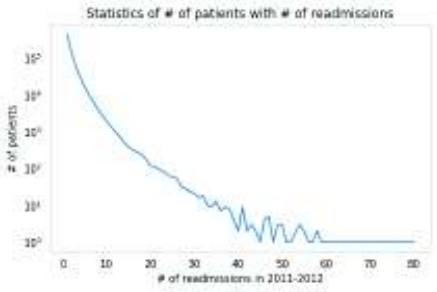

Fig. 1. Representation of number of patients in Florida with their corresponding readmission frequency in 2011-2012

Out of 298 attributes, 70% of the attributes are allocated to mark diagnoses and procedures that a patient follows during their hospital stay. Most importantly, these diagnoses and procedures are represented as *ICD-9-CM*(International Classification of Diseases, Ninth Revision, Clinical Modification) codes. The data reports two varieties of diagnoses and procedures for covering these ICD-9-CM codes. One is simple ICD-9-CM code, which has around 8,900 unique codes in all diagnoses and procedures. And, the other is an aggregated version of these codes, defined by *Clinical Classification Software*(CCS). These codes classify diseases to their major classification and thus we have only around 520 unique ICD-9-CM codes from these attributes. In all our experiments, we use the later versions of codes to improve efficiency of algorithms and robustness in recommendations.

In Figures 2 and 3, we represent diseases that have been most diagnosed and procedured in Florida in years 2011 and 2012. It is interesting to note that the most diagnosed disease(*Coronary Heart Disease*) is not present in the top procedures list and similarly, the top procedure(*Benign Neoplasm*) is not present in top diagnosis.

According to our data, almost 12% of patient visit resulted in death after following certain procedures to cure diseases. In Figure 4, we show the top 15 diseases that result in patient's death during their procedure to cure the disease. From this figure, we can note that these 75% of diseases correlates with top diseases for which the patients have undergone procedures as given in the Figure 3.

We also evidence that our datasets are rich in diversity. Our

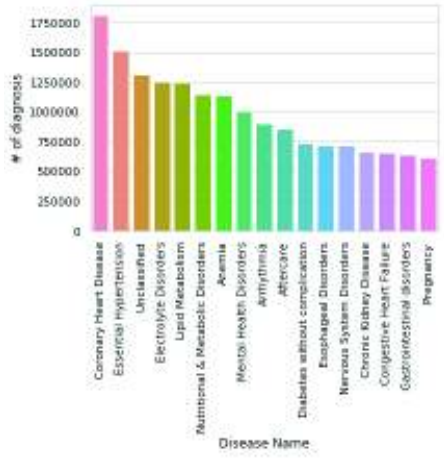

Fig. 2. Top 15 diagnosed diseases for patients in Florida based on their frequency in 2011-2012

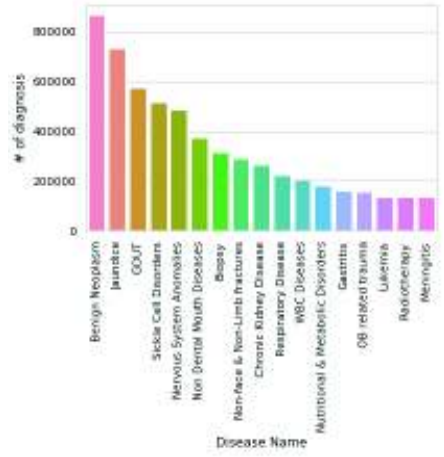

Fig. 3. Top 15 procedured diseases for patients in Florida based on their frequency in 2011-2012

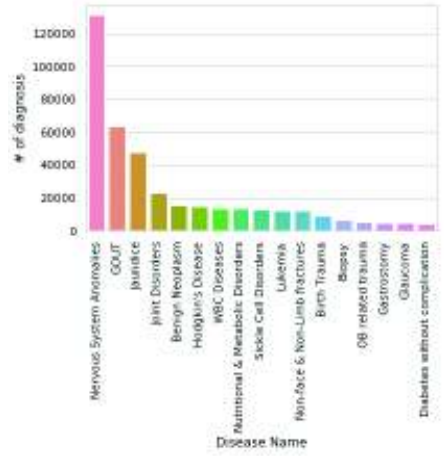

Fig. 4. Top 15 diseases that caused death for patients in Florida during their hospital admission in 2011-2012

dataset comprise of details about 58% female patient and 42% female patients. We show the diversity in patients race in the Figure 5. From this figure, we note that our dataset has a good representation of white, black, and hispanic patients.

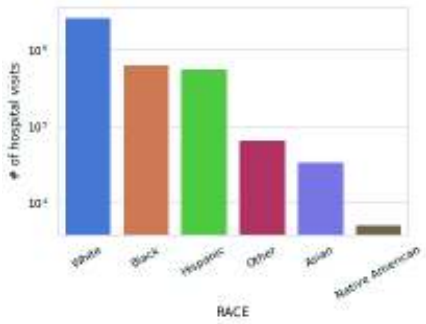

Fig. 5. Distribution of diversity of patients and their corresponding admission rates in Florida hospitals during 2011-2012

V. Methodology

In this work, we propose a graph-based method to search the optimal low cost Action Rules. To extract low cost Action Rules, first we need to extract Action Rules with a distributed mechanism : SARGS [15]. From the extracted Action Rules, we need to build an Action Graph. We then propose a method based on Dijkstra's algorithm to search the Action Graph for low cost Action Rules. In this section, we give the SARGS algorithm, Action Graphs and our search algorithm to extract low cost Action Rules.

A. Distributed Action rules extraction algorithm

In this work, we follow distributed Association Action Rules extraction technique [38] to extract actionable knowledge from the big data using the Spark framework. Association Action Rules method does not scale for big data due to high dimensional data and lacks efficiency in running time. By using vertical data partitioning as proposed in [38], we create partitions by splitting the data by attributes in a high dimension data as given in section **??**. We perform Association Action Rule extraction algorithm on each of those partitions in parallel, which allows for much faster computational time for Association Action Rules extraction in Cloud platforms.

Association Action Rules algorithm is similar to Association Rules extraction algorithm with A-priori method [39]. Association Rules find patterns that occur most frequently together in the given data. The most popular algorithm for extracting Association Rules is the Apriori algorithm [40]. Apriori algorithm starts with 2 element pattern and continues n iterations until it finds n element patterns, where n is the number of attributes in the given data. Sample Association rule, which means that when a pattern $a_1 \cap b_2$ occurs in the data, pattern $c_1 \cap d_2$ also occurs in the same data, is given below.

Figure 6 presents an example vertical data partitioning with the sample Decision system in Table I. The actionable

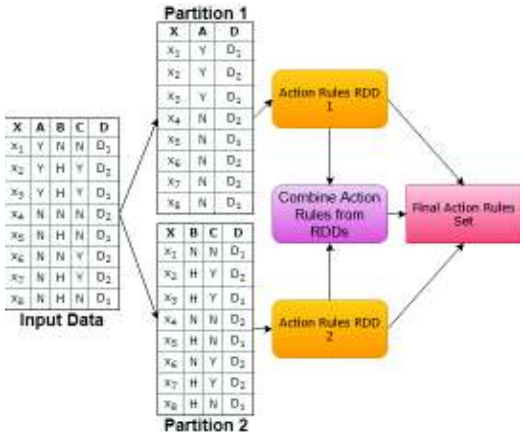

Fig. 6. Example Vertical Data Distribution for Table 1

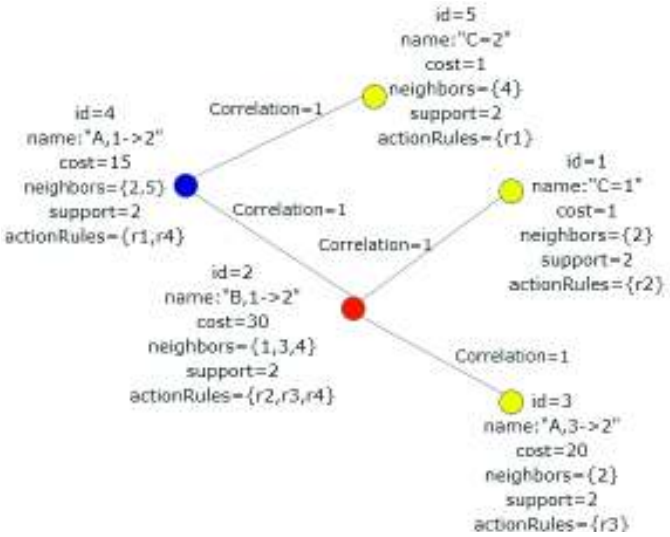

Fig. 7. Sample Action Graph with Vertex Properties and Edge weights; Vertex color represents how frequently the action term occur. Red color representing the most frequent, and Yellow the least.

knowledge extraction algorithm runs separately on each partition, does transformations like *map()*, *flatmap()* functions and combines the results with *join()* and *groupBy()* operations. We later combine action rules from different partitions to get final set of action rules.

B. Action Graph

We build a graph called *Action Graph* from the Action Rules extracted using the method mentioned in the previous section. We build Action Graph by using *action terms* in Action Rules and their relations with other action terms. In general, graphs takes the representation of $G = (V, E)$, where *V* is a set of vertices and *E* is a set of edges connecting vertex pairs in *V*. All vertices and edges can contain properties that when combined together, uniquely represent vertices and edges respectively. We represent our Action Graph as an undirected graph $A_g = (A_v, A_e)$. In Action Graph, we treat action terms that we get from Action Rules as a set of vertices (A_v) and we create edge between a vertex pair $(a_m, a_n | a_m, a_n \in r_i)$, where r_i is an Action Rule. We set basic properties of an action term such as *Vertex Id*, *Name*, *Cost*,*Support*,*Neighbor Ids* and *Action Rules* of low cost based on the vertex as vertex properties of the Action Graph and *Co-occurrence Frequency* of a vertex pair as an edge property. For example, red node means highest frequency, yellow node means medium frequency, and blue node means low frequency. *Figure 6* gives a sample Action Graph for Action Rules extracted from *Table 1*.

C. Dijkstra's Shortest Path Algorithm

In the context of Action Graph, Dijkstra's shortest path algorithm works more similar to one given in Algorithm **??**, but in the notion of cost. Algorithm 1 gives an overview on the Dijkstra's shortest path algorithm for Action Graphs. In Spark GraphX, all nodes process their properties in parallel. Thus we consider following properties to each node in the graph

- *vertexName, vertexCost*: corresponding vertex's name and cost respectively

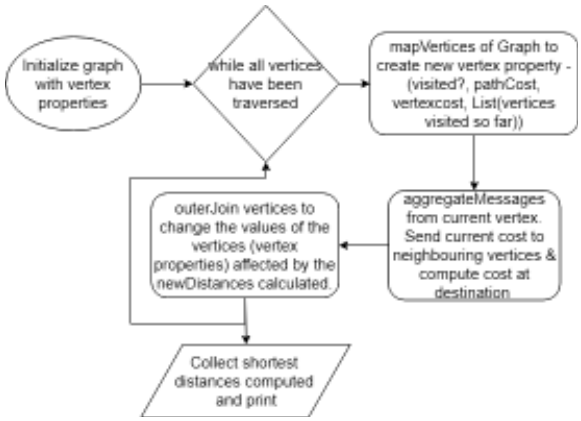

Fig. 8. Dijkstra's algorithm flow chart for Action Graph

- *d*: $(key, value)$ pair, where *key* represents the starting vertex(*s*) and *value* consists of a path followed from *s* to the current node and corresponding path's cost

In $SENDMSG$ function, we choose the sources that the destination does not have and send paths and costs only for the sources that are not available in the destination. In $MERGEMSG$ function, for each source we select a path with minimum cost and in $RECEIVEMSG$, we receive all messages and add current node's cost and update graph properties. By following these functions, eventually paths and costs propagates to all nodes in the graph. By the end of $n/2$ iterations, all nodes would have least cost to reach from source to themselves.

D. Breadth First Search Algorithm for Action Graph

Since maintaining a queue to track the traversal is complex in parallel computing engines like Spark GraphX, we follow modified strategies for *Breadth-First* and *Depth-First* searches in Action Graphs. BFS works alike Algorithm 1 with one

Algorithm 1 Dijkstra's Shortest Path algorithm for Action Graphs

Require: $A_g = (A_v, A_e)$, a source vertex u and cost threshold ρ

A'_g := A_g.mapVertices(v =¿ (v.vertexName,v.vertexCost,*d*)

procedure SENDMSG(id,*srcVertex*,*dstVertex*)

sources := Collect sources from srcVertex.d that are not available in dstVertex.d

return a dictionary with *sources* to *dstVertex*

procedure MERGEMSG(m1,m2)

mergedMessage := ∅

for $source \in m1.sources$ **do**

if m1.source.cost < m2.source.cost **then**

mergedMessage.source := m1.source

else

mergedMessage.source := m2.source

return mergedMessage

procedure RECEIVEMSG(id,oldProp,newProp)

for $source \in newProp$ **do**

newCost := Add *this.name,this.cost* to newProp.source

oldProp.source = newCost

return oldProp

A_g^{final} := A'_g.aggregateMessages(*SendMsg*, *MergeMsg*, *ReceiveMsg*)

return all paths and costs from all vertexes

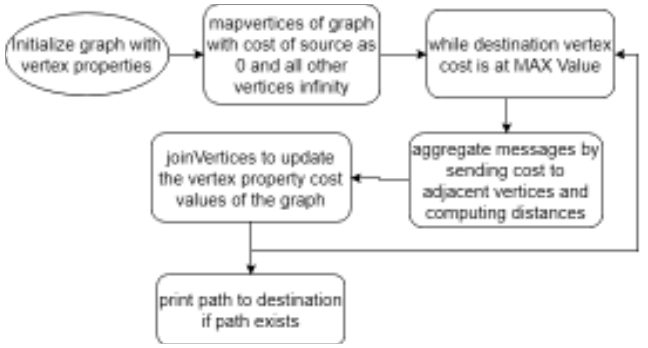

Fig. 9. Breadth First Search algorithm flow chart for Action Graph

exception. Instead of choosing a path with minimum cost in the $MERGEMSG$ function, for each source vertex we choose a path from the latest source. For example, if vertices 1 and 2 are sending path and cost for the source node 3 to vertex 4, the $MERGEMSG$ function of vertex 4 chooses path and cost of source node 3 from vertex 2. Once this entry is updated, it cannot be altered in the future but it can propagate to update its neighbor entries.

E. Depth First Search algorithm for Action Graph

Depth First Search(DFS) is one of the complex problems($P - Complete$) to be incorporated into parallel frameworks. For long time in the literature, parallelizing DFS has been one of the main concerns and several variations of DFS have been proposed [**?**] [**?**]. In this paper, we propose DFS for Action Graphs to extract low cost Action Rules as given in Algorithm 2. For the sake of Spark GraphX framework, we attach the following parameters to each node for the algorithm:

- *vertexName, vertexCost*: corresponding vertex's name and cost respectively
- *neighborPath*: path followed by a node to traverse among immediate neighbors
- *l*: Similar to dictionary *d* in Algorithm 1. We also attach which node to visit next along with path and cost

Thus each vertex share their *neighborPath* in the first iteration with their neighbors(but only to specified neighbor vertex get the content). In the remaining iterations $SENDMSG$ function sends the dictionary *l*. Unlike *Dijkstra's* and *BFS*, we are not gathering paths for all possible source and destination pairs. Instead, we are setting each vertex as a source vertex and collecting a path using DFS traversal to reach all other vertexes. Thus in the $MERGEMSG$ function, we are getting updated path and cost from neighbors. In $RECEIVEMSG$ function, we simply find nodes, from *neighborPath*, that are not visited and attach them to the path in same sequence and update the cost and next node to visit parameters.

Algorithm 2 Depth First Search algorithm for Action Graphs

Require: $A_g = (A_v, A_e)$, a source vertex u and cost threshold ρ

A'_g := A_g.mapVertices(v =¿ (v.vertexName, v.vertexCost, neighborPath, *l*)

procedure SENDMSG(id,*srcVertex*,*dstVertex*)

return *dstVertex.l*

procedure MERGEMSG(m1,m2)

mergedMessage := ∅

for $source \in m1.sources$ **do**

if —m1.source— > —m2.source— **then**

mergedMessage.source := m1.source

else

mergedMessage.source := m2.source

return mergedMessage

procedure RECEIVEMSG(id,oldProp,newProp)

for $source \in newProp.msg$ **do**

if newProp.source.target = id **then**

newPath = newProp.source.path

for $node \in oldProp.neighborPath$ **do**

if $node \notin newProp.source.path$ **then**

newPath := Add (node.name,node.cost)

if $allVertices \in newPath.names$ **then**

target := ∅

else

target := newPath.last.name

oldProp.source := (newPath,target)

return oldProp

A_g^{final} := A'_g.aggregateMessages(*SendMsg*, *MergeMsg*, *ReceiveMsg*)

return all paths and costs from all vertices

TABLE III
HCUP DATA ATTRIBUTES AND ALGORITHM PARAMETERS

Property	Description
Attributes	67 attributes with DX(1-31) ; PR(1-31) ; Gender ; Race ; IsHomeless
Stable attributes	Gender ; Race ; IsHomeless ; PR(1-31)
Decision attribute	IsReadmitted
Required decision action	IsReadmitted($1 \rightarrow 0$)
Minimum support	30
Minimum confidence	40%
No. of diseases	262

VI. EXPERIMENTS AND RESULTS

For all experiments, we use HCUP data (described in Section IV) and we use vertical data distribution method to extract actionable patterns. We evaluate all action graph search methods: *Dijkstra's, Breadth First Search*, and *Depth First Search* algorithms to extract low cost action rules. Action rules from these graph search algorithms determine knowledge in the data that help hospitals to reduce readmissions at the lowest cost possible. For simplicity, we split the data by diagnosis - such that hospitals can extract actionable knowledge for the given disease. With this approach, we add a concept of personalization towards diseases. In Table III, we give a very short description about the data and also, we give parameters that we set for extracting action rules. Since actionable patterns require expert knowledge to assign cost, we assign random cost to these extracted patterns. For action term in the action rule, we assign the random cost values ranging from 0 to 1.

We conduct all the experiments on the University of North Carolina at Charlotte's Hadoop research cluster. The available cluster comprises of 4 master nodes and 16 slave nodes with 87 tera-bytes of Hadoop Distributed File System(HDFS) available to the research faculty and students. Each computer core consists of 12 cores, totaling upto 192 computer cores in the cluster. Each node is dual Intel 2.93GHz 6-core processor with 64GB RAM.

We show the Action Rules extracted using the vertical data distribution method for each diagnosed diseases in Table IV. Due to space constraints, we give action rules of only 2 disease codes: 227(Spinal cord injury) and 251(Other congenital anomalies). We consider these actionable patterns as recommendations to hospitals in such a way that for a given disease, if the hospital provides treatment or care for recommended diseases, hospitals can potentially reduce the number of hospital readmissions. For example, consider the action rule $H217_{AR2}$ that corresponds to disease code *217*(Anomalies during and before child birth). The action rule recommends to the hospital that if hospitals prefer giving diagnosis for disease code *98*(Hypertension) in addition to treatment for disease code *217* and prefer treatment for disease code *138*(Ulcer) in addition to the code *58*(Nutritional disorders), hospitals can reduce readmission by 44%. The support of *35* shows that the framework identifies 81 entries in the data that supports condition. The total cost of this recommendation is *1.37*.

In Figures VI and VI, we give sample action graphs built from actionable recommendations given by the knowledge extraction algorithm. Since the original action graph is much

TABLE IV
SAMPLE ACTION RULES FROM THE HCUP DATA FOR SELECTED DIAGNOSIS

227(Spinal cord injury)

1) $H227_{AR1} : (DX, 237 \rightarrow 254) \wedge (DX, 199 \rightarrow 231) \Rightarrow (Readmission, 1- > 0)[Support : 40.0, OldConfidence : 56\%, NewConfidence : 64.58\%, 1.505]$
2) $H227_{AR2} : (DX, 237 \rightarrow 205) \wedge (DX, 244 \rightarrow 205) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 32.0, OldConfidence : 51.14\%, NewConfidence : 57.82\%, Cost : 1.465]$
3) $H227_{AR3} : (DX, 2 \rightarrow 254) \wedge (DX, 199 \rightarrow 155) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 39.0, OldConfidence : 43.01\%, NewConfidence : 51.62\%, Cost : 1.111]$
4) $H227_{AR4} : (DX, 199 \rightarrow 2) \wedge (DX, 159 \rightarrow 244) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 30.0, OldConfidence : 46.68\%, NewConfidence : 53.27\%, Cost : 1.253]$

217(Other congenital anomalies)

1) $H217_{AR1} : (DX, 217 \rightarrow 205) \wedge (DX, 217 \rightarrow 48) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 40.0, OldConfidence : 75.03\%, NewConfidence : 75.03\%, Cost : 1.627]$
2) $H217_{AR2} : (DX, 217 \rightarrow 98) \wedge (DX, 58 \rightarrow 138) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 35.0, OldConfidence : -44.28\%, NewConfidence : 51.46\%, Cost : 1.37]$
3) $H217_{AR3} : (DX, 213 \rightarrow 53) \wedge (DX, 213 \rightarrow 98) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 47.0, OldConfidence : 46.55\%, NewConfidence : 53.51\%, Cost : 1.085]$
4) $H217_{AR4} : (DX, 122 \rightarrow 205) \wedge (DX, 217 \rightarrow 58) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 39.0, OldConfidence : 55.99\%, NewConfidence : 61.68\%, Cost : 1.556]$

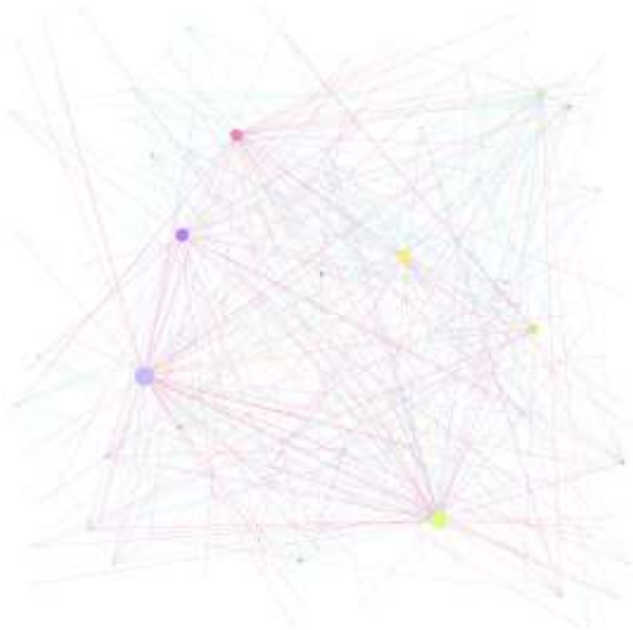

Fig. 10. Sample action graph derived from action rules of Diagnosis 227

bigger for visualization, we used only a sample of the actionable patterns from the complete knowledge. In these graphs, size and color of a node represents the frequency of the actionable pattern given by the recommender's system. Bigger the node, it has been used more in common with other actionable patterns and smaller nodes represent the actionable patterns recommended less frequently.

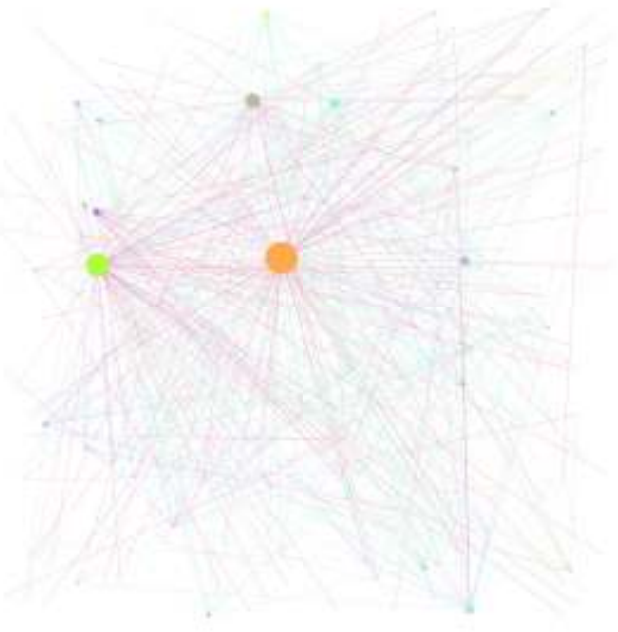

Fig. 11. Sample action graph derived from action rules of Diagnosis 217

In the Table V, we give action rules of lowest cost derived from action rules given in Table IV. It is notable from this recommendation that since the recommendations are made of 2 action terms, the recommender's system removes one of the terms to provide the low cost action rules.

In Tables VI and VII, we give execution times of all the proposed action graph search algorithms for diagnosis codes 217 and 227 respectively. It is notable from these tables that Breadth First Search and Dijkstra's Shortes Path algorithms achieve much faster execution times(ateleast 2x times). On the other case, Depth First Search executes slower compared to the Java version of the algorithm. This is mainly because of complex parallelization approach followed by the algorithm to extract low cost action rules.

VII. Conclusion

In this work, we used the data provided by the HCUP to extract actionable patterns for recommending insights to reduce hospital readmissions. We incorporated the research introduced by our existing work [41] to action graphs and search for low cost actionable patterns from very large data. We used distributed computing tools like Apache Spark GraphX for fast and parallel graph search processing. We showed that our methods can extract actionable patterns that potentially reduce the cost that the hospitals spend for reducing patient readmission. We also showed that our methods extract these information within a span of seconds using the distributed processing tools.

Although our methods give actionable recommendations to hospitals to reduce readmissions at lowest cost, the recommended actions require subject matter experts to analyze the recommendations. Since the recommendations involve the risk of lives of patients, human in the loop to analyze these actionable recommendations is required. This can be addressed in the future to use expert or doctor inputs to evaluate and analyze these results.

TABLE V
Sample Low Cost Action Rules recommendations from the HCUP data for selected diagnosis

227(Spinal cord injury)
1) $H227_{AR1} : (DX, 237 \rightarrow 254) \Rightarrow (Readmission, 1- > 0)[Support : 40.0, OldConfidence : 56\%, NewConfidence : 64.58\%, 0.748]$ 2) $H227_{AR2} : (DX, 237 \rightarrow 205) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 32.0, OldConfidence : 51.14\%, NewConfidence : 57.82\%, Cost : 0.984]$ 3) $H227_{AR3} : (DX, 2 \rightarrow 254) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 39.0, OldConfidence : 43.01\%, NewConfidence : 51.62\%, Cost : 0.854]$ 4) $H227_{AR4} : (DX, 159 \rightarrow 244) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 30.0, OldConfidence : 46.68\%, NewConfidence : 53.27\%, Cost : 0.651]$
217(Other congenital anomalies)
1) $H217_{AR1} : (DX, 217 \rightarrow 205) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 40.0, OldConfidence : 75.03\%, NewConfidence : 75.03\%, Cost : 0.634]$ 2) $H217_{AR2} : (DX, 217 \rightarrow 98) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 35.0, OldConfidence : -44.28\%, NewConfidence : 51.46\%, Cost : 0.641]$ 3) $H217_{AR3} : (DX, 213 \rightarrow 98) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 47.0, OldConfidence : 46.55\%, NewConfidence : 53.51\%, Cost : 0.63]$ 4) $H217_{AR4} : (DX, 122 \rightarrow 205) \Rightarrow (Readmission, 1 \rightarrow 0)[Support : 39.0, OldConfidence : 55.99\%, NewConfidence : 61.68\%, Cost : 0.807]$

TABLE VI
Execution times of Action Graph search algorithms for Diagnosis 217

Algorithm	**Java execution**	**Spark execution**
Breadth First Search	8 mins	4.19 mins
Depth First Search	4 mins	4.25 mins
Dijkstra's Shortest Path	9.53 mins	3 mins

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TABLE VII
EXECUTION TIMES OF ACTION GRAPH SEARCH ALGORITHMS FOR DIAGNOSIS 227

Algorithm	Java execution	Spark execution
Breadth First Search	4.62 mins	2.76 mins
Depth First Search	6.44 mins	8 mins
Dijkstra's Shortest Path	2 mins	1.15 mins

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The Ottoman Artillery: Interdisciplinary Studies of Naval and Field Weapons

E. Mattio

***Abstract*—** The work stems, from the tail of a project funded by Regione Veneto directed by the department of humanities at the University Ca' Foscari of Venice, which has allowed us to group the Venetian artillery preserved in Europe. The project is a starting point to stimulate research on a still sterile topic: Ottoman artillery. It was a journey in search of bombards, cannons and mortars which were studied, cataloged and combined for the first time; preserved in the most important museums in Europe (Venice, Turin, Crotone, St. Pietersburg, London, Fort Nelson, Wien) and Asia (Askary Museum of Istanbul). It is therefore interesting to evaluate the differences and similarities between the productions of Venetian and Ottoman artillery, the technological and architectural developments of foundries, arsenals and *fondaci*, considering the exchanges and the contacts that joined the two Powers. The chronological limits is between XVth and XVIIIth century, between two historical realities: the end of the Middle Ages and the Modern Age, where the guns are the new protagonists of this "revolution/evolution.

The claim is to offer an entirely new case study considering the guns not objects, but as elements to understand the logic and the socio economic dynamics that have hit Europe and the Ottoman world.

The investigation method was interdisciplinary, allowing the history of art, the study of materials, archiecture studies, chemical analysis and epigraphic research to combine to obtain surprising results.

***Keywords*—** Artillery, Founders, Guns, Sublime Porte

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The Underestimation of Cultural Risk in the Execution of Megaprojects

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***Abstract*—**There is a real danger that both practitioners and researchers considering risks associated with megaprojects ignore or underestimate the impacts of cultural risk. The paper investigates the potential impacts of a failure to achieve cultural unity between the principal actors executing a megaproject. The principle relationships include the relationships between the principle Contractors and the project stakeholders or the project stakeholders and their principle advisors, Western Consultants. This study confirms that cultural dissonance between these parties can delay or disrupt the megaproject execution and examines why cultural issues should be prioritized as a significant risk factor in megaproject delivery. This paper addresses the practical impacts and potential mitigation measures, which may reduce cultural dissonance for a megaproject's delivery. This information is retrieved from on-going case studies in live infrastructure megaprojects in Europe and the Middle East's GCC states, from Western Consultants' perspective. The collaborating researchers each have at least 30 years of construction experience and are engaged in architecture, project management and contracts management, dealing with megaprojects in Europe or the GCC. After examining the cultural interfaces they have observed during the execution of megaprojects, they conclude that globally, culture significantly influences their efficient delivery. The study finds that cultural risk is ever-present, where different nationalities co-manage megaprojects and that cultural conflict poses a real threat to the timely delivery of megaprojects. The study indicates that the higher the cultural distance between the principal actors, the more pronounced the risk, with the risk of cultural dissonance more prominent in GCC megaprojects. The findings support a more culturally aware and cohesive team approach and recommend cross-cultural training to mitigate the effects of cultural disparity.

***Keywords*—**Cultural risk underestimation, cultural distance, megaproject characteristics, megaproject execution.

I. Introduction

NATIONAL Culture is an intangible construct and is seldom considered when evaluating risks in the construction industry. These cultural risks can be significantly augmented when dealing with the construction of 'megaprojects'. The authors of this research found that the potential for cultural risk to disrupt a megaproject is frequently underestimated.

Globally, the increasing size, scale and nature of megaprojects require greater co-operation levels between multiple nations. The actors are obliged to (temporarily) work together during the megaprojects delivery, but all too frequently different cultural beliefs and practices take time to adjust before a harmonious working body can be formed. This paper considers how vital an understanding of different cultural practices and beliefs is, for the delivery of megaprojects.

II. Megaprojects and Their Risks

Megaprojects are often described as large-scale, complex ventures commonly associated with a cost of one billion US dollars or more [14]. In principle, they take many years to develop [26], carry high levels of risk [17], involve multiple public and private stakeholders [54], are transformational and impact millions of people [58]. They have been described as 'wild beasts' of the construction industry [76], owing to their unpredictable nature, and were once considered 'privileged particles' of the development process [52]. The level of risk associated with megaprojects grows, as their outcome becomes ever more critical and more complex, as their scale expands [26], [27]. Financial risks are amongst the more easily identified megaproject risks, as megaprojects are frequently in the public eye, due to their vast size and expenditure, and their frequent use of public funds.

Financial exposures can be enormous, and a budget overrun on ventures such as the Panama Canal, Hong Kong's MTR or Dubai Airport, can lower the country's GDP [30]. Financial overspending has attracted and retained the public interest, with several megaprojects throughout the Globe, such as the UK's high-speed railway HS2, Mexico's cancelled airport or Ethiopia's new Dam, headlining popular press stories. The scale of megaprojects is increasing, as demonstrated by one recent Saudi Arabian project, NEOM, which is forecast to have a capital cost of $500 billion [32]. Such large ventures can exceed the entire GDP of countries such as Ireland or Greece [73].

Typically, megaprojects have multiple stakeholders such as funders, taxpayers or investors, and such stakeholders or their nominated representatives yield the power and conduct themselves in a manner which reflects their inherent beliefs and culture. Flyberg's research tends to dominate time and cost studies. It concentrates on megaproject cost overruns, and the practice of deceptive initial underestimating, misleading governments, taxpayers and investors stakeholders, although recent studies suggest there may be inaccuracies or errors in some of his calculations [29], [49].

Significant Megaproject Risks

References [17], [26], [54], [58] and [67] identify megaprojects as risk-filled ventures that can impact millions of people. In addition to much-publicized financial risks, megaprojects are prone to multiple influences during their execution, such as the temporariness of organization and

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uniqueness of the construction in addition to social risks, stakeholder risks and cultural clashes [37], [26], [28], [40]. As megaproject risks come to light, they open the door for researchers to review the cause and effect of the risks on the project's execution, and after that, allow consideration of how to manage or mitigate these megaproject risks.

All too frequently, megaproject risks are ignored until they are too late to control. This paper discusses a lesser researched risk, namely, cultural risk.

III. Cultural Risk

Despite continued efforts to prefabricate construction elements, and despite COVID's restriction on face-to-face interactions, the construction industry remains heavily reliant on people, and therefore the interactions between its principal actors critical to the successful outcome for the megaproject.

Different regions adopt their unique style of building megaprojects, from the labour hungry middle and far east to less labour-intensive European megaprojects. National contractors have also proven more versatile and mobilise to traverse the World, such as Chinese contractors to states such as Montenegro, Africa, or the GCC. Similarly, Western construction management consultants such as Mace, Aecom, Parsons or Arcadis also apply their resources throughout the Globe to search for overseas revenue and market diversification. Megaproject teams are also becoming more international due to the participation of sponsors, funders and contractors from multiple countries [44] and these global collaborations now necessitate extensive cross-culture collaboration [21].

A few studies have recognised how culture-related dissonance has (negatively) impacted megaprojects to date (see for example [45], [69]-[71]). The researchers' combined on-site experiences provide tacit knowledge of the impacts of cultural dissonance globally, and these lived experiences have informed how cultural issues can significantly disrupt a megaproject a more considerable extent than understood to date.

It is not suggested that it is possible to achieve an 'instant' cultural harmony between the multicultural communities involved in delivering megaprojects. There are barriers in the relationship-building processes. Forming relationships is made more complicated as megaprojects are considered 'short-term' ventures, limiting the time needed to develop productive relationships [71]. Megaprojects are frequently one-off 'temporary endeavours', which due to their sheer size, speciality and duration, require specialist multinational parties to converge to execute their construction [13], [19], [67]. References [41], [54], [57] and [50] suggest that the 'higher degree of complexity' due to their vast size, temporary nature, control and bureaucratic issues are making collaboration 'critical, challenging and demanding' for these 'one-off indivisible structures under pressure' [50].

During this research collaboration, the cultural influences upon global megaprojects in different regions are compared. There are sizable differences in the volumes of megaprojects under construction, were recorded comparing. In 2018, 397 western consultancy agreements supported GCC megaprojects' execution, with construction costs estimated at $ 1,750 billion. GCC's reliance on expatriates ranges from 32% in Saudi Arabia to 80% in Qatar (2018). The GCC engages nine million personnel in its construction sector, almost twice the 4.8 million construction personnel participated throughout the European Union [63]. GCC investment in the construction industry sets it aside from the rest of the World. In monetary terms, GCC construction-related activities' value is 19% of GDP, twice the estimated 9% GDP for Europe [15].

Prior Research

Prior research has exposed case studies such as cultural clashes during the construction of megaprojects, such as the Panama Canal expansion, the OMEGA megaproject in France (a French high-speed rail system), Eclipse (a network associated management of large infrastructure projects in Europe) and Nabucco (a 1300 km pipeline through Turkey, Austria, Bulgaria, Romania, and Hungary). These studies concluded that that cultural dissonance between the megaprojects' key actors, significantly disrupted their performance. The studies reveal that cultural acceptance and trust are critical factors for the successful completion of megaprojects [59], [10], [62], [65], [70] express how cultural tensions amongst the management team are a significant risk that requires 'special consideration' and management throughout the lifecycle of the megaproject. Reference [52] found that cultural issues contribute to megaprojects' failure, while 'strongly recommending' that cultural risk is considered in all future megaprojects. Reference [68] shows different forms of cultural risks, including differences in 'national culture', 'organisational culture' or 'professional culture', make megaprojects a 'cultural phenomena'.

The researcher's observation and experience suggest that differences in commercial, professional and social-cultural norms in the management of megaprojects give rise to cultural dissonance. Dissonance describes a lack of agreement or harmony between people. Reference [39] describes the gap between cultures as 'cultural distance', suggesting that the higher the distance between the parties, the more probable that clashes and cultural dissonances will occur. The higher the cultural distance between two societies, the longer it seems to accept the local culture and norms [42], [72].

IV. Methodology - Case Studies

References [20] and [6] promote case studies for complex projects such as megaprojects, as they allow the investigator to retain 'the holistic and meaningful characteristics of real-life events', together with providing an ability to capture vibrant and complex data. Reference [74] supports the use of exploratory case studies to assist with understanding complex social phenomena. This research represents a global collaboration of findings, to overcome a perceived lack of transferable results from a single case study [74] and reduce the dangers of selection bias [5], [11]. A GCC case study explores the causes and impacts of cultural dissonance between Arab and Western actors, while a European case study (Montenegro), helps understand some of the cultural tensions between Chinese and

Western actors.

In both cases, the researchers engaged with less formal face to face semi-structured interviews to evaluate Western perspectives on their cultural interactions with local project sponsors, or contractors. In the GCC, 34 senior Western directors from a broad spectrum of construction fields were asked for their perceptions and provide 'rich data' [6] to evaluate the extent of cultural challenges they face in the GCC. In the European megaproject, a series of semi-structured interviews sought Contractor, Sponsor and Consultant perspectives to the extent and impact of cultural challenges they face, during the megaproject's execution.

V. Cultural Differences

The GCC study considers Western Consultants' interface managing the megaprojects delivery and Arab project stakeholders, for a significant infrastructure project, involving multiple consultants and Contractors, both local to the GCC and international – Korea, China, the Far East, and Europe. The findings informed of specific cases where cultural conflict causes an unrecoverable breakdown in trust, between the actors. The dissonance has resulted in the executives' termination from the megaproject and occasionally the GCC State itself[1]. While there were cultural differences and misunderstandings between the project sponsor and the Contractors, the case study focused on the relationship between the Western Consultants and the Arab project Stakeholder.

The European megaproject considers a highway construction project under FIDIC Yellow, a Chinese Contractor, a National Government, and a Western Consultant. The main problems related to the misunderstanding of the contractual requirements and the different cultural ways of megaproject execution. The European case study found that that the main issues giving rise to cultural dissonance were related to the misunderstanding of the Sponsors culture, practices, and conventions.

Europe vs the Middle East

Traditionally, in most megaprojects in Europe, the Contractor, Consultant and Client are the leading actors, and whilst there are national cultural differences between them, the proximity of their cultural relationships, similar approaches and similar contract standards (Fédération Internationale Des Ingénieurs – Conseils (FIDIC), or something similar), creates a cohesive team dynamic. Due to these close cultural proximities, language and contract's intent and meaning create an atmosphere where the actors became familiar with the mechanics and dynamics of their roles and responsibilities in the megaproject's execution.

Now megaprojects in Europe are beginning to include Asian/Chinese companies, which add a cultural dimension to be considered. One of the early research findings is that the three main stakeholders to the contract, the Employer, Contractor and Consultant need to allow more time, especially in the early stages of the project for the Asian/Chinese Contractor to understand the contract specification and required documentation that needs to be submitted to the Employer.

Owing to a low indigenous population, the GCC has a high dependency on expatriates. The individual GCC States fund most of the Middle East's megaprojects, reducing the typically extensive collection of stakeholders which control European megaprojects (such as principle and secondary investors, banks, government agencies, often the government and the European Central committees, Environmental Protection Agencies, Contractors, the public and other relevant parties). Reference [35] suggests that the greater the number of multicultural stakeholders, the greater the levels of cultural risks, due to more interaction between a more comprehensive, more global set of actors.

Despite the uniqueness of global megaprojects, this joint research identified some of the more common grounds for cultural dissonance in European and GCC megaprojects. Such cultural disagreements were often related to the different cultural interpretation of contract requirements, cross-cultural communication issues, how different nations delegate authority, the introduction of novel construction techniques and the cultural perceptions of the importance of timely completion of projects.

Differing Interpretations of the Contract Requirements

- Different cultures interpret words and meanings in different fashions, but there needs to be an explicit agreement on the contract's language and which one takes precedent.
- Processes and procedures which may appear straight forward and standard in one region may be bureaucratic and cumbersome in others. For example, in the GCC, some believed they were 'imprisoned' by the bureaucracy, referring to excessive paperwork and procedures as a 'conveyor belt mentality'.
- In the GCC and Europe, Contractors from different cultures were perceived as more political or commercially aggressive than the local Contractors.

Communication Issues

- The use of more than one language can lead to long meetings and a need for translators. The native English speaker needs to be very clear in their use of words and explanations. It is very easy for nonnative English speaker to hear the words but misinterpret their meaning differently (with the added complexity that different native English speakers also have at times difficulty in understanding each other);
- Depending on the contractual languages, it might not be easy to find a competent translator who can translate adequately technical and contractual terms.
- In the GCC, some project directors also noted how Arab communication styles were sometimes different from Western norms, explaining how they frequently communicate in differing pitched voices, may appear as

[1] Most GCC States require the expatriate to leave the State within 30 days of cessation of employment.

arguing as opposed to their regular inter-cultural communication. Reference [53] finds that Arabs can be loud and emotionally expressive and may appear to be fighting when they speak loudly or move bodies expressively; however, this should be considered 'speaking with passion' and not a sign of disagreement. There are also communication issues where some items are not said, due to a wish to avoid confrontations.

Power and Authority

- Frustration arises where one person thinks that they are speaking to a decision-maker, but they are not talking to the real authority holder, as in some cultures, all the critical decisions are made from the top down. The person who has the title of Project Manager may not hold and 'real' power and may not be the person making the decision.
- Observing protocols for public communication: A severe cultural mistake would be to misjudge the consequences of embarrassing the Sponsor in public, leading to a loss of face. Is it a matter of 'degrees of sensitivity'. One of the easiest ways to cause someone to lose face is to 'insult an individual or criticise them in front of others' [33]. The Sponsor must be advised of any potential disagreement in private rather than publicly. In workplace meetings between the Western Consultants (WC) and Arab Sponsors, field research has shown that public disputes or public criticism may lead to a 'loss of face' and seen as an insult to the Arab Sponsor [33]. The Sponsor must be advised of any potential disagreement in private rather than publicly.
- In the European case study, it was found that critical decisions were 'recommended' by the project director to the powerbase in mainland China, where the decisions were subsequently made and passed back to the project

Different Methodologies and Approaches

- The research finds that an inability to realise that there can be more than one way to undertake a task, for example, the approach to design in China might be quite different to the approach in European Countries where on a Design and Build contract the Designer is in close contact with the Construction team, and the construction team can implement the design. This means that the design approved by the Client is in the main the one that is being constructed. In an Asian approach to design, the Designer is provided with a broad outline, and then the Construction team will modify to suit the ground condition. So the design approved by the Employer is not necessarily the one that is being built. This leads to a step of extensive and time-consuming design reviews which can have an impact on the time for completion.
- For WC, [22] suggests reviewing the countries' 'cultural mindset' and achieving progress before engagement by following a framework including 'understanding the type of culture and the differences with your own, respecting the differences and enriching yourself through the new'.

Different Prioritization of Time

- Different cultures appear to have different perspectives as to an understanding of the criticality of time.
- The executives also need to be mindful of the consultative nature of the Arabs [55]. This tendency to continually consult each other prompts them to seek advice and consensus before making decisions, resulting in higher perceived bureaucracy levels. In Arab cultures, it is found that the time taken to reach the decision is of lesser importance than the achievement of consensus on the decision.
- There are several professional and social conventions to be considered in the GCC [48], [56], [66]. Cross-cultural experts also warn of bureaucratic, professional procedures as 'nothing happens quickly', and 'trust is paramount' [55].
- Chinese Contractors were generally found to be more concerned with achieving programmes and deliverables.

VI. Impacts of Cultural Differences

If no impacts arise from cultural dissonance, then there are no risks posed to either party or no impact upon the megaproject's execution. The study finds that the real impact of cultural dissonance in the execution of megaprojects is that staff is often removed, to get the megaproject back on track. The study finds that megaproject directors in the GCC are more frequently removed than European megaprojects and the impacts are significant. The megaprojects suffer in crucial areas, delays, and project disruption, leading to high financial costs for the impacted parties and knowledge leakage.

- Delay, disruption & knowledge leakage: Most project directors reported critical impacts when the WC key staff are removed. Many cited a resultant delay to the completion of the megaproject. In addition to the time lost while the position is unfilled, [77] have found that replacement personnel needs time to adjust and reach the same productivity level as their predecessor. Project directors referred to the loss of knowledge associated with removing the critical staff resulting in significant disruption.
- Knowledge leakage: The project suffers as the knowledge gained from years working on a project is often lost. Loss of information results in delays as the project as the prior knowledge is rediscovered.

Cultural dissonance in the European megaprojects examined for this paper had resulted in delays to the megaprojects' execution but had not contributed to the removal of their senior executives or project directors. On the other hand, project directors on each of the GCC megaprojects considered in this study had witnessed a high churn rate for project directors involved in executing their megaprojects. While costs vary according to the specific megaproject, the costs tabled next are most relevant to GCC megaprojects.

- Costs to the displaced Director and site team: Project directors described how they felt reduced job security due to high churn rates, and reported unquantifiable factors, such as personal upheaval; Unplanned repatriation can result in the return of children from education in the middle of a school term, housing penalties and the burden of

repatriation costs. Reference [2] discusses other intangible impacts including a loss of self-confidence, self-esteem and reputation. Upheavals and disruption to the terminated project director, include an automatic closure of their bank account, and an immediate demand to repay any loans in full. Many project directors reported a significant drop in their team morale after colleagues are dismissed. The drop in morale was also reported to impact the removed individual,

- Consultancy practice costs: There are significant variances in assessing the costs incurred due to an expatriate's assignment failure. Reference [47] suggests costs of $150,000 per early repatriation, while studies by [12] suggest higher costs of $1,000,000, per manager[2]. The researcher considers that accurate costs are essential to appreciate the financial exposure and risk scale associated with expatriate failures. In this regard, the cost centres and charges identified in [77] (Table 10.1) are used as a benchmark for evaluating expatriate costs. These financial computations support findings of [12] that the WC incurs costs of up to $1,000,000, per project director, in GCC megaprojects.
- Megaproject Costs: Reference [27] has established that substantial costs are associated with megaprojects' late delivery. Sponsors incur development losses, such as the loss of venue revenue, or as a government, the lack of benefit from roads and infrastructure, if projects are delivered late. GCC megaprojects are generally state-funded and may not be expected to provide a financial return on investment. The absence of income projections makes the quantification of delay damages challenging to assess.

VII. Risk Mitigations

The Project Management Institute defines risks as 'uncertain events or conditions that can have either a positive or negative effect, on one or more of the project's objectives' [34]. 'Successful risk management is positively correlated with project success, as when we discover in advance the things that might drive us off track, and we can implement proactive measures to avoid threats and capture opportunities' [36, p. 59]. This paper explores the impacts of cultural dissonance for WC in megaprojects and potential risk mitigation strategies. Although there are differences between GCC and European megaprojects, many of the proposed risk mitigations are similar and begin with identifying risk before considering how to best contain, transfer, avoid or mitigate the potential risks influences.

Identification & Acceptance of Cultural Differences

A 'healthy dose of particularism' is sometimes recommended [66]. Cross-cultural commentators often use the adage 'when in Rome do as the Romans' [33].

Reference [48] finds that an individual's ability to integrate into a new culture is shaped by their attitude and 'openness to cultural diversity'. References [60] and [46] describe difficulties in accepting new cultures or the 'Other' or ethnocentricity. Reference [8] defines ethnocentricity as 'the relative preference for maintaining one's heritage culture and identity, excluding contact with other ethnocultural groups'. Social integration involves accepting social differences such as religion or cultural norms [39]. Professional integration commences when the parties gain professional respect and trust in each other. Reference [51] describes trust as the 'willingness of a party to be vulnerable to another party's actions based on relationships' [53]. Reference [2] found that trust and respect are two key concepts that 'must become ingrained for all expatriates' preparing to work in the UAE.

There are several professional and social conventions to be considered in the GCC [48], [56], [66], such as acceptance of an appropriate dress code Professional conventions. Matter of history and tradition to be respected includes punctuality, language and manners [41]. Cross-cultural experts also warn of bureaucratic, professional procedures as 'nothing happens quickly', and 'trust is paramount' [55].

Staff Selection

Reference [4] identifies that the team leader should be a project champion (or the senior executive in the WC case), entirely dedicated to the megaproject's successful execution. This executive should also be flexible in responding to emerging risks. Reference [43] identifies how leaders need to provide a co-operative environment, a healthy spirit of collaboration, demonstrate people management skills. Reference [16] suggests that the megaproject leadership should encourage broad participation and be highly visible. These research findings promote an almost invincible senior executive, perceived as a 'special breed' [64]. However, recruitment specialists advise that megaproject project directors look for the same 'high standard of values, ethics, and cultural fit' as other project directors, in similar roles. They identify a need for 'directors to learn the soft skills necessary to manage cultural differences'. This study finds that GCC senior project directors are replaced frequently. Those remaining in position suggest that the executive must acquire high bureaucracy and diplomacy levels, recognise and work with multiple cultures and personalities, and ensure their tenure.

Although team relationships are further complicated by temporariness and their short-term nature, the leader must create a sense of community and collaboration. In the GCC project, directors recommend that actors should be mindful of professional and social conventions to be considered [48], [53], [66], such as acceptance of an appropriate dress code, professional conventions. GCC norms need to be respected, including punctuality, language and manners [1], [3], [41].

Overall, the project leader is required to demonstrate strong business acumen, be well versed in the construction industry, and usually have the specific knowledge necessary for the appropriate type of megaproject. Reference [27] highlights how

[2] This research considers senior project directors at the equivalent manager grade

managers of megaprojects need exceptional piloting skills.

Culture Profiling as an Aid to Staff Selection

References [38], [61], [75] and many others provide professional recruitment advice for those wishing to engage with a new culture. They promote identifying these differences to reduce the participants' exposure to culture shock and make the cultural integration process more comfortable. Several software applications such as 'cultureme' or 'culture compass' offer online support to the prospective expatriate. In the GCC field research, project directors were asked to participate in a trial, and the results are analysed to gauge any potential benefits. Project directors were requested to complete the Hofstede cultural compass survey, and more than two-thirds participated. The completed tailor-made cultural analysis provided the project directors' details of cultural differences between their base and the GCC. It also identified how their results relate to most nationals in their country. The online survey took between 15 and 30 minutes to complete, and participants responded to 42 questions. Their report helps build a profile of how their behaviour may need to be tempered to integrate to GCC successfully. A computer programme then analyses the participants' reactions towards working relationships, preferred authoritarian styles, punctuality, change management, and customer orientation.

Training

Executives report the absence of cultural training or any form of preparation, in all megaprojects. The low level of cultural training delivery could allow or give rise to low cultural empathy, leading to conflict with the project sponsor representatives leading to the expat's dismissal.

Most mitigation measures suggest that focused cultural training reduces cultural risks. References [24] and [31] analysed why employers fail to support ICT training, including high cost, reduced returns, short timeframes or the absence of adequate trainers. GCC studies frequently advise on the benefits of ICT. For the GCC, these studies include research by [2], [43], or [7] as they continually advocate the benefits of cross-cultural training.

Changing Cultural Mindsets to Anticipate and Bridge Differences

Professional construction bodies are also attempting to highlight intercultural co-operation, such as the Royal Institute of Chartered Surveyors (RICS). In 2019, the RICS reviewed its entire 'pathways and competencies framework', which sets the minimum standards of expertise required to practice as a professional member, after consulting with 400 practising members, between 2016 and 2018. They assessed a clear desire, both from RICS and external stakeholder groups, to emphasise 'cross-cultural awareness in a global business' and 'diversity, inclusion and teamworking' competencies. Stakeholder groups studied and helped develop the competency standards they expect from RICS members, including 'diversity, inclusion and team working' and optional competencies in 'cross-cultural awareness in a global business'. Cross-cultural awareness is designed to recognise and appreciate global cultural differences. The RICS aims to provide global consistency and recognise differences in national culture and differing global business mindsets. The focus included

a) 'gaining an understanding and applying effective techniques in conducting business relationships on a global basis' and
b) 'understanding the key national cultural differentiators and use this understanding to achieve effective global project performance'.

The RICS now sets compulsory minimum levels of competency for its members, to integrate with a more global work base, through a competency requirement for 'Diversity, Inclusion and Teamworking'. Diversity, inclusion and teamworking competencies are designed to adapt to global culture. Acquiring the level of prescribed membership is seen as an indicator that the member of that profession is technically competent and, in a position, to provide the necessary advice for the megaproject's execution, under the Sponsors expectations.

Building a Multicultural Environment

Reference [25] identified multicultural challenges as one of the critical factors to achieve project success. Reference [64] highlights the need for the leader of such culturally diverse groups to integrate and unite teams, demonstrate personnel management skills and be good cross-cultural communicators. One of the most critical challenges associated with megaprojects' execution is the successful management of multicultural teams in the GCC. Reference [64] highlights the challenges GCC leaders face in integrating and uniting these culturally diverse groups. These consultancy practices are formed from an extensive gathering of culturally diverse hired in experts from a pool of highly qualified resources from across the Globe [3], [18], [21]. Within the GCC, individual states' reliance on expatriates ranges from 32% in Saudi Arabia to 80% in Qatar, (December 2018). Reference [9] finds that cultural distance between the actors heightens cultural tensions, in what [75] describes as 'cultural soup'.

VIII. Conclusions

The study finds that cultural risks are significant during a megaproject's execution, where different cultures are expected to unite and construct challenging megaprojects, in the shortest possible periods. The cultural dissonance levels exposed in this research can underpin a risk management strategy to minimise its impact. All megaprojects are different; however, cultural risks are evident throughout megaprojects globally. Cultural approaches, such as China and Europe, may differ substantially, and cultural values differ, such as the Arab project Sponsor and Western Consultant in the Middle East region. The case studies sought perspectives from a wide variety of nationalities, with a wide range of views. The constant analysis of these perspectives helps identify cultural dissonance, which correlates with the actors' distance. This dissonance often surfaces in public clashes, which impact the performance and success of the venture. Cross-cultural commentators often use the adage 'when in Rome do as the Romans' [23], [33], [53].

Reference [22] describes the need to appreciate and understand the new culture and your own differences.

The critical mitigation measures suggest the correct selection of project directors, and support training to break down the cultural barriers that give rise to cultural dissonance. Other recommended cultural considerations included all-party engagement, flexible and adaptable management procedures, and maintaining a professional approach [48]. The research has found that cultural risks are lessened by considering the other point of view, acting responsively, and focusing on developing and strengthening key relationships. Risk management also involves respecting the degree of formality, making procedures transparent and limiting (where possible) the influences of politics. The study finds that cultural awareness deserves a more significant consideration if megaprojects' execution is successful.

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Three-Dimensional Evaluation Method for Asphalt Pavement Texture Characteristics

Shihao Dong, Sen Han, Qixin Zhang, Zhuang Zhang, Tengfei Yao

***Abstract*—** To supplement the research on the evaluation method of asphalt pavement texture, novel three-dimensional (3D) methods are proposed. First, pavement textures were measured in laboratory from asphalt mixture specimens using a laser texture scanner (LTS), and the macro-texture and micro-texture were extracted based on spectrum analysis techniques. Then, macro-texture level evaluation indices $f_8?_a$

***Keywords*—** highway engineering, pavement texture, gray level co-occurrence matrix, three-dimensional evaluation index, distribution uniformity.

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Hyperspectral Image Classification at Lonar Crater

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***Abstract*—**Hyperspectral images are of high resolution so helpful in classifying the land surface for variety of applications like land use land cover, lithological discrimination, differentiating different land surfaces, segmentation, etc. This work focused on the hyperspectral image classification at Lonar Crater situated at Buldhana district, Maharashtra. The Spectral angle mapper technique is used showing the 59.23% accuracy in classifying with respect to ground truths from image. This methodology consists of sequence of operations viz. bad band removal, destriping, atmospheric correction, minimum noise fraction, n-D visualization for finding classes and the classification. The land surface at and near Lonar crater is classified with more user accuracy on an average.

***Keywords*—**Classification, Hyperion, Hyperspectral Image, Spectral Angle Mapper.

I. Introduction

THE hyperspectral images are of high resolution and useful for mineral identification. The Hyperion sensor captures data in the hyperspectral images. These images are of 242 spectral bands. some bands are non-informative bands and these are bad bands. Hence, out of 242 bands only 163 bands were selected for further processing after removal of bad bands. These images are of very high spectral resolution enabling the accurate and efficient exploration of minerals. The accurate classification of land surface is possible with hyperspectral data. The classical techniques for analyzing multispectral images cannot take full advantage of spectral dimensionality. With hyperspectral imagery in-depth analysis can be performed.

Lonar crater is the world's largest basaltic crater. It is the meteorite impact crater located in district Buldhana, Maharashtra, India. Its shape is nearly circular and bowl shaped. The diameter is 1.8 km containing salty and alkaline water.

A three-step spectral and spatial methods for hyperspectral image classification were used. Support vector machine algorithm for classification was used on two hyperspectral data. (Ghassemian, 2017) Also, multivariate analysis framework (MAF) and functional data analysis techniques (FDA) used, where first MAF stood better than FDA.

Spectral analysis and classification is having different applications like classification, target detection and discrimination (Chang, 2013). There are variety of classification techniques used for hyperspectral data (Camps-Valls, 2005) like maximum-likelihood, neural networks (Chen, 2015), and SVM. The SVM classifier is excellent at hyperspectral image classification.

II. Methodology for Classification

The proposed work focuses on the classification of land surface at Lonar crater through remote sensing. The methodology

A. Preprocessing-Bad Band Removal

Some bands of Hyperion image are having no information. Bands 1 - 7, 58 - 76, 122-132, 221 – 242 are bad bands due to atmospheric problems like water vapour contents or bad illumination. These bands are removed for next processing.

B. Pre-processing- Destriping

During image acquisition, some CCD cells do not function properly as a result stripes appear in the image. To remove these stripes or lines destriping is performed. This helps in obtaining more accurate results in classification.

C. Pre-processing- Atmospheric Correction

Hyperion image suffer from some atmospheric conditions and the problems due to atmospheric conditions need to be tackled with FLAASH module. After applying FLAASH spectral profile becomes smooth.

D. Dimensionality Reduction-MNF

High dimensional data requires more time for processing it so the dimensions can be reduced using MNF technique. Also, the noise can be reduced with MNF applied on pre-processed image. Few bands are selected for further processing based on the eigenvalues obtained in MNF.

E. Pixel Purity Index

Pure pixels are extracted from the MNF bands to identify the minerals. Usually, threshold of 3 or 5 can be selected to find out pure pixels.

F. n-D Visualiser

Pure pixels identified in PPI technique are grouped into classes. The classes identified are exported in ROI tool. The endmember spectra for those classes are generated and saved as spectral library.

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G.Spectral Classification

There are different Spectral methods for classifying the land surface. Spectral angle mapper is used for hyperspectral image classification. Maximum angle for classification is set as 0.1 radians. The rule image is used to generate classified output image. Threshold is selected by using histogram for each class obtained in n-D visualizer.
The diagram of methodology of hyperspectral image classification is shown in figure 1.

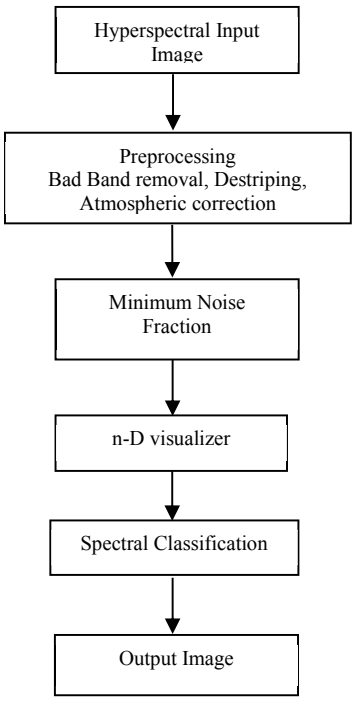

Fig. 1 Methodology of Hyperspectral Image Classification

The hyperspectral image of Hyperion sensor obtained through USGS website.

Figure 2 shows the Hyperspectral image of Lonar Crater obtained by loading RGB bands 37, 32, 17 after removing bad bands.

Fig. 2 Hyperspectral Image of Lonar Crater

III. RESULTS

The hyperspectral image of Hyperion sensor is taken as input for classification. The bad bands are removed and stripes are replaced with average values of neighboring pixel values. The atmospheric correction using FLAASH is performed. The Spectral Subset is taken indicating the region of interest. The MNF bands obtained are shown is figure 3 having eigenvalue more than 1.

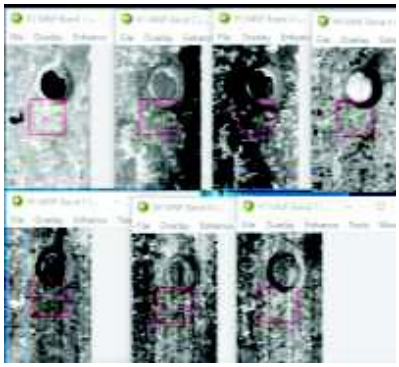

Fig. 3 MNF bands

PPI technique is applied for identifying the pure pixels with band threshold applied on maximum pixel value. Then these pure pixels are grouped into classes and these classes are exported as spectral library or ROI using n-D Visualizer. SAM is a classification technique performed based on angle between two endmember spectra. The angle selected for SAM is 0.10 radiance. The SAM parameters are shown in figure 4.

Fig. 4 SAM Parameters Before Execution

The output of SAM is shown in figure 5.

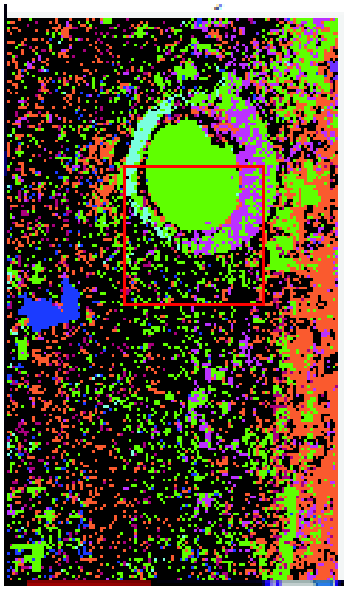

Fig. 5 Classification Output

The classes formed after applying SAM and validating through ground truth from classes obtained through n-D visualizer are as follows-

Class 1 Green lake
Class 2 Blue water_body
Class 3 Purple Pond
Class 4 Cyan Crater_rim_left
Class 5 Magenta Vegetation
Class 6 Sienna (orange) Bare Land
Class 7 Maroon Rocks

IV. Performance Results

The Confusion matrix after applying ground truth from image is shown in figure 5. The overall accuracy obtained is 59.23% with kappa coefficient 0.456.

Overall Accuracy = (3013/5087)= 59.2294%
Kappa Coefficient = 0.4561

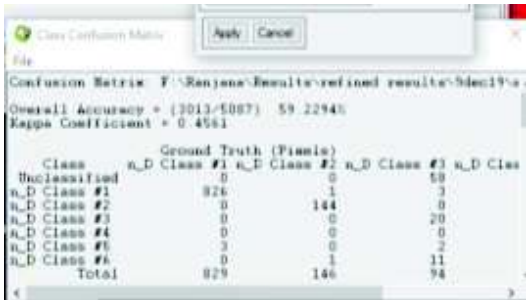

Fig. 5 Performance Results of Classification

The confusion matrix for classes 1 to 6 is shown in Table 1.

TABLE I
Confusion Matrix

Classes	Class1	Class2	Class3	Class4	Class5	Class6
Class1	826	1	3	31	385	690
Class2	0	144	0	2	5	5
Class3	0	0	20	0	1	2
Class4	0	0	0	121	2	3
Class5	3	0	2	1	460	165
Class6	0	1	11	0	44	1442

The percentage matrix with respect to Ground Truth is shown in table 2.

TABLE II
Percentage Matrix w.r.t. Ground Truth

Class	Class1	Class2	Class3	Class4	Class5	Class6
Class1	99.64	0.68	3.19	18.45	35.58	24.93
Class2	0.00	98.63	0.00	1.19	0.46	0.18
Class3	0.00	0.00	21.28	0.00	0.09	0.07
Class4	0.00	0.00	0.00	72.02	0.18	0.11
Class5	0.36	0.00	2.13	0.60	42.51	5.96
Class6	0.00	0.68	11.70	0.00	4.07	52.10

There are two types of errors viz. commission errors and omission errors. The commission error is the overestimation and this error occurs when label is assigned to a class that don't belong to it. The omission error is underestimation.
The class-wise percentage of commission rate and omission rate are shown in table 3.

TABLE III
Class-wise Commission And Omission Rates

Class	Commission (%)	Omission (%)
Class1	57.33	0.36
Class2	7.69	1.37
Class3	13.04	78.72
Class4	3.97	27.98
Class5	27.10	57.49
Class6	3.74	47.90

Producer's Accuracy is calculated by subtracting commission rate from one. It is calculated as dividing the correctly classified pixels by the total number of pixels in the standard reference image. User Accuracy is used for showing the amount of omission errors. It is calculated by dividing the correctly classified pixels by total number of pixels of the class. The Producer's Accuracy vs. User Accuracy is plotted in figure 6.

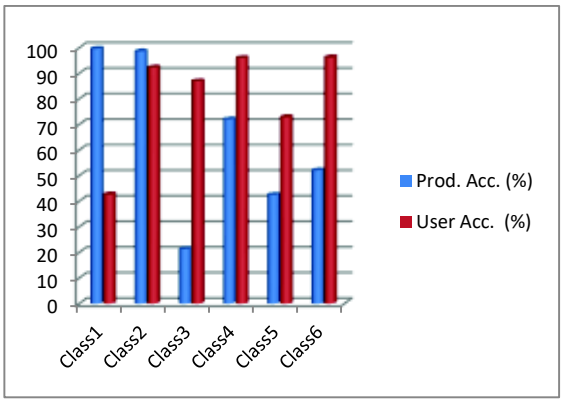

Fig. 6 Prod. Accuracy vs. User Accuracy

V. CONCLUSION

The Hyperion sensor consists of 242 spectral bands and the images are of high resolution. The hyperspectral image classification is useful to distinguish the land surface using SAM technique. The overall accuracy for this classification of land surface at Lonar crater is 59.23%.

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Robust Variable Selection Based on Schwarz Information Criterion for Linear Regression Models

Shokrya Saleh A. Alshqaq, and Abdullah Ali H. Ahmadini .

Abstract—The Schwarz information criterion (SIC) is a popular tool for selecting the best variables in regression datasets. However, SIC is defined using an unbounded estimator, namely, the least squares (LS), which is highly sensitive to outlying observations, especially bad leverage points. A method for robust variable selection based on SIC for linear regression models is thus needed. This study investigates the robustness properties of SIC by deriving its influence function and proposes a robust SIC based on the MM-estimation scale. The aim of this study is to produce a criterion that can effectively select accurate models in the presence of vertical outliers and high leverage points. The advantages of the proposed robust SIC is demonstrated through a simulation study and an analysis of a real dataset.

Keywords—Influence function, robust variable selection, robust regression, Schwarz information criterion.

I. Introduction

THIS study considers the problem of using robust selection variables for linear regression models. In modern regression datasets, outliers are commonly encountered in applications and may appear either in the response variables (vertical outliers) or predictors (leverage points). Moreover, in such dataset, selecting the best variables by using a set of criteria based on the classical estimator least squares (LS) is difficult. The traditionally used selection criteria perform poorly in terms of robustness when vertical outliers exist in the datasets [2], [11]. Consequently, the criteria set cannot select the appropriate models for the data with leverage points. Robust variable selection methods for regression data are needed. Robust variable selection is one of the important topics in regression modeling; and thus has gained the interest of many authors, for instance are the robust Mallow's Cp [8], the robust Akaike information criterion [12], and the robust R-square [13].

The Bayesian information criterion [1] is one of the commonly used criteria for model selection in linear regression. For a more general situation, the Bayesian approach can be used with a penalty term in the form of $(p\log(n))/n$, where n is the sample size, and p is the model dimension [15]. Let a linear regression model be

$$y_i = \mu + \mathbf{X}_i^T \boldsymbol{\beta} + \epsilon_i, \tag{1}$$

where μ is the intercept parameter, $\mathbf{X}_i = (\mathbf{x}_{i1}, ..., \mathbf{x}_{ip})^T$ is a vector containing p explanatory variables, y_i is the response variable, $\boldsymbol{\beta}$ is a vector of p parameters, and ϵ_i is the error component that is independent and identically distributed (iid), with a mean of 0 and a variance of σ^2. The classical SIC based on the LS estimate is defined as

$$SIC_{LS} = \log\left(SSE_p/n\right) + \left(p\log(n)\right)/n, \tag{2}$$

where $SSE_p = \sum_{i=1}^{n} r_i^2$ is the sum of the squares error for sub-model with p variables, and the residual is $r_i = y_i - \hat{\mu}_{LS} - \mathbf{X}_i^T \hat{\boldsymbol{\beta}}_{LS}$. Therefore, the models with small values of SIC_{LS} will be selected. As the LS estimator is vulnerable to the presence of outliers, it is not surprising that SIC_{LS} will also inherit this problem. A robust version of the SIC is one that is based on the M-estimator [5], [7]. In this method, the squared residuals are replaced with a robust function ρ to subsequently derive $SIC_M = \sum_{i=1}^{n} \rho\left(r_i/\sigma\right) + \left(p\log(n)\right)/n$, where ρ is a known function. Incidentally, this criterion is not robust against the contaminations in the predictor variables.

A robust version of the SIC based on least-trimmed squares estimator (LTS) called the SIC_{LTS} criterion was previously proposed [14], [9], where the SIC_{LTS} to be robust aginst the contamination of both response and predictor variables. However, although the influence of the outliers of the SIC criterion could be determined, the LTS estimator was found to be extremely inefficient when all observations for the regression model bad normal errors [14].

The MM-estimator of regression simultaneously includes high breakdown points and high efficiency under normal errors, and it has robustness in a variety of contamination scenarios [16]. MM-estimation combines high breakdown value estimation and efficient estimation. However, the MM-estimator does not use the SIC criterion for variable selection. The purpose of this study is to present the SIC_{MM} criterion as a robust variable selection criterion based on MM-scale estimates. The proposed criterion can be used for most datasets because it takes into account the presence of outliers and the possible departures from the normality assumption of error distribution.

The rest of this paper is organized as follows. Section II presents the definition and the most important properties of the MM-estimator in relation to regression modelling. Section III discusses the definition of the SIC_{MM} criterion, its robustness properties, and the algorithm used to compute this criterion. Section IV presents the simulation result corresponding to the performance of the proposed robust criterion. Section V

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discusses the application of the robust criterion to a real dataset. The concluding remark is presented in Section VI.

II. MM-ESTIMATES

MM-estimators [16] have become increasingly popular and one of the most commonly employed robust regression techniques at present. MM-estimation can reach high levels of robustness and efficiency, by combining the properties of M-estimators [5] and S-estimators [10]. The MM-estimation can be defined in three stages as follows:

Stage 1: Take an initial estimate $\hat{\boldsymbol{\beta}}_0$ of $\hat{\boldsymbol{\beta}}$ in Equation (1) with a high breakdown point, possibly 0.5. The LTS estimation can be selected as $\hat{\boldsymbol{\beta}}_0$.

Stage 2: Compute the residuals with, $r_i = y_i - \hat{\mu}_0 - \hat{\boldsymbol{\beta}}_0 \mathbf{X}_i^T$, and compute the M-scale $\sigma(r_i(\hat{\boldsymbol{\beta}}_0))$, which is defined as the value of σ.

$$\frac{1}{n}\sum_{i=1}^{n} \rho_0 \left((r_i(\hat{\boldsymbol{\beta}}_0)\right) /\sigma) = b,$$

where b is a constant, as defined by $E_\Phi \left(\rho(r_i(\hat{\boldsymbol{\beta}}_0)\right) = b$, where Φ stands for the standard normal distribution. The function ρ_0 used to satisfy the assumption (A_1): $\rho_0(0) = 0$, where $\rho_0(-u) = \rho_0(u)$, $0 \leq u \leq v$ implies $\rho_0(u) \leq \rho_0(v)$, and ρ_0 is continuous. If $a = \sup \rho_0(u)$, then $0 \leq a \leq \infty$. If $\rho_0(u) < a$ and $0 \leq u < v$, then $\rho_0(u) \leq \rho_0(v)$. The use of constant b, such that $b/a = 0.5$, implies that this scale estimate has a breakdown point equal to 0.5.

Stage 3: Let ρ_1 be another function satisfying assumption (A1), where $\rho_1(u) \leq \rho_0(u)$ and $\sup \rho_1(u) = \sup \rho_0(u) = a$. However, if $\psi_1 = \rho_1'$, then the MM-estimate ($\hat{\boldsymbol{\beta}}_{MM}$) is defined as any solution of $\sum_{i=1}^{n} \psi_1 \left(r_i/\sigma\right) \mathbf{X}_i = 0$,. $\hat{\boldsymbol{\beta}}_{MM}$ which is obtained with the iteratively reweighted least squares. The MM-estimators has been proven to be strongly consistent with $\hat{\boldsymbol{\beta}}_0$ [16]; besides, it simultaneously entails the two following properties:

1) normal asymptotic efficiency, and
2) the breakdown point is greater than or equal to the initial estimator.

However, the MM-estimator has the highest possible breakdown point, which equal to 50% [4]. The following section discusses the used of MM-estimators in the SIC_{MM} criterion.

III. SIC_{MM} CRITERION FOR VARIABLE SELECTION IN LINEAR REGRESSION

The SIC method is expressed in terms of variance, which is computed in the LS or robust method as M-estimation or LTS-estimation. A previous study [14] derived the influence function of the SIC criterion and found that its robustness was heavily dependent on scale robustness. In this study, instead of working with these scales, a high breakdown point, and efficient MM-estimators were used for the SIC criterion. This scheme could reduce the effect of outliers and leverage points. Given a scale estimate of errors defined by $S = SSE_p/(n-p)$ with $r_i = y_i - \hat{\mu}_{MM} - \mathbf{X}_i^T \hat{\boldsymbol{\beta}}_{MM}$, then the SIC_{MM} criterion can be defined as

$$SIC_{MM} = \log\left(\frac{(n-p)S^2}{n}\right) + \frac{p\log(n)}{n}. \qquad (3)$$

TABLE I
SIMULATED DATASET

$\mathbf{X}_i$	y_i
-1.2	1.2
-1.15	1.35
-1.1	1.02
-1	0.95
-0.95	1.05
-0.9	0.73
-0.85	0.91
-0.8	0.85
$\mathbf{x}_{10}$	y_{10}
0.8	-0.88
0.85	-0.61
0.9	-0.81
0.95	-0.97
1	-1.18
1.05	-1.08
1.1	-0.99
1.15	-1.11
1.2	-1.14

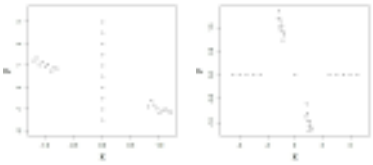

Fig. 1. Data and positions for y_{10} and x_{10}.

The small value of SIC_{MM} indicates that the explanatory variables can be adequately explained in the distribution of y. Following similar previous experiment [14], a set of independent random uniform variables $\mathbf{X}$ on [-2,2] was generated according to the simple regression model, $y_i = \mathbf{X}_i + \epsilon_i$, $i = 1, ..., 19$, where, ϵ_i presents the iid with a normal distribution and an expectation of 0 and a variance of (0.1^2). The data are presented in Table I. The purpose of conducting this experiment is to show the influence of an outlier on the SIC_{MM}, which can be illustrated through the presence of outliers in the Y-direction (vertical outlier) or in the X-direction (leverage point). On this basis, a point with coordinates $(0, y_{10})$ is added, in which the values of y are in the range [-1.5,3]. A similar approach was performed for the leverage points, i.e., the values of x were replaced with $(0, x_{10})$. Fig. 1 shows the situations of y_{10} and x_{10}.

The values of SIC_{MM} are presented in Fig. 2. The behavior of SIC_{MM} is robust and only a slight loss is observed, reaching a constant when the outlier moves farther away from the origin. The results verify the robustness of the SIC_{MM} in the presence of verticals or leverage points. Subsequently, a simulation study with a real dataset is conducted (see Section IV). In this manner, the behavior of the proposed SIC_{MM} can be clearly determined.

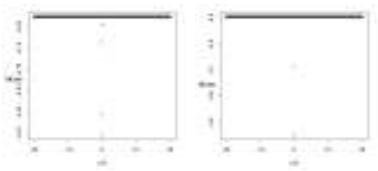

Fig. 2. Effect of adding one observation y_{10} and x_{10} to the values of SIC_{MM}.

A. Properties of the proposed robust SIC_{MM} criterion

Influence function: Consider the linear regression model in Equation (1), and assume that the distribution of errors satisfy $F_\sigma(\mathbf{X}) = F_0(\mathbf{X}/\sigma)$, where σ is the residual scale parameter, and F_0 is symmetric, with a strictly positive density function.

Let $\mathbf{X}$ and y be independent stochastic variables with the distribution H. The functional T is a Fisher-consistent for the parameters $(\mu, \boldsymbol{\beta})$ at the model distribution H, which is as given by:

$$T(H) = \begin{bmatrix} a(H) \\ \mathbf{b}(H) \end{bmatrix} = \begin{bmatrix} \mu \\ \boldsymbol{\beta} \end{bmatrix}. \tag{4}$$

For a Fisher-consistent scale estimator, $T(F_\sigma) = \sigma$ for all $\sigma > 0$. The influence function of T for the distribution F [4] is defined as,

$$IF((\mathbf{X}, y), T, H) = \lim_{\epsilon \to 0} \frac{T((1-\epsilon)H + \epsilon\Delta_{(\mathbf{X},y)}) - T(H)}{\epsilon}$$

$$= \frac{\partial}{\partial \epsilon}(T(\Delta_{(\mathbf{X},y)})). \tag{5}$$

where $T(H)$ is the function defined in the solution of the objective model, and $\Delta_{(\mathbf{X},y)}$ is the distribution containing the outliers. The influence function measures the effect of possible outliers in the SIC_{MM} criterion. Then, the amount of change in the model selection criterion estimator caused by the infinitesimal amount of contamination at $(\mathbf{X}, y)$ is calculated. Theorem 1 can be used to derive the influence function of the SIC based on the scale estimates S [14] as follows:

$$IF((\mathbf{X}, y), SIC_S, H) = \frac{2n}{(n-p)} IF(r_i/\sigma_S, \hat{\sigma}_S^2, F_0), \tag{6}$$

which is bounded in both Y- and X-directions, and $IF(r_i/\sigma, \hat{\sigma}_S^2, F_0)$ is bounded. Following immediately Equation(6), the influence function of SIC_{MM} can be calculated as

$$IF((\mathbf{X}, y), SIC_{MM}, H) = \frac{2n}{(n-p)} \psi_1(r_i)\mathbf{X}_i\sigma_0^2(B(\psi_1, F_0)V)^{-1}, \tag{7}$$

where $V = E_{G_0}(\mathbf{X}_i\mathbf{X}_i^T)$, where G_0 has a second moment, $B(\psi_1, F_0) = E_F\left(\psi_1(\frac{r_i}{\sigma_0})\right)$, and F is the distribution of the error r_i. Meanwhile, the influence function of the proposed criterion is bounded, in which a large zone of vertical outliers has zero influence, even when they are bad leverage points.

B. Gross-error sensitivity of the SIC_{MM} criterion

The gross-error sensitivity of an estimator T with a distribution F [3] is defined as

$$\gamma^\star = \sup_{\mathbf{X}} |IF(\mathbf{X}; T, F)|.$$

By taking the supreme over all $\mathbf{X}$ in which the $IF(\mathbf{X}; T, F)$ exists, the gross-error sensitivity measures the worst possible influence on an estimator by an arbitrary infinitesimal contaminant. If the gross-error sensitivity is unbounded, $\gamma^\star = \infty$, then the estimator is completely intolerant of outliers. A single outlier can ruin the estimator.

According to the above definition, the gross-error sensitivity of the SIC_{MM} criterion can be defined as the supreme influence to be obtined by an observation. If $\hat{\boldsymbol{\beta}}_{MM} = 0$, then $IF = 0$. Thus, $\hat{\boldsymbol{\beta}}_{MM} \neq 0$ can be assumed. If $\mathbf{X}$ tends to move to ∞, then the gross-error sensitivity transforms into

$$\gamma^\star(SIC_{MM}, F) = \sup(\mathbf{X}, y) IF((\mathbf{X}, y), SIC_{MM}, H)$$

$$= 2n(n-p)E_{F_0}[\rho_1(\epsilon)\epsilon] \cdot \rho_1(\infty). \tag{8}$$

Briefly, if $\mathbf{X}$ tends to move towards infinity, then both LS- and M-estimators with the ρ function will yield a high gross-error sensitivity. The MM-estimator can be computed with the ρ function to yield the lowest $\gamma^\star$.

IV. Simulation Study

A. Settings

A simulation study was carried out to investigate the performance of the proposed robust SIC_{MM} criterion. Furthermore, to compare this criterion with the existing robust criteria, namely the SIC_{LTS}, SIC_M and the classical SIC_{LS} criterion. For simplicity, the case of $p = 3$ was considered. The parameters set $(\mu, \beta_1, \beta_2, \beta_3)$ was estimated with the set of differently correlated random errors ϵ_i from the independent normal distribution with a mean of 0 and variances of $\sigma^2 = 0.7$.

The regression variables $\mathbf{x}_{i1}$, $\mathbf{x}_{i2}$, and $\mathbf{x}_{i3}$ were generated in the following two different cases

Case 1: independent uniform random variables on [-1,1]; and

.

Case 2: correlated multivariate normal distribution, $N(0, \Sigma_r)$. For some $r \geq 0$, the variance matrix of the variables is defined by $\Sigma_{r,i,j} = r^{|i-j|}$ for $1 \leq i, j \leq 3$, $r = 0.03, 0.1, 0.5$. Then the true model is given by: $y_i = \mu + \mathbf{x}_{i1} + \mathbf{x}_{i2} + \epsilon_i$. Then, we introduced vertical and leverage outliers into the data such that the percentages of contamination used were c%= 10%, 20%, 30% and 40% from two different sample sizes, namely, n= 50 and 100 . To investigate the robustness of the criteria against the vertical and leverage outliers, we considerred the following scenarios:

(a) no contamination,

(b) vertical outliers (outliers in some y_i only),

(c) good leverage points (outliers in the y_i and $\mathbf{X}$), and

(d) bad leverage points (outliers in some $\mathbf{X}$ only).

For the vertical outliers, we randomly generated different

percentages of the outliers from $N(50, 0.1^2)$ for each of the simulated cases. For the good leverage point, we considered the different percentages of the outliers on variables $\mathbf{x}_1$ and $\mathbf{x}_2$, which were generated from the $N(100, 0.5^2)$ distribution, after which the values were generated on y. For the bad leverage points, different percentages of the outliers were generated on variables $\mathbf{x}_1$ and $\mathbf{x}_2$ from the $N(100, 0.5^2)$ distribution.

The performance of the criteria was determined by summarizing the percentages for the following models: (i) correct fit (true model); (ii) overfit (models containing all of the variables in the true model plus other variables that are redundant in $\mathbf{x}_1$, $\mathbf{x}_2$, and $\mathbf{x}_3$); (iii) underfit (models with only a strict of variables in the true model); and (iv) wrong fit (the model that does not accord with (i), (ii), and (iii)). The simulations were performed using the statistical software R with s = 1000 Monte Carlo trials. The functions rlm and $ltsreg$ from the software library (robust) were used for M- and LTS-estimations, respectively. The function $lmrob$ from the library (robustbase) was used for the MM-estimation.

B. Results and discussion

First, we consider the data without the outliers. Table II shows the detailed simulation results of the two cases with simulation settings that include all of the different SIC criteria. The proposed SIC_{MM} was able to select nearly 70% to 80% of correctly fitted models, but the classical SIC_{LS} performed better than the robust SIC (94% to 96%). However, as the percentage of outliers increased (Table III), the SIC_{LS} was able to select a larger proportion of wrongly fitted models than other criteria. this trend holds for cases 1 and 2. Meanwhile, the SIC_M continued to yield a relatively high percentage of correct fittings, with the percentage of vertical outliers increased to 20%; then, it tends to be underfitted. The SIC_M method notably ignored some of the important variables in the model. Higher proportion of overfitted and correctly fitted models were selected by the SIC_{LTS}. As expected, the percentages of the true models in all cases of SIC_{MM} were always large in the presence of vertical outliers; this result holds for both cases and in the presence of high-contamination levels of vertical outliers. Table IV shows the situation in which the data were contaminated with good leverage points. we can deduce that the good leverage points only slightly affect the different SIC criteria, but the presence of bad leverage points would dramatically change this trend. As shown in Tables V, the SIC_{LS} and SIC_M can select a higher proportion of wrongly fitted models than the SIC based on LTS-estimators. The SIC_{LTS} tended to produce either correct fitted or overfitted models, and the proposed criterion performed better when the bad leverage points were present in the data.

In general, the robust SIC criteria with M- and LTS-estimations are robust in the presence of outliers in the response variable. However, in the presence of bad leverage points (i.e., percentage of bad leverage point increases), the values of these criteria become affected and will differ significantly from the true fit. The SIC_{MM} criterion is less affected in all cases in the presence of outliers in the X- and Y-directions.

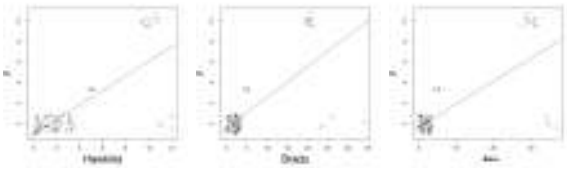

Fig. 3. The regression plot of y via Hawkins, Bradu, and Kass

V. Practical Example

Hawkins-Bradu-Kass Data: The data were generated by to illustrate the merits of the robust technique [6]. The first 10 observations represent the bad leverage points (the first 10 observations are outliers), whereas the succeeding 4 observations represent the good leverage points. Fig. 3 illustrates the regression plot of y_i by using the different variables.

Table VI shows the values of different criteria for the Hawkins-Bradu-Kass data for the different sets of variables. Small values of the criteria were considered to show the best model. The SIC_{MM} agrees well with the importance of all three variables (i.e., low values of SIC_{MM}). The values of the other criteria were small with underfitted values.

VI. Conclusion

In this study the SIC criterion was used with a high breakdown. The criterion was found to be efficient and could be bounded by influence scale estimators. The influence function of the criterion for the linear regression model based on the MM-scale approach was explored. The simulation results and the application of a real dataset suggest that among the selected scenarios, the proposed SIC_{MM} criterion could provide the best selection of correct models with uncontaminated datasets, and its stability was superior in the presence of outliers.

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TABLE II
PERCENTAGE OF SELECTED MODELS FROM DIFFERENT CRITERIA FOR DATA WITH NO CONTAMINATION

		n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	70.6	36.3	55.6	94.8	100	79.3	48.3	64.1	96.6
	Under fit		4.2	2.8	10.0	0.1		0.2	0.1	2.7	0.0
	Over fit		23.6	57.1	27.1	5.1		20.5	50.3	31.0	3.4
	Wrong fit		1.6	3.8	7.3	0.0		0.0	1.3	2.2	0.0
Case 2, r=0.03	Correct fit	50	75.2	39.8	63.8	94	100	78.7	46.1	66.5	97.1
	Under fit		0.0	0.1	0.4	0		0.0	0.0	0.0	0.0
	Over fit		24.6	59.8	35.1	6		21.3	53.9	33.5	2.9
	Wrong fit		0.2	0.3	0.7	0		0.0	0.0	0.0	0.0
Case 2, r=0.1	Correct fit	50	75.8	36.9	64.0	93.6	100	78.9	49.1	65.8	97.7
	Under fit		0.2	0.4	0.9	0.0		0.0	0.0	0.0	0.0
	Over fit		24.0	62.6	34.6	6.4		21.1	50.9	34.2	2.3
	Wrong fit		0.0	0.1	0.5	0.0		0.0	0.0	0.0	0.0
Case 2, r=0.5	Correct fit	50	71.8	38.2	62.5	94.5	100	81.0	47.7	68.8	96.9
	Under fit		0.3	0.0	2.0	0.0		0.1	0.2	0.2	0.0
	Over fit		27.4	60.8	33.5	5.5		18.9	51.9	30.5	3.1
	Wrong fit		0.5	1.0	2.0	0.0		0.0	0.2	0.5	0.0

TABLE III
PERCENTAGE OF SELECTED MODELS FROM DIFFERENT CRITERIA FOR DATA WITH VERTICAL OUTLIERS

5% verticals	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	72.9	39.3	53.7	0.8	100	82.6	49.6	64.3	0.5
		Under fit	5.3	3.2	11.9	67.6		0.2	0.4	3.1	69.3
		Over fit	19.9	54.4	27.1	0.1		17.1	49.3	31.0	0.0
		Wrong fit	1.9	3.1	7.3	31.5		0.1	0.7	1.6	30.2
Case 2, r=0.03	50	Correct fit	78.1	38.4	62.7	0.7	100	80.3	48.2	67.4	1.2
		Under fit	0.1	0.1	1.2	70.6		0.0	0.0	0.0	77.7
		Over fit	21.8	61.2	35.5	0.2		19.7	51.8	32.6	0.0
		Wrong fit	0.0	0.3	0.6	28.5		0.0	0.0	0.0	21.1
Case 2, r=0.1	50	Correct fit	78.6	40.8	65.2	1.2	100	83	47.7	66.8	1.2
		Under fit	0.0	0.1	0.5	71.4		0	0.0	0.0	77.5
		Over fit	21.4	59.1	34.0	0.3		17	52.3	33.2	0.0
		Wrong fit	0.0	0.0	0.3	27.1		0	0.0	0.0	21.3
Case 2, r=0.5	50	Correct fit	79.2	41.1	61.4	1.4	100	82.4	49.9	67.3	0.4
		Under fit	0.5	0.6	1.9	70.9		0.0	0.0	0.0	78.8
		Over fit	19.8	57.6	33.8	0.1		17.6	50.1	32.7	0.0
		Wrong fit	0.5	0.7	2.9	27.6		0.0	0.0	0.0	20.8
10% verticals	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	77.8	40.7	57.3	0.8	100	82.2	51.6	65.6	0.3
		Under fit	3.2	3.4	9.1	66.6		0.0	0.8	1.9	67.9
		Over fit	18.0	52.1	27.9	0.0		17.7	47.1	30.7	0.0
		Wrong fit	1.0	3.8	5.7	32.6		0.1	0.5	1.8	31.8
Case 2, r=0.03	50	Correct fit	83.4	44.3	64.6	0.8	100	84.5	52	66.5	0.8
		Under fit	0.0	0.1	0.6	69.0		0.0	0	0.0	68.1
		Over fit	16.6	55.4	34.6	0.0		15.5	48	33.5	0.0
		Wrong fit	0.0	0.2	0.2	30.2		0.0	0	0.0	31.1
Case 2, r=0.1	50	Correct fit	80.7	41.4	64.8	0.9	100	85.3	55.1	67.2	0.3
		Under fit	0.2	0.3	0.9	68.3		0.0	0.0	0.0	73.4
		Over fit	19.0	58.0	33.6	0.2		14.7	44.9	32.8	0.1
		Wrong fit	0.1	0.3	0.7	30.6		0.0	0.0	0.0	26.2
Case 2, r=0.5	50	Correct fit	80.0	42.4	62.7	0.7	100	85	51.2	68.7	0.7
		Under fit	0.1	0.4	1.9	67.0		0	0.0	0.1	72.1
		Over fit	19.8	56.2	33.4	0.0		15	48.7	31.1	0.0
		Wrong fit	0.1	1.0	2.0	32.3		0	0.1	0.1	27.2
20% verticals	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	85.5	48.0	54.9	0.7	100	88.5	58.0	66.8	0.6
		Under fit	4.0	4.9	13.4	64.8		0.0	0.1	3.5	69.0
		Over fit	9.9	43.6	22.8	0.0		11.4	41.1	28.1	0.0
		Wrong fit	0.6	3.5	8.9	34.5		0.1	0.8	1.6	30.4
Case 2, r=0.03	50	Correct fit	88.1	51.2	67.6	0.4	100	90.4	59.6	66.7	0.3
		Under fit	0.0	0.1	1.1	63.0		0.0	0.0	0.0	69.6
		Over fit	11.8	48.5	30.2	0.1		9.6	40.4	33.3	0.0
		Wrong fit	0.1	0.2	1.1	36.5		0.0	0.0	0.0	30.1
Case 2, r=0.1	50	Correct fit	86.3	51.0	67.8	0.4	100	89.5	63	68.1	0.5
		Under fit	0.0	0.3	1.8	68.5		0.0	0	0.0	69.2
		Over fit	13.6	48.6	29.4	0.1		10.5	37	31.8	0.0
		Wrong fit	0.1	0.1	1.0	31.0		0.0	0	0.1	30.3
Case 2, r=0.5	50	Correct fit	86.2	49.9	63.9	0.7	100	89.5	62.6	67.7	0.1
		Under fit	0.2	0.5	3.4	64.6		0.0	0.0	0.3	69.4
		Over fit	13.3	48.6	29.4	0.1		10.5	37.3	31.9	0.0
		Wrong fit	0.3	1.0	3.3	34.6		0.0	0.1	0.1	30.5
30% vertical	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	89.2	57.0	4.7	0.2	100	94.1	69.7	8.3	0.3
		Under fit	3.0	4.4	60.0	66.0		0.1	0.4	60.3	68.9
		Over fit	7.0	37.0	1.7	0.0		5.8	29.8	0.7	0.0
		Wrong fit	0.8	1.6	33.6	33.8		0.0	0.1	30.7	30.8
Case 2, r=0.03	50	Correct fit	92.7	61.2	7.7	0.2	100	93.7	71.7	15.6	0.4
		Under fit	0.0	0.1	63.3	67.0		0.0	0.0	58.8	68.1
		Over fit	7.3	38.7	1.7	0.1		6.3	28.3	2.2	0.0
		Wrong fit	0.0	0.0	27.3	32.7		0.0	0.0	23.4	31.5
Case 2, r=0.1	50	Correct fit	93.1	59.8	8.3	0.6	100	94	69.8	18.2	0.0
		Under fit	0.0	0.1	60.2	66.4		0	0.0	57.8	67.2
		Over fit	6.9	40.0	1.3	0.0		6	30.2	1.0	0.0
		Wrong fit	0.0	0.1	30.2	33.0		0	0.0	23.0	32.8
Case 2, r=0.5	50	Correct fit	91.6	58.3	7.5	0.4	100	94.4	73.1	15.4	0.2
		Under fit	0.3	0.3	65.5	63.5		0.0	0.0	60.5	66.1
		Over fit	8.0	40.7	1.6	0.2		5.6	26.9	1.4	0.1
		Wrong fit	0.1	0.7	25.4	35.9		0.0	0.0	22.7	33.6
40% verticals	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	86.6	69.4	5.3	0.4	100	97.1	81.7	1.1	0.1
		Under fit	10.9	5.2	61.9	68.0		0.1	0.2	69.1	67.5
		Over fit	1.8	24.4	3.6	0.0		2.8	18.1	0.9	0.0
		Wrong fit	0.7	1.0	29.2	31.6		0.0	0.0	28.9	32.4
Case 2, r=0.03	50	Correct fit	97.3	74.0	2.6	0.1	100	98.4	82.7	3.8	0.1
		Under fit	0.0	0.1	68.2	66.1		0.0	0.0	77.6	67.4
		Over fit	2.7	25.9	2.9	0.0		1.6	17.3	0.5	0.0
		Wrong fit	0.0	0.0	26.3	33.8		0.0	0.0	18.1	32.5
Case 2, r=0.1	50	Correct fit	98.8	76.2	3.8	0.8	100	97.9	81.7	2.4	0.2
		Under fit	0.0	0.1	67.8	65.2		0.0	0.0	77.0	67.3
		Over fit	1.2	23.7	2.4	0.0		2.1	18.3	0.3	0.0
		Wrong fit	0.0	0.0	26.0	34.0		0.0	0.0	20.3	32.5
Case 2, r=0.5	50	Correct fit	98.1	74.9	3.4	1.2	100	98.1	82.5	2.0	0.9
		Under fit	0.1	0.4	68.8	64.8		0.0	0.0	78.7	67.6
		Over fit	1.8	24.5	3.6	0.3		1.9	17.5	1.0	0.0
		Wrong fit	0.0	0.2	24.2	33.7		0.0	0.0	18.3	31.5

TABLE IV
PERCENTAGE OF SELECTED MODELS FROM DIFFERENT CRITERIA FOR DATA WITH GOOD LEVERAGE POINTS

5% good leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	93.4	67.5	76.0	100	100	97.3	78.1	84.9	100
		Under fit	2.1	2.6	3.4	0		0.2	0.2	0.2	0
		Over fit	3.9	26.9	19.0	0		2.5	21.2	14.7	0
		Wrong fit	0.6	3.0	1.6	0		0.0	0.5	0.2	0
Case 2, r=0.03	50	Correct fit	96.0	69.4	78.9	100	100	97.4	82.5	87.3	100
		Under fit	0.0	0.6	1.0	0		0.0	0.0	0.1	0
		Over fit	3.8	29.1	19.7	0		2.6	17.5	12.5	0
		Wrong fit	0.2	0.9	0.4	0		0.0	0.0	0.1	0
Case 2, r=0.1	50	Correct fit	94.6	70.9	76.2	100	100	97.5	79.1	88.3	100
		Under fit	0.1	0.3	1.6	0		0.0	0.0	0.0	0
		Over fit	4.8	27.6	21.0	0		2.5	20.9	11.7	0
		Wrong fit	0.5	1.2	1.2	0		0.0	0.0	0.0	0
Case 2, r=0.5	50	Correct fit	94.0	70.7	78.6	100	100	97.6	76.9	85.6	100
		Under fit	0.3	0.4	1.3	0		0.0	0.0	0.0	0
		Over fit	5.3	28.1	19.6	0		2.4	23.1	14.4	0
		Wrong fit	0.4	0.8	0.5	0		0.0	0.0	0.0	0
10% good leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	97.2	81.2	86.0	100	100	100	94.0	96.4	100
		Under fit	0.8	2.3	2.5	0		0	0.4	0.6	0
		Over fit	1.5	14.1	9.4	0		0	5.6	2.9	0
		Wrong fit	0.5	2.4	2.1	0		0	0.0	0.1	0
Case 2, r=0.03	50	Correct fit	98.7	85.6	90.2	100	100	99.7	94.3	95.9	100
		Under fit	0.0	0.0	0.0	0		0.0	0.0	0.0	0
		Over fit	1.3	14.4	9.8	0		0.3	5.7	4.1	0
		Wrong fit	0.0	0.0	0.0	0		0.0	0.0	0.0	0
Case 2, r=0.1	50	Correct fit	98.5	83.8	90.1	100	100	100	94.8	96.9	100
		Under fit	0.0	0.0	0.0	0		0	0.0	0.0	0
		Over fit	1.5	16.1	9.8	0		0	5.2	3.1	0
		Wrong fit	0.0	0.1	0.1	0		0	0.0	0.0	0
Case 2, r=0.5	50	Correct fit	98.0	82.6	88.9	100	100	99.9	94	95.1	100
		Under fit	0.3	0.5	1.1	0		0.0	0	0.1	0
		Over fit	1.5	15.7	9.1	0		0.1	6	4.8	0
		Wrong fit	0.2	1.2	0.9	0		0.0	0	0.0	0
20% good leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	98.6	94.7	92.8	100	100	99.9	94	95.1	100
		Under fit	0.8	1.2	3.7	0		0.0	0	0.1	0
		Over fit	0.1	1.1	0.6	0		0.1	6	4.8	0
		Wrong fit	0.5	3.0	2.9	0		0.0	0	0.0	0
Case 2, r=0.03	50	Correct fit	100	98.7	99.3	100	100	100	99.9	100	100
		Under fit	0	0.0	0.2	0		0	0.0	0	0
		Over fit	0	1.2	0.5	0		0	0.1	0	0
		Wrong fit	0	0.1	0.0	0		0	0.0	0	0
Case 2, r=0.1	50	Correct fit	100	98.5	99.2	100	100	100	99.9	100	100
		Under fit	0	0.0	0.1	0		0	0.0	0	0
		Over fit	0	1.4	0.4	0		0	0.1	0	0
		Wrong fit	0	0.1	0.3	0		0	0.0	0	0
Case 2, r=0.5	50	Correct fit	99.8	97.3	97.2	100	100	100	99.7	99.9	100
		Under fit	0.1	0.5	1.2	0		0	0.0	0.1	0
		Over fit	0.0	1.1	0.2	0		0	0.1	0.0	0
		Wrong fit	0.1	1.1	1.4	0		0	0.2	0.0	0
30% good leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	99.0	96.9	94.3	100	100	100	99.8	99.2	100
		Under fit	0.5	0.6	2.4	0			0.1	0.4	0
		Over fit	0.0	0.1	0.0	0		0.0	0.0	0	
		Wrong fit	0.5	2.4	3.3	0		0	0.1	0.4	0
Case 2, r=0.03	50	Correct fit	100	99.9	99.5	100	100	100	100	100	100
		Under fit	0	0.0	0.0	0		0	0	0	0
		Over fit	0	0.0	0.0	0		0	0	0	0
		Wrong fit	0	0.1	0.5	0		0	0	0	0
Case 2, r=0.1	50	Correct fit	100	99.4	99.2	100	100	100	100	100	100
		Under fit	0	0.1	0.1	0		0	0	0	0
		Over fit	0	0.1	0.0	0		0	0	0	0
		Wrong fit	0	0.4	0.7	0		0	0	0	0
Case 2, r=0.5	50	Correct fit	99.8	97.9	95.9	100	100	100	99.7	99.4	100
		Under fit	0.0	0.1	2.3	0		0	0.1	0.3	0
		Over fit	0.0	0.0	0.0	0		0	0.0	0.0	0
		Wrong fit	0.2	2.0	1.8	0		0	0.2	0.3	0
40% good leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	50	Correct fit	98.8	96.0	93.5	100	100	100	99.7	99.0	100
		Under fit	0.6	1.2	4.1	0		0	0.0	0.7	0
		Over fit	0.0	0.0	0.0	0		0	0.0	0.0	0
		Wrong fit	0.6	2.8	2.4	0		0	0.3	0.3	0
Case 2, r=0.03	50	Correct fit	99.8	99.4	98	100	100	100	100	100	100
		Under fit	0.1	0.1	1	0		0	0	0	0
		Over fit	0.0	0.0	0	0		0	0	0	0
		Wrong fit	0.1	0.5	1	0		0	0	0	0
Case 2, r=0.1	50	Correct fit	99.8	99.3	98.9	100	100	100	100	99.8	100
		Under fit	0.1	0.4	0.4	0		0	0	0.1	0
		Over fit	0.0	0.0	0.0	0		0	0	0.0	0
		Wrong fit	0.1	0.3	0.7	0		0	0	0.1	0
Case 2, r=0.5	50	Correct fit	98.9	97.3	94.9	100	100	100	100	99.9	100
		Under fit	0.5	0.7	2.8	0		0	0	0.1	0
		Over fit	0.0	0.0	0.0	0		0	0	0.0	0
		Wrong fit	0.6	2.0	2.3	0		0	0	0.0	0

TABLE V
PERCENTAGE OF SELECTED MODELS FROM DIFFERENT CRITERIA FOR DATA WITH BAD LEVERAGE POINTS

5% bad leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	71.8	36.3	19.6	1.8	100	80.9	47.1	15.2	1.1
	Under fit		3.8	3.0	30.7	49.0		0.0	0.8	35.2	49.2
	Over fit		21.2	55.9	9.3	0.0		19.0	51.6	8.4	0.0
	Wrong fit		3.2	4.8	40.4	49.2		0.1	0.5	41.2	49.7
Case 2, r=0.03	Correct fit	50	75.5	39.6	17.1	4.0	100	83.2	51.4	19.4	3.7
	Under fit		0.1	0.3	32.4	50.9		0.0	0.0	31.7	48.3
	Over fit		24.4	60.1	8.7	0.1		16.8	48.6	7.8	0.0
	Wrong fit		0.0	0.0	41.8	45.0		0.0	0.0	41.1	48.0
Case 2, r=0.1	Correct fit	50	77.5	40.1	18.6	4.0	100	79.9	50.6	14.4	2.7
	Under fit		0.0	0.2	31.5	47.0		0.0	0.0	35.4	45.0
	Over fit		22.5	59.7	9.9	0.1		20.1	49.4	9.7	0.1
	Wrong fit		0.0	0.0	40.0	48.9		0.0	0.0	40.5	52.2
Case 2, r=0.5	Correct fit	50	80.1	37.9	9.5	0.4	100	80.5	50.4	6.1	0.1
	Under fit		0.4	0.6	16.6	2.9		0.0	0.0	12.2	0.4
	Over fit		19.5	60.9	19.4	4.1		19.5	49.6	22.6	4.9
	Wrong fit		0.0	0.6	54.5	92.6		0.0	0.0	59.1	94.6
10% bad leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	72.8	41.1	17.1	2.0	100	85.5	53.2	15.8	0.5
	Under fit		4.5	3.7	31.6	49.2		0.3	0.9	34.0	49.1
	Over fit		18.5	50.4	7.6	0.0		14.1	45.2	7.1	0.1
	Wrong fit		4.2	4.8	43.7	48.8		0.1	0.7	43.1	50.3
Case 2, r=0.03	Correct fit	50	80.7	44.6	16.7	4.7	100	84	54.3	15.8	2.7
	Under fit		0.1	0.2	32.4	47.7		0	0.0	34.0	49.8
	Over fit		19.0	54.9	8.7	0.2		16	45.7	7.2	0.0
	Wrong fit		0.2	0.3	42.2	47.4		0	0.0	43.0	47.5
Case 2, r=0.1	Correct fit	50	78.5	42.3	18.2	5.1	100	84.5	53.7	14.6	3.0
	Under fit		0.1	0.2	31.4	44.3		0.0	0.0	31.8	45.3
	Over fit		21.3	57.1	7.1	0.1		15.5	46.3	8.8	0.0
	Wrong fit		0.1	0.4	43.3	50.5		0.0	0.0	44.8	51.7
Case 2, r=0.5	Correct fit	50	80.7	42.6	9.1	0.7	100	81.8	52.6	5.2	0.0
	Under fit		0.6	0.7	16.6	2.8		0.0	0.0	12.2	0.0
	Over fit		18.1	56.0	20.2	3.8		18.2	47.4	23.9	3.9
	Wrong fit		0.6	0.7	54.1	92.7		0.0	0.0	58.7	96.1
20% bad leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	54.4	37.8	17.1	2.0	100	70.9	52.8	16.4	0.5
	Under fit		15.5	4.5	31.7	48.5		8.0	3.4	32.5	52.4
	Over fit		9.3	44.0	6.7	0.1		9.5	35.7	5.0	0.0
	Wrong fit		20.8	13.7	44.5	49.4		11.6	8.1	46.1	47.1
Case 2, r=0.03	Correct fit	50	87.0	47.6	17.0	4.2	100	87.4	60.5	13.7	2.4
	Under fit		0.5	0.5	32.9	47.6		0.0	0.0	34.3	47.1
	Over fit		11.8	50.9	8.5	0.1		12.6	39.5	7.6	0.0
	Wrong fit		0.7	1.0	41.6	48.1		0.0	0.0	44.4	50.5
Case 2, r=0.1	Correct fit	50	87.5	52.5	17.3	4.7	100	90.4	60.9	16.0	2.4
	Under fit		0.6	0.4	32.8	45.9		0.0	0.0	31.1	43.6
	Over fit		11.6	46.7	7.6	0.2		9.6	39.1	7.2	0.2
	Wrong fit		0.3	0.4	42.3	49.2		0.0	0.0	45.7	53.8
Case 2, r=0.5	Correct fit	50	87.9	50.0	7.9	0.4	100	89.2	59.2	5.9	0.2
	Under fit		0.2	0.4	17.9	2.9		0.0	0.0	11.5	0.0
	Over fit		11.3	48.2	20.2	3.0		10.8	40.8	20.8	3.3
	Wrong fit		0.6	1.4	54.0	93.7		0.0	0.0	61.8	96.5
30% bad leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	43.7	29.6	17.3	2.6	100	44.3	36.7	16.1	0.7
	Under fit		20.0	10.9	30.7	46.9		15.9	10.3	32.1	49.9
	Over fit		31.0	34.2	7.5	0.1		36.5	26.8	7.9	0.0
	Wrong fit		5.3	25.3	44.5	50.4		3.3	26.2	43.9	49.4
Case 2, r=0.03	Correct fit	50	75.7	53.3	18.4	4.5	100	91.4	69.6	17.5	2.3
	Under fit		6.6	1.5	29.2	46.6		0.9	0.2	31.2	50.2
	Over fit		7.9	40.7	7.9	0.1		5.7	29.5	7.9	0.0
	Wrong fit		9.8	4.5	44.5	48.8		2.0	0.7	43.4	47.5
Case 2, r=0.1	Correct fit	50	79.2	54.7	15.9	3.0	100	92.8	70.0	17.6	1.9
	Under fit		6.2	1.8	29.3	44.4		1.1	0.3	32.4	41.9
	Over fit		7.3	39.3	8.6	0.2		4.6	29.0	7.6	0.0
	Wrong fit		7.3	4.2	46.2	52.4		1.5	0.7	42.4	56.2
Case 2, r=0.5	Correct fit	50	83.6	56.1	8.4	0.4	100	94.0	69.1	5.4	0.0
	Under fit		1.1	0.6	16.3	2.6		0.1	0.2	12.2	0.2
	Over fit		8.1	39.9	17.4	3.1		5.1	30.6	20.5	3.3
	Wrong fit		7.2	3.4	57.9	93.9		0.8	0.1	61.9	96.5
40% bad leverage	n		SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}	n	SIC_{MM}	SIC_{LTS}	SIC_{M}	SIC_{LS}
Case 1	Correct fit	50	46.3	19.5	15.1	3.3	100	47.1	22.0	17.3	1.4
	Under fit		12.5	14.3	29.6	48.6		11.4	15.2	30.9	51.2
	Over fit		36.7	33.1	11.7	0.0		39.1	24.4	7.7	0.0
	Wrong fit		4.5	33.1	43.6	48.1		2.4	38.4	44.1	47.4
Case 2, r=0.03	Correct fit	50	44.7	42.1	15.5	4.3	100	62.9	17.4	16.0	1.9
	Under fit		33.6	7.8	29.4	48.3		5.0	34.7	32.8	46.1
	Over fit		4.9	31.2	8.9	0.1		21.5	3.8	6.7	0.0
	Wrong fit		16.8	18.9	46.2	47.3		10.6	44.1	44.5	52.0
Case 2, r=0.1	Correct fit	50	45.4	42.2	16.8	4.4	100	65.9	22.4	15.5	3.0
	Under fit		18.8	8.3	25.5	42.6		4.5	30.6	30.5	41.6
	Over fit		31.1	32.1	9.6	0.1		18.7	2.7	7.9	0.0
	Wrong fit		4.7	17.4	48.1	52.9		10.9	44.3	46.1	55.4
Case 2, r=0.5	Correct fit	50	43.0	15.1	7.2	0.1	100	65.8	19.7	5.5	0.0
	Under fit		1.9	9.4	16.0	2.1		0.9	3.8	11.6	0.1
	Over fit		37.0	11.7	18.7	3.2		22.5	11.4	20.4	2.6
	Wrong fit		18.1	63.8	58.1	94.6		10.8	65.1	62.5	97.3

TABLE VI
VALUES OF DIFFERENT CRITERIA FOR HAWKINS-BRADU-KASS DATA FOR DIFFERENT SET OF VARIABLES

Set of variables	$SIC_{MM},$	SIC_{LTS}	SIC_{M}	SIC_{LS}
(y,Hawkins)	-0.3877	-0.6233	0.8786	1.7553
(y,Bradu)	-0.4056	-0.6277	0.2157	1.8609
(y,Kass)	-0.3982	-0.5835	-0.3089	1.7077
(y,Hawkins,Bradu)	-0.3525	-0.5904	-0.2360	1.7898
(y,Hawkins,Kass)	-0.3999	-0.6514	**-0.1147**	1.7358
(y,Bradu,Kass)	-0.3766	**-0.5719**	-0.2206	**1.6839**
(y,Hawkins,Bradu,Kass)	**-0.4062**	-0.6816	-0.1385	1.7077

Bounded Solution Method for Geometric Programming Problem with Varying Parameters

Abdullah Ali H. Ahmadini, Firoz Ahmad, Intekhab Alam

***Abstract*—**Geometric programming problem (GPP) is a well-known non-linear optimization problem having a wide range of applications in many engineering problems. The structure of GPP is quite dynamic and easily fit to the various decision-making processes. The aim of this paper is to highlight the bounded solution method for GPP with special reference to variation among right-hand side parameters. Thus this paper is taken the advantage of two-level mathematical programming problems and determines the solution of the objective function in a specified interval called lower and upper bounds. The beauty of the proposed bounded solution method is that it does not require sensitivity analyses of the obtained optimal solution. The value of the objective function is directly calculated under varying parameters. To show the validity and applicability of the proposed method, a numerical example is presented. The system reliability optimization problem is also illustrated and found that the value of the objective function lies between the range of lower and upper bounds respectively. At last, conclusions and future research are depicted based on the discussed work.

***Keywords*—**Varying parameters; Geometric programming problem; Bounded solution method; System reliability optimization.

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Quintessential Inflation from Lorentzian Slow Roll

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***Abstract*—** From the assumption that the slow roll parameter ε has a Lorentzian form as a function of the e-folds number N, a successful model of a quintessential inflation is obtained, as succinctly studied in [1]. The form corresponds

to the vacuum energy both in the inflationary and in the dark energy epochs and satisfies the condition to climb from small values of ε to 1 at the end of the inflationary epoch.

We find the corresponding scalar Quintessential Inflationary potential with two flat regions. Moreover, a reheating mechanism is suggested with numerical estimation for the homogeneous evolution of the universe. The suggested mechanism is consistent with the BBN bound.

***Keywords*—** inflation, dark energy, gravity, cosmology.

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The Effective Solution of Last Mile Delivery by Using Drone Delivery

Sultan Alkaabi

***Abstract*—** This paper ought to show the future of drone delivery for commercial use globally and how it will make last-mile delivery more efficient and effective. It might face some challenges in the beginning but with time once it starts to operate in developed countries it will start spread around the world very fast. Many challenges found in this paper but for sure organizations will be able to work on those challenges and make it an opportunity. In the next few years, we will see drone delivery are very common and will receive our goods by drones.

***Keywords*—** Drone, Last Mile Delivery, COVID-19, UAS.

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Field and Numerical Investigation of the Impact of Nakhle Nakhoda Breakwater Construction on Bandar Abbas Coastal Current Patterns

Majid Zarezadeh

***Abstract*—** The purpose of this study is to study the coastal currents and to investigate the impact of the construction of Nakhlnakhoda pier on this coastal current. In addition to measuring the velocity of coastal currents in the bilayer, over a period of 30 days by ADCP, as well as measuring other parameters such as turbidity, temperature, salinity, density, etc. in 11 CTD stations were statistically analyzed. The results show the influence of different parameters, which are related to the change of coastal currents. Therefore, using the available data, numerical modeling with ROMS open source code was performed. In order to investigate the effects of Nakhlnakhoda pier construction on coastal currents and the parameters affected by it, modeling was performed in two modes, with and without pier, and calibrated and monitored by field data. The results show the effects of this pier on coastal currents as well as reducing the effect of tidal currents around the pier and changes in the magnitude and direction of coastal currents, leading to sediment around the pier.

***Keywords*—** Coastal current, Field Measurement, Numerical Modeling, Regional Ocean Modeling System.

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Dietary Phenylalanine Requirement of Fingerling Oreochromis Niloticus (Linnaeus)

Seemab Zehra, Ramzy Yousif

***Abstract*—** This study was conducted to determine the dietary phenylalanine for fingerling Oreochromis niloticus by conducting an 8 weeks experiment in a flow-through system (1-1.5L/min) at 28°C water temperature. Phenylalanine requirement was determined by feeding six casein-gelatin based amino acid test diets (350 g kg–1 CP; 16.72 kJ g–1 GE) with graded levels of phenylalanine (4, 6.5, 9, 11.5, 14 and 16.5 g kg–1 dry diet) at a constant level (10 g kg–1) of dietary tyrosine to triplicate groups of fish (1.65±0.09 g) near to satiation. Absolute weight gain (AWG g fish-1), feed conversion ratio (FCR), protein deposition (PD%), phenylalanine retention efficiency (PRE%) and RNA/DNA ratio was found to improve with the increasing concentrations of phenylalanine and peaked at 11.5 g kg–1 of dry diet. Quadratic regression analysis of AWG, PD and PRE against varying levels of dietary phenylalanine indicated the requirement at 12.1, 11.6, and 12.7 g kg–1 dry diet, respectively and the inclusion of phenylalanine at 12.1 g kg–1 of dry diet, corresponding to 34.6 g kg–1 dietary protein is optimum for this fish. Based on above data, total aromatic amino acid requirement of fingerling O. niloticus was found to be 20.6 g kg–1 (12.1 g kg–1 phenylalanine+8.5 g kg–1 tyrosine) of dry diet, corresponding to 58.8 g kg–1 of dietary protein.

***Keywords*—** Amino acid, Requirement, Nile tilapia, Fingerlings.

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Effect of Dairy Products Intake and Some Physical Activities on Body Mass Index and Bone Mineral Density: A Survey at Sohag University

Mohamed Ali Kelany, Mohamed Orabi, Doaa Kabil

***Abstract*—** This study was designed to determine the effects of dairy products (milk, yogurt and cheese) intake and some physical activities (walking, running and using elevators) on bone mineral density (BMD) and body mass index (BMI) which are used as indicators of Osteoporosis and Obesity respectively. BMI was calculated by dividing weight (kg) by the square of height (m2) (k/m2) and classified as following: Underweight (< 18.5 BMI), Normal weight (18.5-24.9 BMI), Overweight (25-29.9 BMI) and Obese (> 30 BMI) considered as Obesity degrees. BMD was measured for the right foot with a pDEXA densitometer with a dual-energy X-ray absorptiometry (DXA) and expressed as a T-score index then divided as following: Normal (T ≥ 1), Osteopenia (T (-1) - (-2.5)) and Osteoporosis (T < -2.5). The correlation has been done according to Pearson Correlation Coefficient Formula. Results showed that the average of BMI, BMD and dairy products intake were 27.3 ± 0.98, 0.79 ± 0.77 and 62 ± 0.43 respectively. Findings revealed that the most of respondents used to consume insufficient amounts of dairy products which led to high rate of osteoporosis (21%) and osteopenia (37%). Correlation value of physical activities was negative with BMI (-0.073) and it was positive with BMD (0.053). Findings conclude that dairy products consumption and daily physical activities may enhance bone mineral density and prevent obesity.

***Keywords*—** dairy products, bone mineral density, body mass index, osteoporosis.

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Metabolomics Fingerprinting Analysis of *Melastoma malabathricum* L. Leaf of Geographical Variation using HPLC-DAD Combined with Chemometric Tools

Dian Mayasari, Yosi Bayu Murti, Sylvia Utami Tunjung Pratiwi, Sudarsono

Abstract**—** *Melastoma malabathricum* L. is an Indo-Pacific herb that has been traditionally used to treat several ailments such as wounds, dysentery, diarrhea, toothache, and diabetes. This plant is common across tropical Indo-Pacific archipelagos, and is tolerant of a range of soils, from low-lying areas subject to saltwater inundation, to the salt-free conditions of mountain slopes. How the soil and environmental variation influences secondary metabolite production in the herb, and an understanding of the plant's utility as a traditional medicine, remain largely unknown and unexplored. The objective of this study is to evaluate the variability of the metabolic profiles of *M. malabathricum* L. across its geographic distribution. By employing High Performance Liquid Chromatography-Diode Array Detector (HPLC-DAD), a highly established, simple, sensitive and reliable method was employed for establishing the chemical fingerprints of 72 samples of *M. malabathricum* L. leaves from various geographical locations in Indonesia. Specimens collected from six terrestrial and archipelago regions of Indonesia were analyzed by HPLC to generate chromatogram peak profiles that could be compared across each region. Data corresponding to the common peak areas of HPLC chromatographic fingerprint were analyzed by hierarchical component analysis (HCA) and principal component analysis (PCA) to extract information to the most significant variables contributing to characterization and classification to analyzed samples data. Principal component values were identified as PC1 and PC2 with 41.14% and 19.32%, respectively. Based on variety and origin the high performance liquid chromatography method validated the chemical fingerprint results used to screen the in vitro antioxidant activity of *M. malabathricum* L. The result show that the developed method has potential values for the quality of similar *M. malabathrium* L. samples. This findings provide a pathway for the development and utilization of references for identification of *M. malabathricum* L. Our results indicate the importance of considering geographic distribution during field-collection efforts as they demonstrate regional metabolic variation in secondary metabolites of *M. malabathricum* L., as illustrated by HPLC chromatogram peaks and their antioxidant activities. The results also confirm the utility of this simple approach to rapid evaluation of metabolic variation between plants and their potential ethnobotanical properties, potentially due to the environments from whence they were collected. This information will facilitate optimization of growth condition to suit particular medicinal qualities.

Keywords**—**Fingerprint**,** High Performance Liquid Chromatography, Melastoma malabathricum L., metabolic profiles, Principal Component Analysis

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Econometrics' of Nigeria's Exports and Import Value of Petroleum Resources from 2010-2014

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Abstract: This research is conducted to analyze data on Nigeria's value on exports and import of petroleum resources in million dollars among OPEC members. by collecting secondary data from OPEC document titled 50th edition of the annual statistical bulletin(ASB) during its 50th anniversary publications for the period of five years(2010-2014) ,the research uses Econometrics such as correlation , regression and analysis of variance to evaluate relationship between Nigeria value of exports and import which shows that there is positive correlation but not quite reliable while regression analysis was used to predict future occurrences from 2015 to 2010 respectively ,Aim of this research has been analyzed and predicted the future in which, the import predicted to be on increase path but not really reliable, which means that total number of exports increases than import.

Index terms: econometrics; export value; import value

INTRODUCTION

Nigeria is a very large economy with population of about 150 million according to United Nation estimate. In 2011 the World Bank data estimated Nigeria population to be 162 million. Economic Watch (2013) estimates Nigeria population to be 169, 282 million. The country represents about 20 percent of total population of sub-Saharan Africa. Statistics is a mathematical science pertaining to the collection, analysis, interpretation or explanation, and presentation of data .it is applicable to wide variety of academic disciplines, from the natural and social sciences to humanities, government and business. Statistical measures that attempt to determine the strength of the relationship between one dependent variable (usually denoted by Y) and a series of other changing variables (known as independent variable X) is called regression.

Correlation provides a numerical measure of the linear or "straight-line" relationship between the two continuous variables X and Y. The resulting **correlation coefficient** or "**r value**" is more formally known as the **Pearson product moment correlation coefficient** after the mathematician who first described it. X is known as the **independent** or **explanatory variable** while Y is known as the **dependent** or **response variable**. A significant advantage of the correlation coefficient is that it does not depend on the units of X and Y and can therefore be used to compare any two variables regardless of their units.Simple correlation measures the degree of association between two variables. The following facts about correlation should be noted. Correlation involving two variables implies a co-relationship between variables that puts both on an equal footing and does not distinguish between them by referring to one as the dependent variables and the other as the independent variable.in other words we may do a regression of y on x on y. The fitted lines in the two cases will in general be different. The question as to which line to fit is answered if we consider the variable about which we wish to make predictions to be the dependent variable. If the objectives are to obtain a measure of the strength of the relationship between two variables does not matter which line is fitted, since this measure will be the same in either case. Under the correlation model of x and y are measured to vary together in what is called a **joint distribution**. If the form of this distribution is normal it is called **bivariate normal distribution**. Inferences regarding this population may be made based on the results of samples properly drawn from it.

The correlation between variables x and y is perfect if all the points of the scatter diagram lie on a straight line.

The correlation between two variables x and y is positive or direct if y increases as x increases or if the regression line slopes from left to right.

The correlation between two variables x and y is negative or inverse if y decreases as x increases or y increases as x decreases or if the regression line slopes upwards from right to left.

There is no correlation between two variables x and y if there is no definite pattern in the direction of the variables x and y.
Mathematically describes the dependence of the Y variable on the X variable and constructs an equation which can be used to predict any value of Y for any value of X. It is more specific and provides more information than correlation. Unlike correlation, however, regression is not scale independent and the derived regression equation depends on the units of each variable involved. As with correlation, regression assumes that each of the variables is normally distributed with equal variance. In addition to deriving the regression equation, regression analysis also draws a **line of best fit** through the data points of the scatter gram. These "regression lines" may be linear, in which case the relationship between the variables fits a straight line, or nonlinear, in which case a polynomial equation is used to describe the relationship. Regression (also known as **simple regression**, **linear regression, or least squares regression**) fits a straight line equation of the following form to the data: $Y = a + bX$ where Y is the dependent variable, X is the single independent variable, a is the Y-intercept of the regression line, and b is the slope of the line (also known as the **regression coefficient**). Once the equation has been derived, it can be used to predict the change in Y for any change in X. It can therefore be used to extrapolate between the existing data points as well as predict results which have not been previously observed or tested.

BACKGROUND OF THE STUDY

The term "econometrics" is the application of mathematics, statistics and computer science in Economics, it aimed at measures of economic theories, forecasting, decision making and export decision policy evaluation originated by sir, Powel Ciompa in the year 1910. Correlation and regression originated from a geographer, Meteorologist, Tropical explorer and inventor of finger print identification, Eugenicist, Half-Cousin of Charles Darwin and best-selling author, Sir Francis Galton (1922) he tries to measure everything from the weather to female beauty invented correlation and regression. Galton's experiment start with sweet peas (1975) leads to the development of initial concept of linear regression. Such as;- sweet peas could self-fertilize. "Daughter plant expresses genetic variations from mother plants without contribution from second parent". Karl pearson (1957-1936) formalized Galton's method and invented least square method for determining regression line (John, F., Joel, L. & Hasheem, M (2006)).Francis Galton is the Origins of the Regression Equation: The equation have been proposed for determining the household expenditure is described as a regression equation. This odd terminology is due a Victorian man of science by name of Francis Galton (1811–1911). The development of statistical theory in the hands of Galton, Edgeworth and Pearson was taken up in economics with speed and diligence. The earliest applications of simple correlation analysis in economics appear to have been carried out by Yule (1895, 1896) on the relationship between pauperism and the method of providing relief, and by Hooker (1901) on the relationship between the marriage-rate and the general level of prosperity in the United Kingdom, measured by a variety of economic indicators such as imports, exports, and the movement in corn prices.

LITERATURE REVIEW

In accordance with Ahmed,K.,Annamul,H.&Jabaer, S.(2013) A econometrics research conducted in order to monitor and to study the effect of export and import on GDP of Bangladesh using annual data from 1972-2006, The researcher uses world bank data report and analyzed with econometrics tools ie correlation ,regression and analysis of variance techniques. The result shows moderately related to the growth of GDP in Bangladesh. Ebiefe,V.(2014)uses simple regression as a statistical techniques in testing hypothesis. The researcher find out after all analysis that export and exports, exchange policy rate are effective tools for economic development which helps in trading of commodities in which CBN bulletin were used as a data source. Ogbonna,G and Ebimobowei,A.(2011) Carried out research in order to investigate the impact of petroleum revenue and the economy of Nigeria from 1970-2009.using rank correlation ,regression and descriptive statistics. After the analysis, the result revealed that petroleum effect the growth domestic products and per capital income in Nigeria positively. Ezike,J.and Ogege,S.(2012) the researcher is able to use correlation analysis and least square techniques to test the effect of trade policies on non-oil export in Nigeria. And hence, the result shows that there is negative relationship between trade policies and non-oil sector in Nigeria.Sekumade,A.(2009)observed the relationship between the cash crop and the exogenous variables. And least square result indicates that the value of oil export and import increased with agricultural production. Ja'afaru,S.(2013) use simple regression model in order to test for the degree of relationship between variables and tested the good

ness of fitness with coefficient of determination and hence, f-test were used to find test of significance of the estimated regression coefficient evaluation. The research recommends that, revenue generated from export be expanded on projects that will bring about positive transformation in the country. Odularu,G.(2007) uses least square regression techniques in finding out the relationship between crude oil sector and Nigeria economic performance. The result revealed that crude oil consumption and export have contributed to the improvement of Nigeria economy. Inyiama,O.and Ikechukwu,O.(2015) uses multiple regression and correlation .in which the analysis indicates that foreign exchange rate is positively influenced by the volume of crude oil exports. And hence, the result shows weak insignificant relationship existence between crude oil export and crude oil production and foreign exchange rate. Li,Y.,Chen,Z.and San,C.(2010) Researches on the relationship between foreign trade and the GDP growth of east china from 1981-2008.carried out empirical analysis uses of time series analysis and regression analysis .based on causality, the research shows that there is existence of long term or short term causality between GDP and total export and import as well as between GDP and export. Sota,L. and Kolaneci,F.(2001) carries correlation and regression analysis to test for Annual GDP growth and money laundering. The research result shows negative correlation between money laundering process and economic growth rate in Albania. Means there is negative correlation between money laundering and import from the result gathered from the analysis of correlation and regression. Chakrabartya,R.& Lahiri Chakravarty,S(2012) analyzed export and import of black gold(oil)with respect to the Indian scenario and it indicates that they are strongly related.

SOURCES OF DATA

The sources of data is secondary data from published and obtained from the 50th edition of OPEC (organization of the petroleum exporting countries) .an Annual statistical bulletin of the organization of

the petroleum exporting countries from 2010-2014. **"***Organization of the Petroleum Exporting Countries (OPEC) — Members: Algeria (1969), Angola (2007), Ecuador (rejoined 2007), Islamic Republic of Iran (1960), Iraq (1960), Kuwait (1960), Libya (1962), Nigeria (1971), Qatar (1961), Saudi Arabia (1960), United Arab Emirates (1967) and Venezuela (1960)"*OPEC (2005) .

RESEARCH METHODOLOGY

The research of the study was conducted in a sample of 12 OPEC countries in which secondary data was collected on OPEC member's values of Nigeria export and import in million US dollars. Regression and correlation were carried out on the data to find the relationship and predict future trend.

AIMS AND OBJECTIVES

The aims and objectives of this research is to look at area application of econometrics techniques as a statistical aspects into Nigerian economic data ie 2015 OPEC statistical bulletin and by the used of Nigeria economic data to apply the statistical techniques to bring out meaningful improvement and to add knowledge from the idea of the previous researches for national development.

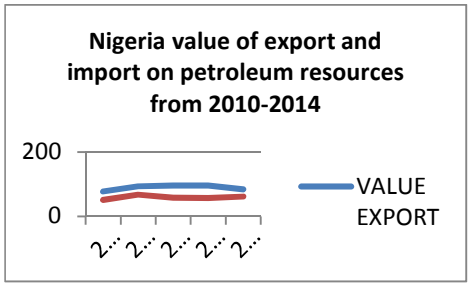
DATA PRESENTATION AND ANALYSIS

This research paper tends to look at the presentation and analysis of data obtained from the 50th edition of OPEC Annual statistical bulletin of the organization of the petroleum exporting countries from 2010-2014.

Table I :- table presentation of Nigeria data for value exports and import (m$) from 2010-2014

YEAR	VALUE EXPORT	VALUE IMPORT	TOTAL
2010	77.409	51.088	128.497
2011	93.676	67.094	160.77
2012	95.360	58.152	153.512
2013	95.118	56.453	151.571
2014	83.897	61.980	145.877

Fiq. I:-CHART presentation of Nigeria data on export and import of petroleum resources



ANALYSIS OF DATA

This is a process whereby data collected has to be analyzed so as to make recommendation or conclusion about the problem of the study. Such analysis involves summarizing the data such that necessary information can be obtained for conclusion. The statistical techniques used in these research for data analysis is the correlation and regression analysis, which is under regression, the model applied or the method (model) make use of regression equation(line) where we have (Y) dependent and (X) independent variables applied respectively(Gupta(2004)).

Table ii:-correlation and regression analysis table

X	Y	X^2	XY
77.409	51.088		
93.676	67.094		
95.360	58.152		
95.118	56.453		
83.897	61.980		
EX=445.46	∑Y=294.767	EX^2 =39,947.01639	EXY=26,354.77577

From the table "X" Nigeria value export and "Y" is the Nigeria value import.

KARL PEARSON'S PRODUCT MOMENT CORRELATION COEFFICIENT COMPUTATIONS

This can be defined by the formula

$$r^2 = \frac{S^2_{xy}}{S^2_x S^2_y}$$

where

$$S_{xy} = \frac{\sum xy}{n} - \left(\frac{\sum x}{n}\right)\left(\frac{\sum y}{n}\right)$$

$$S_x = \sqrt{\frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2}$$

$$S_y = \sqrt{\frac{\sum y^2}{n} - \left(\frac{\sum y}{n}\right)^2}$$

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n} \times \sum y^2 - \frac{(\sum y)^2}{n}}}$$

$$= \frac{26{,}354.77577 - \frac{445.46.294.767}{5}}{\sqrt{\sum 39{,}947.01639 - \frac{(445.46)^2}{5} \times \sum 17{,}521.70529 - \frac{(294.767)^2}{5}}}$$

$= 0.482269164 \approx 0.482$

There is positive correlation between Nigeria's value of exports and import on petroleum resources.

Test of significance of coefficient

$\boldsymbol{Ho}: r = 0 (export\ value\ and\ import\ value\ are\ not\ related$

$H1: r \neq 0 (export\ value\ and\ import\ are\ related)$

$Ho: 0\ VS\ H1: \neq 0$

$t(0.05, n-2) = \mathrm{t}(0.05,3) = 3.182$

test statistic

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

$$t = 0.48\sqrt{\frac{5-2}{1-0.23}}$$

$$t = 0.48\sqrt{\frac{3}{0.77}}$$

$$t = 0.95$$

Decision rule: if $|t|$ calculated $> t$ tabulated Ho is rejected, it means that there is relationship between the variables under investigation i.e. (export value and import value).Since 0.95<2.262 it means H1 is accepted that, there is relationship but the relationship is not evidently supported.

$$t = 0.48\sqrt{\frac{5-2}{1-0.48^2}}$$

$S_{xy} = \sum xy - \frac{\sum x \sum y}{n}$ =26,354.77577 $- \frac{(445.46)(294.767)}{5}$ = 93.394206

$S_{xx} = \sum x^2 - \frac{(\sum x)^2}{n}$ =39,947.01639 $- \frac{(445.46)^2}{5} =$ 260.09407

$S_{yy} = \sum y^2 - \frac{(\sum y)^2}{n} =$ 17,521.70529 $- \frac{(294.767)^2}{5}$ =144.1884352

$a = \frac{\sum y}{n} - \frac{b \sum x}{n}$ *the regression line* $y = a + bx$

$$\bar{X} = \frac{\sum x}{n} = \frac{445.46}{5} = 89.092$$

$$\bar{Y} = \frac{\sum y}{n} = \frac{294.767}{5} = 58.9534$$

REGRESSION ANALYSIS COMPUTATTIONS

By applying the least square method to compute the data collected.

This is stated as follows ;

$$b = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2} = \frac{S_{xy}}{S_{xx}}$$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

$$= 0.359078567 \approx 0.359$$

$$a = \left\{\frac{(\sum y - b\sum x)}{n}\right\} = \frac{294.767 - 0.36(445.46)}{5} = 26.96237229 \approx 26.962$$

Hence the linear regression equation: $\hat{y} = a + bx = 26.962 + 0.359x$

EVALUATING THE REGRESSION EQUATION

When the regression equation has been obtained it must be evaluated to determine whether it adequately describes the relationship between the two variables and whether it can be used effectively for prediction purposes.

The deviations of y_i from the mean $\bar{y}$ can be observed below:-

$$(y - \bar{y}) = (y_i - \hat{y}) + (\hat{y} - \bar{y})$$

$$TSS = \sum (y - \bar{y})^2 = \sum [(y_i - \hat{y}) + (\hat{y} - \bar{y})]^2$$

By expansion of the right hand side of this expression it can be shown that:

$$TSS = \sum (y - \bar{y})^2 = S_{yy} = \sum y^2 - \frac{(\sum y)^2}{n}$$

$$TSS = \sum (y_i - \hat{y})^2 + \sum (\hat{y} - \bar{y})^2$$

$TSS = SS(residual)$+SS (regression)

Hence the total variation can be split into two parts, one due to residual (error) variation and the second due to regression.

$$= \frac{5(26{,}354.77577) - (445.46)(294.767)}{5(39{,}947.01639) - (445.46)^2}$$

Further it can be shown that SS (regression)

$$SS(regression) = \frac{(S_{xy})^2}{S_{xx}}$$

$$SS(residual) = \sum (y_i - \hat{y})^2 = SST - SS(regression)$$

$$SS(residual) = S_{yy} - \frac{(S_{xy})^2}{S_{xx}}$$

Properties of b

After much mathematical manipulation it can be shown that $E(b) = \beta$, which is perhaps to be expected, and also

$$V(b) = \frac{\sigma^2}{S_{xx}}$$

Since y is normally distributed (with variance σ^2) it follows that b is normally distributed:

N~$(\beta, \frac{\sigma^2}{S_{xx}})$ hence $\frac{b-\beta}{\frac{\sigma^2}{S_{xx}}}$ is a standard normal variable. Since $\sigma^2$is not known, it must be replaced by estimate S^2.

$$S^2 = \frac{SS(residual)}{n-2}$$

Then $\frac{b-\beta}{\frac{S^2}{S_{xx}}}$ follows a t-distribution with n-2 degree of freedom (n-2 since have been estimated from the data).

Similarly, it can be estimated that $a \sim N(a, (\frac{1}{n} + \frac{\bar{x}}{S_{xx}})\sigma^2)$ so that is a **standard normal**.

Again since is not known, it must be replaced by its estimate $\frac{a-\hat{a}}{(\frac{1}{n}+\frac{\bar{x}}{S_{xx}})\sigma^2}$ which also follows a t- distribution with n-2 degree of freedom.

The distribution can be used to:

- Form confidence intervals from the value of the slope and intercept

- Test of hypothesis about the slope and intercept usually($a = 0, \beta = 0$).
- Test intercept or slope of two regression lines to see if they are equal or not.

Test the null hypothesis

$$H_0: b = 0 \, VS \, H_1: b \neq 0$$

$$SS(residual) = SST - SS(regression)$$

$SS(residual) = S_{yy} -$
$\frac{(S_{xy})^2}{S_{xx}} = 144.1884352 - \frac{(93.394206)^2}{260.09407} = 110.6525775$

Now,$S^2 = \frac{SS(residual)}{n-2} = \frac{110.6525775}{3} = 36.88419251$

$V(b) = \frac{S^2}{S_{xx}} = \frac{36.88419251}{260.09407} = 0.14181097$

SE (b)= $\sqrt{V(b)} = \sqrt{0.14181097} = 0.376577974$

$|t| = \frac{b}{\text{SE (b)}} = \frac{0.359078567}{0.376577974} = 0.9535304555$

$$t(0.05,3) = 3.182$$

It can be concluded that Ho is accepted, since t-calculated $<$ t-tabulated. Hence, at 95% **confidence intervals**

$$b \pm (t_{1-\alpha}, n-2)SE(b)$$

$$0.359078567 \pm 3.182 \times 0.376577974$$

$$0.359078567 \pm 1.198271113$$

$$-0.839192546 < B < 1.55734968$$

For The Future prediction can be made using regression equation for export and import value of Nigeria petroleum resources from 2015-2015 for y on x (when import (y) depend on export(x).

Y on X

2015: 26.96 + 0.36(1) y = 26.96 + 0.36 y = 27.32

2016: 26.96 + 0.36(2) y = 26.96 + 0.72 y = 27.68

2017: 26.96 + 0.36(3) y = 26.96 + 1.36 y = 28.04

2018: 26.96 + 0.36(4) y = 26.96 + 1.44 y = 28.40

2019: 26.96 + 0.36(5) y = 26.96 + 1.80 y = 28.76

2020: 26.96 + 0.36(6) y = 26.96 + 2.16 y = 29.12

Using the measurement of trend to study the past behavior and predict the future tendencies, it shows that Nigeria values on importation is on the increase as it gives; 27.32, 27.68, 28.04, 28.40, 28.76, 29.12 (m$) in the year 2015,2016,2017,2018,2019 and 2020 respectively.

Also, prediction can be carried out For The Future prediction using regression equation for export and import value of Nigeria petroleum resources from 2015-2015 for X on Y (when export (x) depend on import(y).

X on Y after computation as above, a=50.907

b = 0.648 therefore, X = 50.907+0.648y

2015 = 51.56

2016=52.20

2017=52.85

2018=53.50

2019=54.15

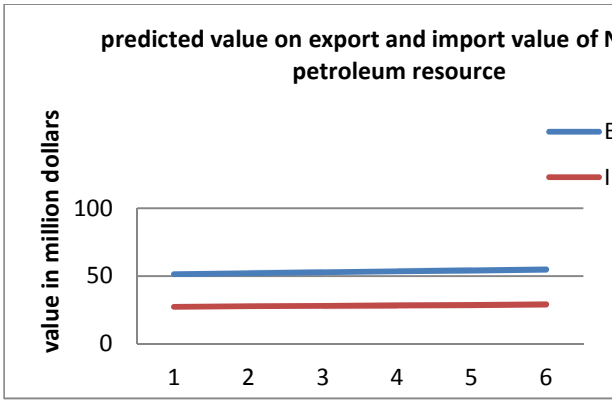
2020=54.80

To combine the predicted value of export value and import value of petroleum resources

Table II

years	Export value	Import value
2015	51.56	27.32
2016	52.20	27.68
2017	52.85	28.04
2018	53.50	28.40
2019	54.15	28.76
2020	54.80	29.12

Fig II



from the charts above, figure I shows that the relationship only exist between year 2011 and 2012 but not quite related from the remaining years but from the predicted value it indicates that there will be positive and perfect relationship between export and export value of petroleum resources.

SUMMARY

From the research work, it is observed that data was collected from the secondary source, these data comprises the Nigeria value export and import on petroleum and in each year. And from the data, it shows that the number of export value increase and number of import increase.

CONCLUSION

With reference to the data analyzed in this paper, it is noticed that the value of export is not much equivalent to that of value import. But there is positive correlation but weak positive relationship that is Nigeria export cannot be determine by import directly but not reliable.

RECOMMENDATIONS

Base on this research work, it indicates that Nigeria value on export is related even though the relationship is very weak thereby recommend that seeing that Nigeria depend fully on petroleum there is need for federal government to concentrate more on this area to increase in value exportation than importation which advance the economy to the quite greater height.,.

The government should establish more companies in the countries thereby increase in the production and exportation of petroleum resources than importation. Also the sensitization agency should educate Nigerians on the need for encouragement in exportation than importation

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Factors That Influence the Shopping Behavior of Foreigners in China

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***Abstract*—** This project aims to underpin the several factors that have contributed to the pattern of online shopping behavior of foreigners in China. It is also intended to set a stream of concepts into play determining how these concepts or factors have influenced these behaviors. It is important to note that there are several factors in play and this project aims to highlight which of these factors have played roles with regards to the large spectrum of people under review. There is a conduction of a questionnaire of foreigners living in China. The factors determined from the research stipulate what characteristics affect the shopping behavior of foreigners in China. It is determined by TAM, recommendation, price of the product, occupation, spending habits and many other factors determining the pre-sale and post-sale services and its related quality resources, explaining the shopping behavior of foreigners in China.

***Keywords*—** E-commerce, Shopping, foreigners, TAM (Technology Acceptance Model), Social Commerce.

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