ASREN

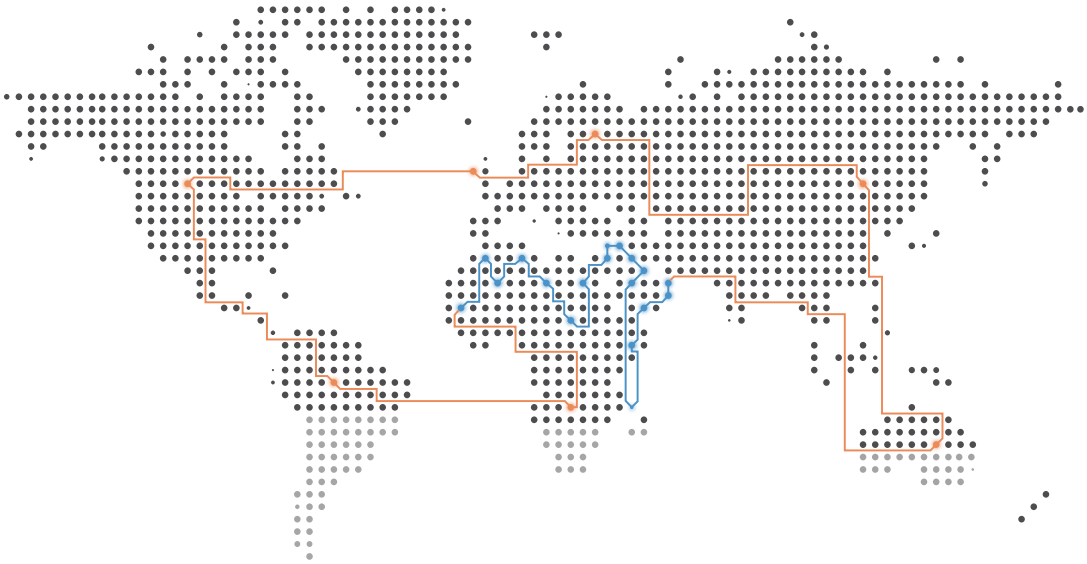
e-AGE18

PROCEEDINGS

The 8th International Platform on Integrating Arab e-Infrastructure in a Global Environment

"CAPACITY FOR TRANSFORMATION"

Under The Patronage of His Excellency
Minister of Higher Education and Scientific Research in Jordan



Amman Marriott Hotel, Jordan
2-3 December 2018

Committees

Program / Steering Committee

- Boubakar Barry, West and Central African Research and Education Network (WACREN), Senegal
- Dale Smith, NSRC, USA
- David West, GEANT, UK
- Federica Tanlongo, Consortium GARR, Italy
- Federico Ruggieri, GARR Consortium, Italy
- Florencio I. Utreras, UTTICA, Chile
- Ghazi Al Sukkar, The University of Jordan, Jordan
- Helga Spitaler, GEANT, UK
- Ibrahim Fathy Moawad, EUN, Egypt
- Johnathon Chapman, Internet2, USA
- Luis Eliecer Cadenas, RedCLARA, Chile
- Pascal Hoba, UbuntuNet Alliance, Malawi
- Redouane Merrouche, MARWAN, Morocco
- Salem Al-Agtash, German Jordanian University (GJU), Jordan
- Yousef Torman, Arab States Research and Education Network (ASREN), Jordan

Organizing Committee

- Ashraf Mashaleh, Balqa Applied University, Jordan
- Yasmeen Al-Kouz, Arab States Research and Education Network (ASREN), Jordan
- Yousef Torman, Arab States Research and Education Network (ASREN), Jordan

Scientific Committee

- Ahmed Dabbagh, Emirates College of Technology, UAE
- Ahmed Hassan, Egyptian Universities Network (EUN), Egypt
- Ala' Khalifeh, German Jordanian University, Jordan
- Boubakar Barry, West and Central African Research and Education Network, Senegal
- David West, GEANT, UK
- Enrique Arias Antúnez, Universidad de Castilla-La Mancha, Spain
- Federico Ruggieri, GARR Consortium, Italy
- Florencio Utreras, UTTICA, Chile
- Ghazi Al Sukkar, The University of Jordan, Jordan
- George Ghinea, Brunel University, UK
- Habib Yousef, CCK, Tunisia
- Ibrahim Fathy Moawad, EUN, Egypt
- Johnathon Chapman, Internet2, USA
- Khalid Elbadawi, Sudan Research and Education Network, Sudan
- Majid M.AlSadek, Egyptian National Scientific and Technical Information Network, Egypt
- Markus Baumann, Asia Pacific Advanced Network, Australia
- Mowaffaq Ottom, Yarmouk University, Jordan
- Ognjen Prnjat, GRNET, Greece
- Pascal Hoba, UbuntuNet Alliance, Malawi
- Paul Lefrerre, OPEN UK University, UK
- Rainer Herpers, Bonn-Rhein-Sieg University of Applied Sciences, Germany
- Rami Iskander, SCU, Egypt
- Roberto Barbera, University of Catania, Italy
- Salem Al-Agtash, German Jordanian University (GJU), Jordan
- Walid Karam, Balamand University, Lebanon
- Yousif Asfour, American University of Beirut, Lebanon
- Yves Poppe, APAN/ A*Star, Singapore

Chairman's message

"ASREN is the pan-Arab research and education network contributing to boosting scientific research, innovation and education across the Arab world.

The practice of scientific research is changing dramatically. Long gone are the days in which researchers working in isolation contributed to technological innovation and social development. Only through multidisciplinary collaborations among research centres, industry and public entities knowledge, innovation, and exchange of know-how can be facilitated. e-Infrastructures play a major role in making such collaboration possible and enabling institutions to "boot up" and join the globalizing developed world.

ASREN has been founded in 2010 with an objective to establish an Arab Regional Network to interconnect existing Arab National R&E networks (NRENs) with each other and to their counterparts across the globe, and to act as a catalyst for e-Infrastructures in Arab countries where they are not yet available".

Chairman

Dr. Talal Abu-Ghazaleh

Contents:

Evaluating ICT Preparedness of Higher Education in Somalia

Yunis Ali Ahmed[1], Mohamed Mohamud Mohamed[2], Mohamud M. Alasso[3], Ahmed Dahir Siyad[4] and Abdifatah Farah Ali[5]

[1]*Faculty of Computing, SIMAD UNIVERSITY, yunisali@simad.edu.so*
[2]*Faculty of Engineering, SIMAD UNIVERSITY, myare81@simad.edu.so*
[3]*Faculty of Computing, SIMAD UNIVERSITY, alasow@simad.edu.so*
[4]*Broadband Connectivity, SomaliREN, ahmed.siyad@somaliren.org*
[5]*Faculty of Computing, SIMAD UNIVERSITY, fitaaxfarah@simad.edu.so*
Mogadishu, Somalia

Abstract: Information and Communication Technology (ICT) have been transforming the process of teaching-learning and promoting collaboration and information exchange in educational environments. Especially within today's era of digital transformation, ICT readiness and adaption in Higher Education has become one of the key priorities in most developing countries. Although the advancement of computer-based technologies and high-speed internet on mobile networks with social networking tools is already widespread in Somalia despite the prolonged conflict, staff and student readiness for ICT as teaching and learning tools has yet to be well accepted. However, when it comes to understanding what drives ICT readiness and usage in Somali higher education institutions little research attention has been received. This study investigates the factors for ICT readiness using an integrated model which derived from the existing different E-readiness models and added one new contract to determine the in-depth problems related to ICT preparedness in higher educations of Somalia. Four major factors for ICT readiness were considered, ICT Infrastructure, Institutional ICT Learning, ICT Strategic Planning, and Society Attitudes towards ICT. A survey was conducted using quantitative methods to obtain information from 30 different public and private universities using a stratified random sampling method. The results reveal that most of the universities staff and students perceptions toward the use of ICT tools were positive, although availability of adequate local contents, ICT security and policy, and internet affordability readiness appears weak, while access to one's own PC or shared computers and network speed and quality indicator also shows reasonable results. The findings of this study provide valuable implications for ways to increase ICT readiness and usage though the Somali higher education institutions for teaching and learning purposes.

Keywords: ICT, ICT readiness, Learning innovation and Higher Education.

I. INTRODUCTION

It is strongly believed that Information and communication technology (ICT) can empower the process of teaching and learning and promote collaboration and information exchange within educational environments [1-4]. ICT has opened new ways for teaching and learning perspectives, especially in today's society where new trends of technology revolves in all fields and every aspect of our lives [5, 6]. The increasing usage of ICT in Higher Education Institutions (HEIs) is a proof of its necessity in the field of education to improve the efficiency and effectiveness of learning and teaching [5, 7].

According to [8] in order for universities and related institutions to be able to utilize and benefit fully from current advanced ICT tools, depending on a particular number of factors that may influence user readiness which needs first in place. For example, to put ICT to effective use, a society must be ready in terms of infrastructure (e.g. computer hardware and software), strategy, and planning [9]. It was argued that beyond the knowledge, needs society attitude towards understating and beliefs of ICT benefits for teaching and learning [1].

Nevertheless, ICT readiness research in determining antecedents to technology readiness and psychological traits include society's general attitude is scarce, especially in African higher institutions [10].

Although ICT readiness has been studied for over a decade in developing countries, the primary portion of these studies was devoted to assessing technology readiness on the national level [11-14]. In Somalia the advancement of computer-based technologies and high speed internet on mobile networks with social networking tools is already widespread, despite the prolonged conflict [15], however, when it comes to understand of what drives the ICT readiness and usage in higher education institutions little research attention has been received. However, educators' willingness and readiness of ICT remain key factors that can be influence integration with ICT tools in teaching and learning process.

Thus, the three main objectives of this research study are:

1. To understand the ICT preparedness of Somali higher education institutions and factors that university staff and students consider important in ICT readiness.
2. To identify the current level of ICT usage in Somali higher education institutions.
3. To evaluate the society's attitude towards ICT usage for teaching and learning perspectives.

II. PROPOSED ICT READINESS RESEARCH MODEL FOR HIGHER EDUCATION

Several e-readiness assessment tools and models related to ICT have been specifically designed and used [16-20]. However, these tools are not suitable for use to asses such countries like Somalia. Thus, this study derived some indicators from the existing e-readiness models with new added indicators to determine in-depth problems related to ICT preparedness in HEIs of Somalia.

This model is comprised of four different factors consisting of 14 indicators:

- ICT Infrastructure - access to own computer or sharing, internet access, campus infrastructure, campus network, internet affordability and network speed and quality.
- Institutional ICT learning - technology and tools, adequacy of ICT skills, and availability of adequate local content.
- ICT Strategic plan - ICT strategy and policy, ICT financing, ICT human skill development and ICT security.
- Societal attitudes toward ICTs - management awareness for ICT importance and staff understanding of benefits ICT. Figure 1 illustrates the proposed research model, which presents these four groups of independent variables or factors.

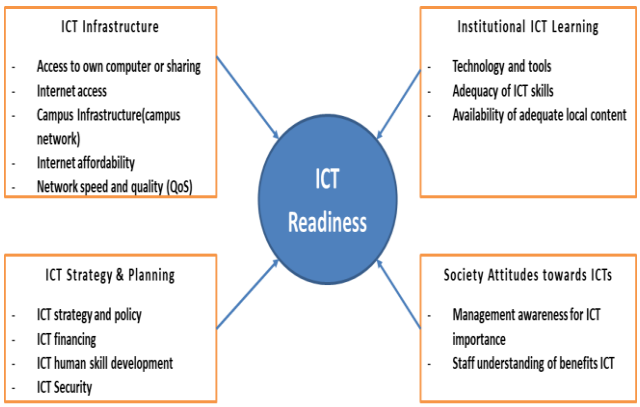


Fig 1. Proposed ICT readiness model

Based on the literature review, a summary of the research on each factor along with the relevant description is presented in Table 1.

Factors	Indicators	Purpose
ICT Infrastructure	Access to own PC or Shared Computers	This indicator measures basic of computer access of students and staff
	Campus Networking and Environment	This indicator measures the extent of campus network infrastructure and its environment
	Internet Availability	This indicator measures the extent of availability of Internet in the institutions.
	Internet Affordability	This indicator measures the extent to which Internet is affordable to the institutions.
	Network Speed and Quality	This indicator measures the quality of Internet services at institutions
Institutional ICT Learning	Technology and Tools	This indicator measures the integration of ICT in the curricula and the readiness of institution to offer e-learning courses and use ICT in the classrooms.
	Adequacy of ICT Skills	This indicator measures the level of ICT staff skills and the extent to which an institution is preparing and training its ICT staff.
	Availability of Adequate Local Content	This indicator measures the extent to which an institution has adequate locally created contents
ICT Strategically Planning	ICT Financing	The indicator measures the degree to which an institution has sufficient budgetary allocation for ICT
	ICT Strategy	The indicator assesses the extent to which strategic ICT planning takes place and is linked to the institution strategic planning
	ICT Human Skill Development	The indicator measures the degree to which an institution has competent and well trained ICT professional and support staff.
	ICT Security	The indicator measures the level of ICT security plan in the organizations. It includes the security of information, network, computers, and application.
Society Attitudes Towards ICT	Management Awareness for ICT Importance	This indicator measures the degree to which managers are aware of the importance of ICT in education
	Staff Understanding of ICT Benefits	This indicator measures the level of the staff understandings to the ICT benefits and importance by campus community

Table 1. Key ICT -readiness enablers for higher Education

III. METHODOLOGY

A quantitative survey method was used to determine the ICT readiness in Somali higher education institutions.

This study examined 30 higher education institutions with student populations of more than 1000 established prior to 2012. According to the above constraints, the Universities were selected across all Somali regions. The targeted respondents were heterogeneous consisting of faculty members, administration staff and senior students.

A total of 300 questionnaires were distributed throughout all 30 universities. 272 questionnaires were completed and returned representing a response rate of 91%.

The questionnaire was comprised of two parts: Part one focused upon the respondents' demographic data while part two concentrated primarily upon ICT preparedness and identifying the level of ICT usage in Somali higher education institutions. A descriptive analysis was conducted using IBM SPSS statistical package version 20 to analyze the data.

IV. RESULTS AND DISCUSSIONS

A. Profile of respondents

A sample of 272 impartially selected respondents, as shown in Table 2, 37% of respondents were female and 63% were male, 58% of respondents were enrolled bachelor level programs while 31% in Masters level. Regarding the level of positions, 37% were under academics, 25% were involving administrations, while 27% were senior students. This demonstrates that that the respondents were aware of the subject matter and thus appropriate participants for a study such as this.

DISTRIBUTION		FREQUENCY	Percentage (%)
Gender	Male	171	63
	Female	101	37
Education Level	Bachelor	158	58
	Master	84	31
	PhD	5	2
	Others	24	9
Position	Academic	68	25
	Administration	101	37
	Support Staff	30	11
	Senior Student	73	27

Table 2. Demographic Data

B. ICT Infrastructure

The ICT infrastructure contains five indicators including Access to own PC or Shared Computers, Campus Networking and Environment, Internet Availability, Internet Affordability, and Network Speed and Quality. The study found that the average all universities surveyed achieved stage 2.0 and above in Access to own PC or Shared Computers and Network Speed and Quality with ICT infrastructure but performed poorly in all other indicators that were below stages 2.0 as shown in Figure 2 and Figure 3 which shows sub-indicators. The internet availability indicator was at stage 1.5, suggesting that most of the universities providing limited internet access to students. The Internet Affordability indicator was at stage 1.4 means that universities were spending less than 1 per cent of the annual budget of the universities.

The Campus networking and Environment indicator was at stage 1.4, means that not all universities invested adequately in their campus networks, data Centers, backup power Source.

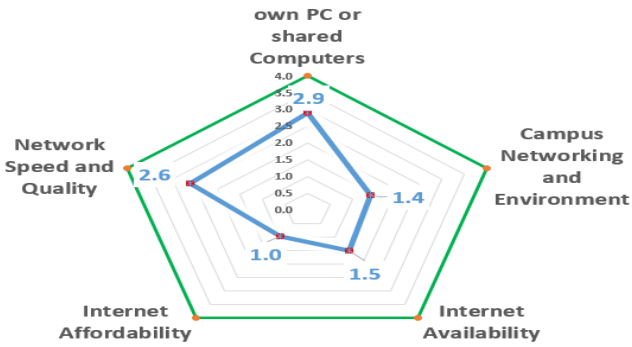


Fig 2. ICT Infrastructure

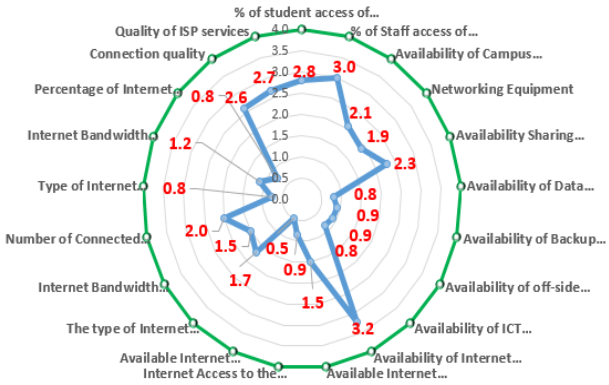


Fig 3. ICT Infrastructure: Overall sub-indicators

C. Institutional ICT Learning

The Institutional ICT Learning contains three indicators: Technology and Tools, Adequacy of ICT Skills, and Availability of Adequate Local Content. This indicator is one of the major factors affecting integration of ICT in education which is the adequacy of the technological tools, ICT skills and the availability of local content, if the available ICT resources are not adequate enough for both lectures and students, full utilization of these resources may never be realized. This study found that Technology and Tools indicator was at stage 1.5, suggesting that most of the universities have adequate educational software, technology tools for research, availability of course management Systems, ICT in classroom, and availability of integrated campus management system technology in education; and Adequacy of ICT staff Skills was at stage 1.4, this means that most of the university staff have the ability to use ICT educational tools and also for the most part ICT staff hold professional certificates, but performed poorly in availability of adequate local content. Specifically, the availability of online academic databases indicators that were below stages 1.0, the result shows that the current practices in all universities will not improve the visibility and utilization of the local content as shown in Figure 4 and Figure 5. According to Ezema [21], the institutions should encourage the submission of electronic version of their local content to facilitate their publication in institutional repository. These findings are very fundamental for these factors are essential for having an efficient institutional repositories and they are lacking in Somalia. These findings have also been reflected in studies of [22, 23].

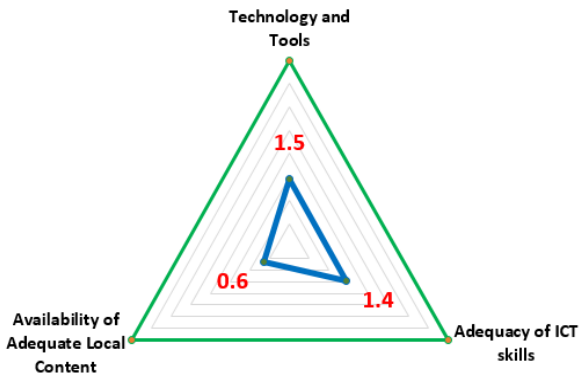


Fig 4. Institutional ICT learning

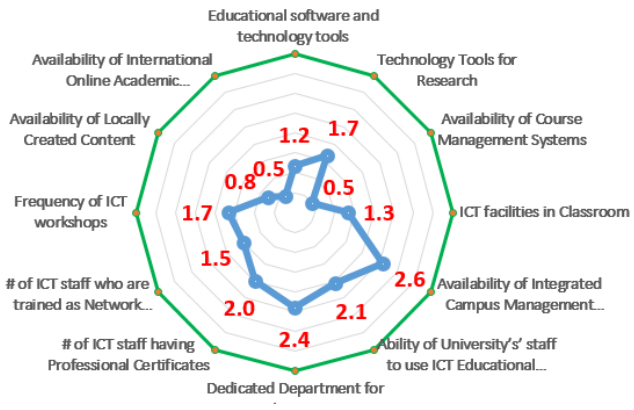


Fig 5. The Institutional ICT Learning: Overall sub-indicators

D. ICT Strategical plan

The ICT Strategy and Planning contains four indicators: ICT Financing, ICT Strategy, ICT Human Skill development, and ICT Security. The study found that the ICT financing indicator was at stage 1.6 as shown in figure 6 and 7, this indicates that institutions give ICT the least priority with only less than 3% of institutional total annual expenditure is allocated for ICT in education but performed poorly in ICT security indicator that was below stages 1.0, suggesting that most universities don't have firewalls to protect their intranets. Thus, this study suggest that allocating enough resources to maintain ICT security policy and procedures, employing ICT security experienced personal, protecting security needs for the hardware and software, these factors can successfully contribute in maintaining ICT security. The ICT Human Skill development indicator was at stage 2.5, which means that most universities were attracting highly qualified ICT staff and expending considerable effort in developing ICT staff capacity. The ICT Strategy indicator was at stage 2.2, suggesting that all universities has strategic ICT planning takes place and is linked to corporate strategic planning.

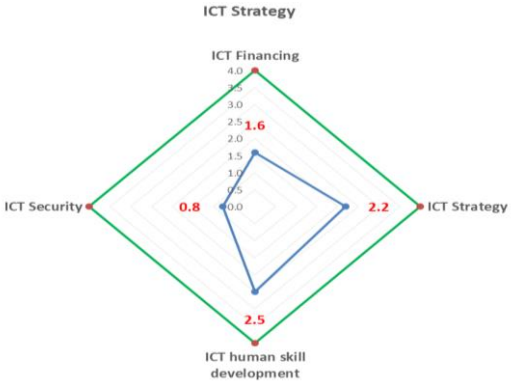


Fig 6. ICT strategical plan

Fig 7. ICT strategical plan, overall sub-indicators

E. Societal Attitudes Toward ICT

The societal attitudes toward ICT are visible by two indicators: Management Awareness for ICT Importance and Staff Understanding of ICT Benefits. This study attempts to understand people's beliefs towards the importance of ICT use in Somali higher educational institutions. The societal attitudes towards ICTs category, which consist of two essential indicators: Management Awareness for ICT Importance, and Staff understanding of ICT benefit. These indicators also have each sub-indicators distributed over the 30 universities in Somalia to provide a suitable answer. Fig. 8 shows six sub-indicators for the two main indicators (Management Awareness for ICT importance which indicatd level 2.9 and staff undersatnding, and Staff understandings of ICT benefits, which showed level 2.0).

The overall 30 universities highlighted that 76% of management does not pay attention the importance of ICT as shown in Figure 8. The below average score of awareness and supports towards use of ICT suggests that most of the University. This means that many staff and students were not get encouragement and opportunities such training to expand their ICT skills. However, despite these potential drawbacks, training and development provides of staff. There are more than 66.9% of staff are aware of the importance of ICT as teaching and learning tool at University.

The result of the study shows that most of the staff and students at universities perceptions towards use of ICT tool was positive. This indicator measures ICT usage for developing different work activities at university, more than 77% are aware of the benefits and prospects of ICT, specifically with regard to staff members who recognize they are able to obtain resources or information easily at their office. For example, 74% of the staff in the 30 universities surveyed reported that the usage of ICT can help in the treatment of students with special educational needs. Though the study found that some staff do not utilize ICT in their teaching-learning they rarely encounter barriers or challenges when it comes to the integration of the technology into their institutions.

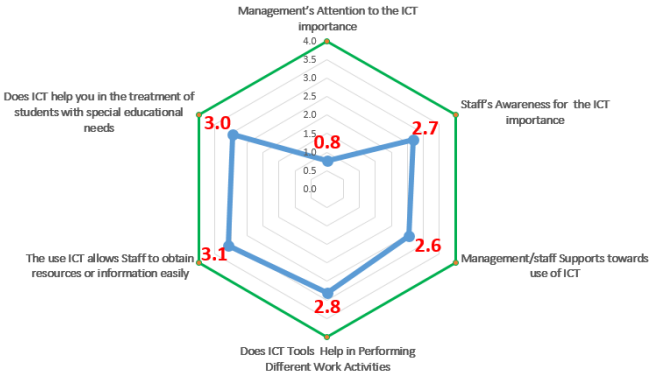


Fig 8. Society attitudes towards ICT: Overall sub-indicators

V. CONCLUSION

The goal of this paper was to better understand the state of ICT readiness of institutions involved in higher education in Somalia and to better prepare for the implementation of e-services addressing the current weaknesses of ICT preparedness by putting in place the required policies, procedures, awareness, fund and commitment. To meet this goal the following are necessary to keep in mind and focus:

- ICT Readiness Assessment Model was developed and applied with the 30 largest and well-respected Higher Education Institutions (HEIs) in Somalia whereby 300 respondents from these institutors revealed the ICT strengths and weaknesses existing in HEIs in the country.

- This ICT Readiness Assessment Model is suitable for use in assessment of the ICT readiness in HEIs in a least developed country such as Somalia. The model is composed of 14 prominent indicators to evaluate four different ICT pillars: ICT infrastructure (5), Institutional ICT Learning (3), ICT Strategically Planning (4), and Society Attitudes towards ICT (2). However, the model employed 47 critical sub-indicators to understand the situation of ICT readiness more in-depth and detail.

- After applying the model, the main conclusion of this study is that HEIs in Somalia are ready to use ICT for education, research, and management. Regardless, less management attention of ICT importance in education, inadequate campus networks, difficulty in internet affordability, the squatness of Internet bandwidth per 1000 students, lack of adequate local contents, lack of ICT security plan and awareness, absence of International academic databases, and unavailability of educational software and technology tools are some critical issues stakeholders should understand. Conversely, the accessibility of one's own or shared PCs, the understanding of ICT benefits in education, and ICT human skills can be considered the main strengths that HEIs actually possess.

ACKNOWLEDGMENT

The authors thank the Center of Research and Development of SIMAD University, for funding this study under Research Grant Scheme (The use of ICT to support teaching and learning in higher education), with Grant No: SU-DA-RG-2018-005. The authors also thank all the respondents of this research.

REFERENCES

[1] P. Appavoo, K. S. Soyjaudah, and V. Armoogum, "Readiness of mathematics' educators to incorporate ICT as a teaching.

[2] tool in Mauritius," in AFRICON, 2013, 2013, pp. 1-5.

[3] E. Adu and G. Galloway, "Information and communication technologies (ICT) and teacher education preparation in South Africa: Implications for 21st century classroom-based practice," Journal of Communication, vol. 6, pp. 242-247, 2015.

[4] F. Siddiq, R. Scherer, and J. Tondeur, "Teachers' emphasis on developing students' digital information and communication skills (TEDDICS): A new construct in 21st century education," Computers & Education, vol. 92, pp. 1-14, 2016.

[5] J. Gil-Flores, J. Rodríguez-Santero, and J.-J. Torres-Gordillo, "Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure," Computers in Human Behavior, vol. 68, pp. 441-449, 2017.

[6] N. Duţă and O. Martínez-Rivera, "Between theory and practice: the importance of ICT in Higher Education as a tool for collaborative learning," Procedia-Social and Behavioral Sciences, vol. 180, pp. 1466-1473, 2015.

[7] S. E. Wildevuur and L. W. Simonse, "Information and communication technology–enabled person-centered care for the "big five" chronic conditions: scoping review," Journal of medical Internet research, vol. 17, 2015.

[8] Y. Perbawaningsih, "Plus minus of ICT usage in higher education students," Procedia-Social and Behavioral Sciences, vol. 103, pp. 717-724, 2013.

[9] P. Chanyagorn and B. Kungwannarongkun, "ICT readiness assessment model for public and private organizations in developing country," International journal of information and education technology, vol. 1, p. 99, 2011.

[10] K. Pillay and L. Erasmus, "e-Readiness in South African Higher Education: A Delphi study," 2017.

[11] E. Lwoga, "Making learning and Web 2.0 technologies work for higher learning institutions in Africa," Campus-Wide Information Systems, vol. 29, pp. 90-107, 2012.

[12] M. G. Aboelmaged, "Predicting e-readiness at firm-level: An analysis of technological, organizational and environmental (TOE) effects on e-maintenance readiness in manufacturing firms," International Journal of Information Management, vol. 34, pp. 639-651, 2014.

[13] W.-Y. Sit, K.-B. Ooi, B. Lin, and A. Yee-Loong Chong, "TQM and customer satisfaction in Malaysia's service sector," Industrial Management & Data Systems, vol. 109, pp. 957-975, 2009.

[14] M. Irfan, S. Putra, C. Alam, A. Subiyakto, and A. Wahana, "Readiness factors for information system strategic planning among universities in developing countries: a systematic review," in Journal of Physics: Conference Series, 2018, p. 012046.

[15] L. Beig, G. Montazer, and A. Ghavamifar, "Adoption a proper tool for e-readiness assessment in developing countries (case studies: Iran, Turkey and Malaysia)," J Know Econ Know Manag, vol. 2, pp. 54-69, 2007.

[16] Y. A. Ahmed, M. N. Ahmad, and N. H. Zakaria, "Towards Exploring Factors That Influence Social Media-Based Knowledge Sharing Intentions In Disaster Management," Journal of Theoretical & Applied Information Technology, vol. 88, 2016.

[17] M. Kashorda and T. Waema, "The E-Readiness Survey of Kenyan Universities," report, Kenya Education Network, Nairobi, available at: www. kenet. or. ke/sites/default/files/E-readiness, vol. 202013, 2013.

[18] B. K. Addom, "E-readiness Assessment of Seven Higher Education Institutions in Ghana," Cornell University, 2004.

[19] C. Machado, "Developing an e-readiness model for higher education institutions: Results of a focus group study," British journal of educational technology, vol. 38, pp. 72-82, 2007.

[20] B. Darab and G. A. Montazer, "An eclectic model for assessing e-learning readiness in the Iranian universities," Computers & Education, vol. 56, pp. 900-910, 2011.

[21] K. Pillay and L. Erasmus, "e-Readiness in South African Higher Education: A Delphi study: With a focus on determining key factors and stakeholders," in AFRICON, 2017 IEEE, 2017, pp. 758-763.

[22] I. J. Ezema, "Journal impact factors and the crisis of scholarly communication in Africa: the dilemma of Nigerian academics," Library Review, vol. 59, pp. 350-359, 2010.

[23] G. E. Christian, "Issues and challenges to the development of open access institutional repositories in academic and research Institutions in Nigeria," 2009.

[24] S. C. A. Utulu and A. A. Akadri, "Institutional Repositories: the untapped academic goldmine," 2010.

Tactical Data Link (Tdl) A Resilient Long Haul Wired Medium for Tactical Armed Forces Communications

Ahmed Qaddus[1], Abid Ali Minhas[2] and Hammad Anwar Syed[3]
[1]*Bahria University, Islamabad, Pakistan, ahmedqaddus@gmail.com*
[2]*Al Yamamah University, Riyadh, Kingdom of Saudi Arabia, a_minhas@yu.edu.sa*
[3] *National Radio Telecom Corporation, Haripur, Pakistan, hammadsyed83@gmail.com*

Abstract: In Armed Forces Tactical Communications rapid deployment and robustness counts during the mission critical applications. Therefore, Tactical Data Link (TDL) can proved to be a best long haul wired medium for tactical armed forces Communications. This system can be easily deployable in the field over a copper shielded wire. The basic operation of Tactical Data Link (TDL) is to convert Ethernet traffic into electrical signals, which can be traveled over a copper shielded wire of appropriate diameter and gauge. The Tactical Data Link (TDL) system can provide communications over a 15 km with data rate up to 15 Mbps depending upon the copper wire conductor thickness in ideal environment. The major operational hurdle faced by Tactical Data Link (TDL) system when deployed in field over a 15 km hop length is the establishment of circuit switched connectivity between the near and far end Tactical Data Link (TDL) units. The connectivity could not be established due to high Bit Error Rates (BER), which results in low Signal to Noise Ratio (SNR) levels, which further results in repercussion of transmission and reception of data due to poor line conditions and tentative disconnections. In this research, Authors propose the use of two deployment scenarios for the achievement of Maximum data rates through the Tactical Data Link (TDL) system once deployed over a 15 km hop length. In first scenario authors purposes to deploy a thick copper conductor diameter wire of AWG-15 & AWG-18 which offers low resistance which allow maximum flow of electrical pulses through it, which results in low Bit Error Rates (BER) and high Signal to Noise Ratio (SNR) levels. In second scenario authors purposes to adjust the transmission and reception line rates of the Tactical Data Link (TDL) system units both on the transmission and reception sides by changing firmware configuration settings, which can allow the Tactical Data Link (TDL) system units to transmit and receive in poor line conditions with thinner copper conductor diameter wires. In future by deploying Tactical Data Link (TDL) system in Armed Forces Tactical Communications network constraints of mission critical applications can be carry out in a proficient way.

Keywords: Tactical Data Link (TDL), Bit Error Rates (BER), Signal to Noise Ratio (SNR), Long haul Transmission, Armed Forces Tactical Communications, Pulse Amplitude Modulation (PAM)

I. INTRODUCTION

For meeting day-to-day challenges of Armed Forces Tactical Communications during mission critical applications, we can commission Tactical Data Link (TDL) as a sustainable and reliable solution. The Tactical Data Link (TDL) is Ethernet Extender technology based on Symmetrical high-speed digital subscriber line (SHDSL). The device can form a long haul operational Ethernet network on a single twisted pair cable (up to 15 km) at data rates up to 14 to 15 Mbit/s. Further the data rate can be doubled up to 27 to 30 Mbit/s by using port bonding. The primary built in switch permits 2 Ethernet devices to be connected to a legacy piece of equipment like layer2 or layer3 switch which can be further incorporated into the IP network. Tactical Data Link (TDL) transmit Ethernet traffic over the copper conductor wire by using line-coding technique.

Line coding technique is a mechanism for converting binary bits 0 and 1 present in a data stream into square wave Electrical pulses which can be transmitted over a copper conductor wire. Here in Tactical Data Link (TDL) system 2B1Q line coding scheme is used, in which a block of two binary bits 0 and 1, can represent four different 00, 01, 10 and 11 values. These 00, 01, 10 and 11 values are represented to one quaternary value, which is further encoded by means of four different types of voltage levels -3, -1, +1 and +3. In 2B1Q line coding scheme first binary bit in case of 0 bit will represent negative voltage and if first binary bit is 1 bit it will represent positive voltage. Further in 2B1Q line coding scheme secondary binary bit in case of 0 bit will represent 3-volt line potential and if first binary bit is 1 bit it will represent 1-volt line potential. Figure 1 and 2 shows the difference between the ordinary binary transmission and 2B1Q line-coding scheme [1-4, 12-15].

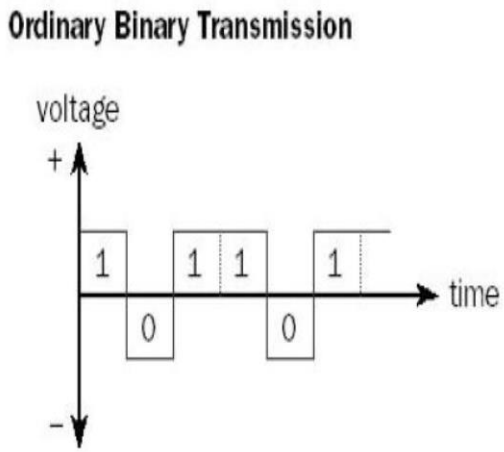


Fig 1. Ordinary Binary Transmission

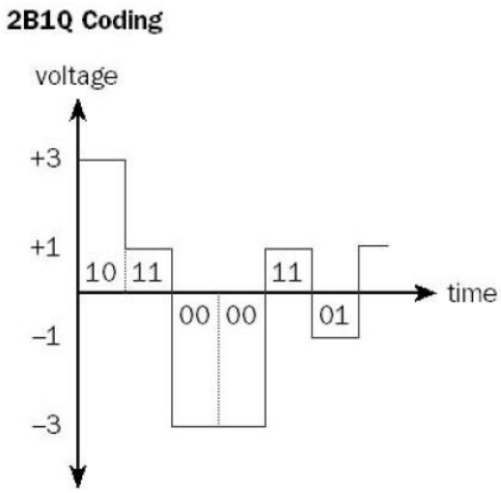


Fig 2. 2B1Q Line Coding Scheme

In Symmetrical high-speed digital subscriber line (SHDSL), 2B1Q line coding scheme is used which is a four-levels pulse amplitude modulation (PAM-4) scheme and is also referred as signal modulation technologies. Further 2B1Q line coding scheme is also used in the U interface of Integrated Services Digital Network (ISDN) Basic Rate Interface (BRI). Here a particular electrical pulse is denoted by 2 binary bits which is different from its predecessor binary transmission schemes where a particular electrical pulse was denoted by 1 binary bit only. By denoting single electrical pulse by 2 binary bits results in the maximization of available bandwidth of the Communication channel two times.

This eventually results in the increase of data transmission in available ISDN bandwidth of 4 KHz, specified for a twisted pair wire. Table 1 shows the binary data and their representation in 2B1Q line coding voltage Levels [3-6].

Binary Data Represented	Voltage of Electrical Pulse
00	-3
01	-1
10	+3
11	+1

Table 1. Binary Data representation in 2B1Q Voltage Levels

II. TDL SYSTEM DESIGN & FUNCTIONAL PARAMETERS

Currently the system as shown in figure 3 has 04 x transmission channels in one unit capable of 15 Mbps at each channel (with combine auto aggregate (port bonding) to (30+30=60 Mbps) in uplink & downlink direction). TDL can be configure for all modes of operation including Point to point, ring and mesh topologies. It can be managed and configured via in built touch screen or externally via Ethernet interfaces. It can be configured in Point to Point, Mesh and Ring pattern. It has 07x switch ports and its range is extendable with the help of repeaters [2, 7].

The fundamental designing parameters of the Tactical Data Link (TDL) are, 12 to 48 VDC Rated Voltage, 9.8 to 60 VDC Operating Voltage, 475 mA @ 12 VDC Rated Current for single circuit, IP Network Functionality, SHDSL Functionality, Web based Management interface, Port Bonding Feature and Inbuilt 07 x port switching unit. Each TDL unit has following major constituents, 2 x Ethernet Extender Modules, 4 x SHDSL Ports, 4 x LAN: 10 / 100Mbps RJ-45 Ethernet port, 1 x DC Input Charging Port, 7 x port Switch [2, 7].

Fig 3. Tactical Data Link (TDL) System Units

III. TDL SYSTEM LAB & FIELD TESTING

The functionality of Tactical Data Link (TDL) system units were practically tested in Lab and Field scenario both. In Lab during an ideal environment when thick copper conductor diameter wire of AWG-15 & AWG-18 was used, which offers low resistance. Due to low resistance in wire, maximum flow of electrical pulses can pass through the wire, which results in low Bit Error Rates (BER) and high Signal to Noise Ratio (SNR) levels. These high Signal to Noise Ratio (SNR) levels permits Tactical Data Link (TDL) system units to accommodate 14 to 15 Mbps uplink and downlink TCP traffic on a single channel. These results were practically verified by generating 14 to 15 Mbps uplink and downlink TCP traffic via external Ethernet generator source like Tomosoft, which occupy whole available channel bandwidth as shown in the statistical graph in Figure-4 [5, 8, 9].

In second phase the functionality of Tactical Data Link (TDL) system units were practically tested in Lab scenario for 02 dual channels. Here 02 dual channels were logically combine by Bandwidth Aggregation feature which can support the flow of 27 to 30 Mbps uplink and downlink TCP traffic. These results were further practically verified again by generating 27 to 30 Mbps uplink and downlink TCP traffic via external Ethernet generator source like Tomosoft, which occupy whole available channel bandwidth as shown in the statistical graph in Figure-5 [5, 8, 9].

In both the testing scenarios of single and dual channel Authors used line load Resistance simulator to test the Tactical Data Link (TDL) system units on a 15 km hop length in a real time environment. Here in Lab the near and far end Tactical Data Link (TDL) units were separated over a 15 km hop length distance creating a real time Armed Forces Tactical Communication field deployment scenario [5, 8, 9].

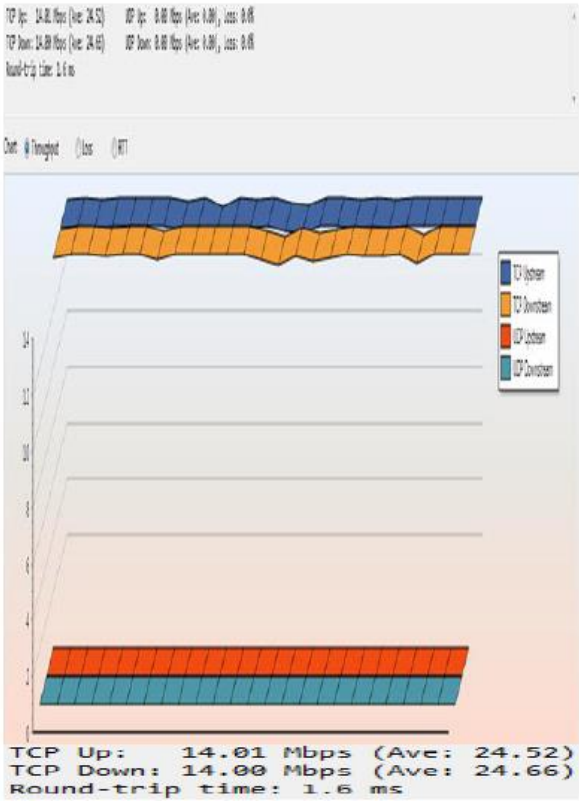


Fig 4. (01) Single Channel Traffic

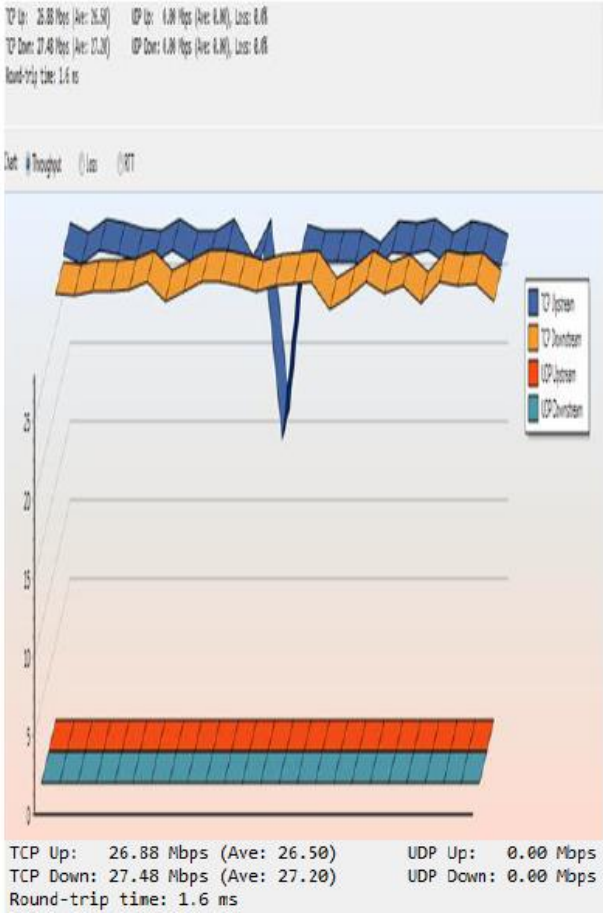


Fig 5. (02) Dual Channel Traffic

IV. SOFT CONFIGURATION OF TDL SYSTEM

For the configuration of single 15 Mbps channel without port bonding or aggregation, we have to perform two software configuration steps on both the near end and far end Tactical Data Link (TDL) system units. In first step near end unit of TDL has to be configured as Central Office (CO) and the second far end unit of TDL has to be configured as Customer Premises Equipment (CPE). Further in second step Port menu is selected in the Configuration page for entering into SHDSL configuration window where Central Office (CO) is selected on the near end TDL unit with port 1 enable and Customer Premises Equipment (CPE) is selected on the far end TDL unit with port 1 enabled as shown in figure 6 and 7 [1, 6-9].

Further for the configuration of two 15 Mbps channels with port bonding or aggregation to generate 30 Mbps we have to perform two software configuration steps on both the near end and far end Tactical Data Link (TDL) system units. In first step near end unit of Tactical Data Link (TDL) system has to be configured as Central Office (CO) and the second far end unit of Tactical Data Link (TDL) system has to be configured as Customer Premises Equipment (CPE), with port bonding enabled. Port bonding refer to PME Aggregation Function (PAF) [12-15] in computer networking which permits to join together one or more Physical Medium Entities (PMEs) like two separate physical channels to form a single logical Ethernet link. By using PME Aggregation Function (PAF) in Tactical Data Link (TDL) system units both the 15 Mbps at each channel is logically port bonded to one logical channel giving data rate through put of (30+30=60 Mbps) in uplink & downlink direction). Further in second step Port menu is selected in the Configuration page for entering into SHDSL configuration window where Central Office (CO) is selected on the near end TDL unit with both ports 1 & 2 enabled and Customer Premises Equipment (CPE) is selected on the far end TDL unit with both port 1 & 2 enabled with port bonding options on both near and far end TDL units, as shown in figure 8 and 9 [1, 6, 14].

Fig 6. Central Office (CO) Configurations

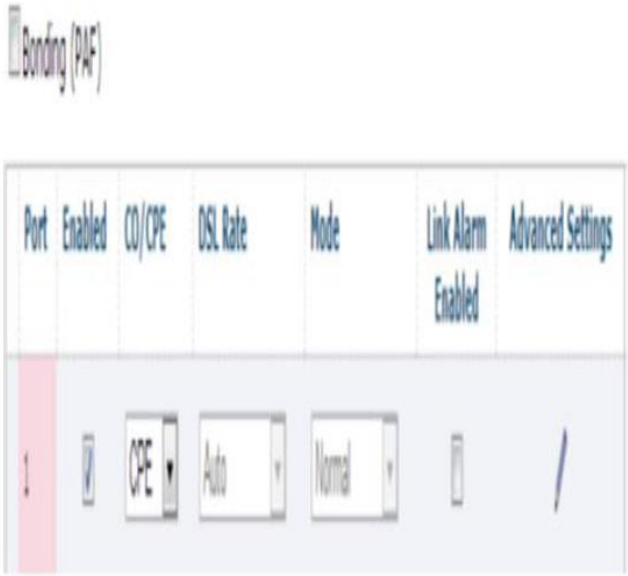


Fig 7. Customer Premises Equipment (CPE) Configurations

Fig 8. Central Office (CO) with Port Bonding

Fig 9. Customer Premises Equipment (CPE) with Port Bonding

V. PROBLEM STATEMENT

The major operational hurdle faced by Tactical Data Link (TDL) system when deployed in field over a 15 km hop length is the establishment of circuit switched connectivity between the near and far end Tactical Data Link (TDL) units. The connectivity could not be established due to high Bit Error Rates (BER) which consequences are low Signal to Noise Ratio (SNR) levels which further results in repercussion of transmission and reception of data due to poor line conditions and tentative disconnections [1, 8-11].

VI. PROPOSED SOLUTION

Authors in this investigation recommend the use of two deployment scenarios for the achievement of Maximum data rates through the Tactical Data Link (TDL) system [1, 6] once deployed over a 15 km hop length. In first scenario authors purposes to deploy a thick copper conductor diameter wire of AWG-15 & AWG-18 which offers low resistance which allow maximum flow of electrical pulses through it, which results in low Bit Error Rates (BER) and high Signal to Noise Ratio (SNR) levels [8-11]. In second scenario authors purposes to adjust the transmission and reception line rates of the Tactical Data Link (TDL) system [1, 6] units both on the transmission and reception sides by changing firmware configuration settings, which can allow the Tactical Data Link (TDL) system [1, 6] units to transmit and receive in poor line conditions with thinner copper conductor diameter wires.

VII. USE OF THICK DIAMETER WIRE

In first scenario, Authors have practically proven that by deploying thick copper conductor diameter wire of AWG-15 & AWG-18 results in low resistance, which allow maximum flow of electrical pulses through the wire. Due to less resistance, low Bit Error Rates (BER) and high Signal to Noise Ratio (SNR) levels [8-11] are achieved on the transmitter and receiver side of the Tactical Data Link (TDL) system [1, 6] units. In this research the statistical graphs in Figure 3 and 4 already shows the maximum transmitted and received data rate of 15 Mbps and 30 Mbps over a Tactical Data Link (TDL) transmission system.

Therefore by using copper wire of appropriate thick diameter we can achieve the desirable transmitted and received data rates over a 15 km hop length Tactical Data Link (TDL) transmission system. In the

practical field deployment a 15 km AWG-18 copper conductor wire was laid in a circuit switch configuration between the near and far end units of Tactical Data Link (TDL) transmission system. Ultimately the desirable results of transmitted and received data rates of 15 Mbps and 30 Mbps in port bonding were achieved at the both ends of the Tactical Data Link (TDL) units which is shown in Figure 10 and 11 by using software based NetPerSec Ethernet Traffic Monitoring tool.

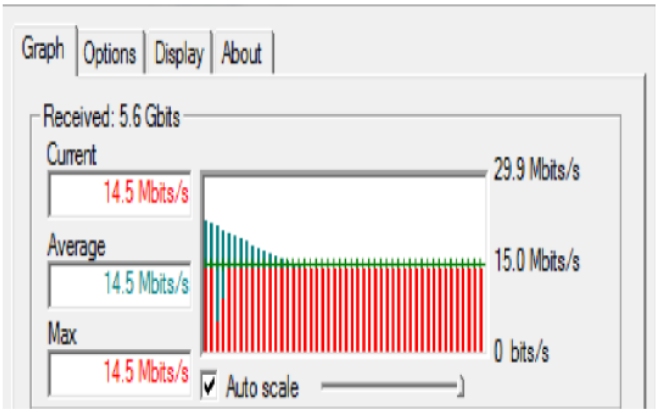


Fig 10. Receive data rate on a Single Channel

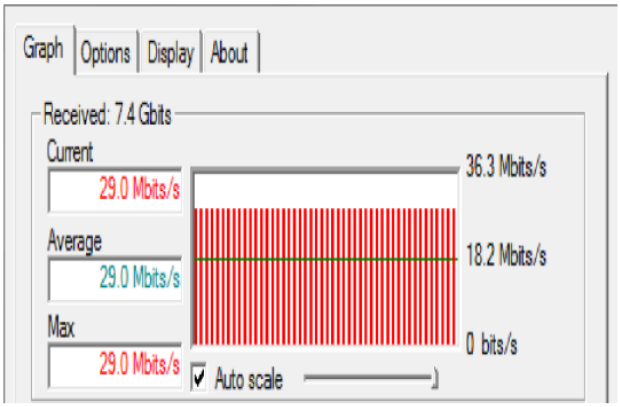


Fig 11. Receive data rate on a Dual Channels via Port Bonding

VIII. SELECTION OF TX & RX LINE RATES

In second scenario, Authors have practically proven that by manually changing firmware configuration settings of transmission and receiving line rates of the Tactical Data Link (TDL) system units of both transmission and receiver sides eventually results in establishing a connectivity even in poor line conditions with thinner copper conductor diameter wires. In the practical field deployment a 15 km TT Field wire having 4 copper tinned strands and 3 steel tinned strands was laid in a circuit switch configuration between the near and far end units of Tactical Data Link (TDL) transmission system. TT Field wire has high resistance due to thinner diameter of the copper and steel strands present in a wire which causes high Bit Error Rates (BER) and low Signal to Noise Ratio (SNR) levels at both the transmitter and receiver side of the Tactical Data Link (TDL) system units [1, 6, 8-11].

Here Authors have manually changed the settings of Symmetrical high-speed digital subscriber line (SHDSL) transmission and reception data rates in both the transmission and receiver units of the Tactical Data Link (TDL) system to 32 Kbps as shown in figure 12 and 13. After testing the different line rates on both the near and far end TDL units, Authors were eventually able to establish a circuit switched connectivity between the near and far end Tactical Data Link (TDL) units on 32 Kbps data rate limit as shown in figure 14.

Bonding (PAF)

Port	Enabled	CO/CPE	DSL Rate	Mode	Link Alarm Enabled	Advanced Settings
1	✓	CO	32 kbps	Normal		
2	✓	CO	32 kbps	Normal		

Fig 12. SHDSL data rate Configurations on CO side

Bonding (PAF)

Port	Enabled	CO/CPE	DSL Rate	Mode	Link Alarm Enabled	Advanced Settings
1	✓	CPE	Auto	Normal		
2	✓	CO	32 kbps	Normal		

Fig 13. SHDSL data rate Configurations on CPE side

Link Status	Up
Link Uptime	0 Days 0 Hours 9 Mins 16 Secs
Negotiation State	UP_DATA_MODE
Data Rate	32000
Current SNR Margin (dB)	22
Negotiations	1

Fig 14. Statistics of SHDSL TX & RX Line Data Rates

IX. CONCLUSIONS

In this investigation Authors have suggested the use of two deployment scenarios for the achievement of Maximum data rates through the Tactical Data Link (TDL) system once deployed over a 15 km hop length. In first scenario authors purposes to deploy a thick copper conductor diameter wire of AWG-15 & AWG-18 which offers low resistance which allow maximum flow of electrical pulses through it, which results in low Bit Error Rates (BER) and high Signal to Noise Ratio (SNR) levels.

In second scenario authors purposes to adjust the Symmetrical high-speed digital subscriber line (SHDSL) transmission and reception line rates of the Tactical Data Link (TDL) system units both on the transmission and reception sides by changing firmware configuration settings, which can allow the Tactical Data Link (TDL) system units to transmit and receive in poor line conditions with thinner copper conductor diameter wires. From the statistical results, authors in this investigation determine that by adopting above mention scenarios Tactical Data Link (TDL) system units can be deployed in any harsh terrain environments which can fully achieve the requirements of Armed Forces Tactical Communications network constraints in mission critical applications circumstances.

REFERENCES

[1] Davis, Steven A. O'Gara, Mike. "Key tactical data link systems clear operational testing: NGC2P, MIDS on ship programs prepare for f", CHIPS, July-Sept 2008 Issue.

[2] http://westermo.com.

[3] http://multitech.co.uk.

[4] http://mdpi.com.

[5] Raghuram Ranganathan, “Cognitive Radio for Smart Grid: Theory, Algorithms and Security” in International Journal of Multimedia Broadcasting, Mar. 2013.

[6] David R. Smith, "Digital Transmission Systems", in Springer Nature, 2004.

[7] Jin, Yongzhe, Larry Tsang, Cedric F. Lam, and Yuan-Hao Lin. "", Metro and Access Networks II, 2002.

[8] Qaddus, Ahmed, Aamir Ali Raza, and Ali Mustafa. "Deploying uninterrupted wireless communication networks by using Software Define Cognitive Radios (SDCR) and Time Division Duplex (TDD) transmission techniques in 5G networks", 2015 International Conference on Information and Communication Technologies (ICICT), 2015.

[9] Ahmed Qaddus, Saleem Aslam, Abid Ali Minhas, Abdulaziz Almazyad. "5G Hetrogeneous Cellular Networks a Viable Mode for Implementing Future Smart Grid Networks", Proceedings of the International Conference on Future Networks and Distributed Systems -ICFNDS '17, 2017.

[10] Roman Yankevych, "Newly Developed Mechanism of Signal to Noise Ratio Estimation", in IEEE, 2015

[11] Manli Li, Yi Tang and Jie Wu, "Model the Real Time Failure Rate of Protection Channels Due to Communication Latency and Bit Error", in IEEE, March 2015.

[12] http://www.thenetworkencyclopedia.com/entry/line-coding/

[13] http://www.rfwireless-world.com/Tutorials/ISDN-2B1Q-signal-format.html

[14] https://en.wikipedia.org/wiki/PME_Aggregation_Function

[15] Whitham D. Reeve, “Subscriber Loop Signaling and Transmission Handbook”, in IEEE Telecommunications Handbook Series. IEEE Press, 1995.

Mobile Healthcare Benefits and the Health Threat Posed by Mobile Health Technologies in Africa

Ramadile Moletsane[1], Keneilwe Zuva[2] and Tranos Zuva[3]

[1]*Dept. of Software Studies, Vaal University of Technology, Vanderbijlpark, South Africa,* ramadilem@vut.ac.za

[2]*Dept. of Computer Science, University of Botswana, Gaborone, Botswana,* zuvak@ub.ac.bw

[3]*Dept. of ICT, Vaal University of Technology, Vanderbijlpark, South Africa,* tranosz@vut.ac.za

Abstract: The widespread introduction of mobile devices has made enabling conditions for the deployment of mobile health activities. Although mobile health is a relatively new concept, it is transforming healthcare all over the world. It is a rapidly progressing area with tremendous rate. Fifteen publications were identified from Elsevier, PubMed and Google scholar databases and specific to the purpose of this paper. The search was restricted to humans, date of publication (2014 to 2017) and publication language (English). The aim of this narrative review paper was to analyse possible hazards and benefits of mobile phones as mobile health equipment to the environment and wellbeing respectively and suggest an intervention. Mobile phones were found to be the most mHealth equipment used in Africa. The continent is realizing the benefits from mHealth practices. The most concerning issue about mobile phones when they reach their end-of-life is their toxicity to the environment and wellbeing. Africa is found to manage electronic waste in a manner that is not friendly to the environment. Therefore the study suggests that awareness of detrimental effects of this waste be prioritized.

Keywords: mobile health, electronic waste hazards, environment, African countries, Mobile phone.

I. INTRODUCTION

Mobile health (mHealth) is an emergent field of a long-term health and wellbeing support that uses mobile technologies. mHealth uses mobile devices such as mobile phones, laptops, tablet computers and any handheld device with internet connectivity. The effect of portable innovation in the everyday lives of individuals worldwide has expanded uniquely after the previous decade and keeps on extending. Presently there is no standard definition of mHealth [1]. It is characterised by healthcare practices supported by mobile gadgets. For the purpose of this paper, mHealth means any public or private health activities made possible by mobile device(s). mHealth has the potential to transform health care [2]. Mobile health services are not time and place bound. They deliver services that address for example, emerging chronic diseases associated with poor or unhealthy lifestyle, high cost of current national health services. mHealth is key to modern healthcare solutions [3]. It has developed as of late to a great extent as an application for developing countries originating from the rapid rise of mobile phone penetration. Mobile devices portability and ability to operate with minimal infrastructure are regarded as better option to deliver health services in the developing countries [3]. In developing countries, healthcare is characterised by limited access, high costs, low quality and delay to meet the needs of the clients. Most African countries healthcare system is crippled by poverty, ever-increasing population growth, loaded with high cases of diseases and inadequate health workers [4]. The healthcare players are separated by vast distances and further constrained by poor communication infrastructure, obsolete information technology solutions that impede their potential to collect and disseminate information [4]. Within this context, mHealth has been identified as a viable solution to serve the pressing healthcare needs in the developing countries.

Africa and other developing countries need to immerse themselves in the development of mHealth to improve healthcare delivery systems in their regions [3].

Africa has a potential to make mHealth a reality especially when considering minimal mHealth gadget necessary to make this a reality i.e. mobile phone [3, 4]. In 1998, Africa had less than four million mobile phones [4]. At the end of 2015 about 46% of African population subscribed to mobile services. Africa is expected to have more than 725 million unique subscribers by the year 2020. According to African health Observatory [5], penetration of mobile phones and associated mobile networks in developing regions such as Africa makes mHealth legitimate and possible in such countries. This is good news to the proponents and enterprises of mHealth equipment in developing countries i.e. particularly African countries. There is so much enthusiasm on what mHealth in Africa does, but it is silent about electronic waste generated by these mHealth equipment when obsolete. Most studies focus on the utilisation of mHealth equipment [6, 7].

According to Needhidasan, Samuel [8] electronic waste is one of the 21st century challenges facing the world of today. Problem with e-waste is that it is harmful to the wellbeing and the environment especially when not managed properly. Hence, this study is motivated by limited awareness of e-waste issues such as harmful effects on the environment and human health [9]. This study is structured as follows: In Section 2 methods used to conduct the study is discussed. Section 3 and Section 4 provides results and discussions of this review paper respectively. Under the results, Section 3.1 discusses the benefits of mHealth and Section 3.2 provides environmental risks and wellbeing effects of obsolete mHealth equipment. The study concludes in Section 5.

II. METHODS

A review of the literature assisted by Atlas.ti software on mHealth benefits was undertaken. Formal searches were done using Elsevier, PubMed, Google scholar databases to identify literature. The search was restricted to research articles, date of publication (2014 to 2017) and publication language (English). Information on the benefits of mHealth was taken using keywords ‘mobile health’, ‘mHealth benefits’. Within selected articles, we went further deep into those that addresses the benefits of mHealth worldwide and funnel the search results to articles that talk mHealth benefits in Africa.

A second literature search included grey literature, Google, scholar and Elsevier databases focused on the effects of mHealth obsolete devices on the environment and health. A combination of the following search terms were used: ‘mobile health devices and environment friendliness’, ‘green mobile health ‘ , ‘electronic waste and environment’ and ‘e-waste and health’.

A relatively brief examination of the various benefits of mHealth was presented. The benefits of mHealth were then followed by an extensive review of the potential environmental and wellbeing hazards associated with discarded or unwanted mHealth waste.

III. RESULTS

A. Benefits of mobile phones

Most developing nations have seized the utilization of mHealth applications as a way to enhance essential healthcare services delivery and general wellbeing for their masses. mHealth transformative power of healthcare services is also known to Africa. It enhances communities both rural and urban with up-to-date knowledge and information, improved service delivery and reduced reaction time during emergencies [5]. Amid all these benefits, mHealth is also prone to human errors. Mobile phone can be lost or stolen. Smartphones and tablets are also vulnerable to hacking, viruses and malware especially when these devices use unsecured internet connections. The following discussion talks on how a simple SMS service could help in diseases control and prevention.

In Kenya, short message service (SMS) is benefiting users to get up-to-date list of health professionals and centres starting with the closest ones. Locating healthcare service quickly can save lives. In Mozambique, the SMS is used to relay much needed information to people with human immunodeficiency virus (HIV). The educational information help infected people on how to adhere to treatment and prevent mother to child transmission of HIV. In South Africa, the SMS is used to provide pregnancy, postnatal and baby care information to women in their preferred language. The service is called MAMA SMS service. In Rwanda an SMS service called Rapid SMS and mUbuzima is used to track pregnant women and newly born babies, and promote early detection of life threatening emergencies [5]. These are basic benefits of mHealth through the use of simple SMS service available from any mobile phone regardless of the phone value. Healthcare services coordinated to women by means of SMS service could engage them with fundamental information and knowledge to advance not only their wellbeing but also health of their family members [10]. These are some of the benefits provided by mHealth to any community member armed with a basic mobile phone. Worldwide evidence underpins the utilisation of SMS as a service to improve adherence to medicine and participation to scheduled appointments [11, 12]. However according to Househ [13] there is a paucity of evidence on the benefits of SMS service interventions for appointment updates, advancing wellbeing in developing countries and preventive healthcare.

The next concerning issue is what happens to these mobile phones when they are no longer wanted by their users. What are environmental and wellbeing threats contained by these retired equipment? The next discussion explores the environmental and wellbeing hazards of these devices. Literature shows that when these obsolete equipment are not managed properly they become health and environment hazards.

B. Environmental risks and wellbeing hazards of mobile health devices

E-waste is a complex problem because it is non decomposable and there is no single method to properly manage it available yet. E-waste is both valuable and toxic [8]. Components of value include and not limited to gold, silver, copper and aluminum [14]. The toxic metals include cadmium, mercury, bromine and lead [8]. There is no standard definition of e-waste yet. E-waste comes with different definitions given by literature [8]. Characteristics of e-waste include: valuable and toxic metals, non-decomposable waste, obsolete electronic equipment, the list goes on and on [8, 14]. For the purpose of this paper e-waste will be defined as: any mobile health equipment unwanted by its owner or users regardless of equipment functional state. What makes e-waste bad is its toxicity that eventually causes environmental hazards and wellbeing harm when they are not managed properly [14].

Proper management is relatively safer than poor management in terms of hazardous effects to health and ecology. Improper management has been found to result adverse effects on the environment and health. Literature classified these harmful consequences into health and the environment [14]. There have been studies that reported serious health effects under controlled conditions. Julander, Lundgren [15] found elevated exposure to electronic waste toxic metals from a formal recycling facility. They concluded that the results are even higher in an informal recycling setting. Contaminants released by e-waste were associated with cases of liver cancer , lower birth weight, asthma and other health problems [16]. E-waste when not properly managed may leach into soil or water and tap into household water sources or contaminate food chain. A study conducted in Ghana suggests that contaminated water has the potential to kill aquatic life [17].

Developing countries and particularly African countries were found to manage electronic waste in an environmentally unfriendly manner. Findings are disturbing given the dangers of electronic waste on the environment and wellbeing [18, 19]. Before tapping into devastating effects of electronic waste, it is essential to determine factors of improper management in African countries.

In African countries electronic waste regulation is absent and if any, it is characterized by bribery and is laxer. The legislation issue is also characterised by failure of the International regulation—Basel Convention to be not binding and allowing loopholes for illegal electronic waste trade [20]. Babatunde [21] argues that illegal trade is motivated by poverty and corruption.

IV. DISCUSSIONS

A relatively brief examination of the various benefits of mHealth was presented. The benefits of mHealth were then followed by an extensive review of the potential environmental and wellbeing hazards associated with discarded or unwanted mHealth waste. Electronic waste generated by these mHealth devices could result into adverse health and ecological consequences if not managed properly.

V. CONCLUSIONS

The transformative power of mHealth cannot be ignored. There is more evidence-based work needed on how mHealth advances the healthcare in developing nations, especially in the African region. mHealth has been found instrumental in educating and informing both rural and urban communities in health-related matters. SMS service has been identified as significant in reshaping how healthcare is seen in African context. The downside is the management of obsolete mHealth equipment. In the African region management of e-waste is inadequate. E-waste is toxic and harmful. This paper suggests awareness about the detrimental effects of e-waste on health and ecology.

REFERENCES

[1] Ali, E.E., L. Chew, and K.Y.-L. Yap. (2016) "Evolution and current status of mhealth research: a systematic review." BMJ Innovations 2(1): 1-8.

[2] Bosak, K. and S.H. Park. (2017) "Characteristics of Adults Seeking Health Care Provider Support Facilitated by Mobile Technology: Secondary Data Analysis." Jmir Hum Factors 4(4): e33

[3] Jahan, S. and M.H. Chowdhury. (2014) "mHealth: A Sustainable Healthcare Model for Developing World." American Journal of Modeling and Optimization 2(3): 73-76.

[4] Folaranmi, T. (2014) "mHealth in Africa: challenges and opportunities." Perspectives in Public Health 134(1): 14-15.

[5] African health Observatory. (2015) "Mobile health: transforming the face of health service delivery in the African Region." Available from: http://www.aho.afro.who.int/en/blog/2015/03/10/mobile-health-transforming-face-health-service-delivery-african-region Accessed 7 July 2018

[6] Chaudhary, P. and P. Kaul. (2015) "Factors affecting utilization of medical diagnostic equipment: A study at a tertiary healthcare setup of Chandigarh." Chrismed Journal of Health and Research 2(4): 316-323.

[7] Marufu, C. and K.A. Maboe. (2017) "Utilisation of mobile health by medical doctors in a Zimbabwean health care facility." Health SA Gesondheid (Online) 22: 228-234.

[8] Needhidasan, S., M. Samuel, and R. Chidambaram. (2014) "Electronic waste: An emerging threat to the environment of urban India. Journal of Environmental Health Science & Engineering." (2014): 12-36.

[9] Kitila, A.W. (2015) "Electronic Waste Management in Educational Institutions of Ambo Town, Ethiopia, East Africa." International Journal of Sciences: Basic Applied Research 24(4): 319-331.

[10] DeSouza, S.I., et al. (2014) "Mobile Phones: The Next Step towards Healthcare Delivery in Rural India?" PLoS ONE 9(8): e104895.

[11] Mbuagbaw, L., et al. (2015) "Mobile phone text messaging interventions for HIV and other chronic diseases: an overview of systematic reviews and framework for evidence transfer" BMC Health Services Research, 2015. 15(1): p. 33.

[12] Ershad Sarabi, R., et al. (2016) "The Effectiveness of Mobile Phone Text Messaging in Improving Medication Adherence for Patients with Chronic Diseases: A Systematic Review." Iran Red Crescent Med J 18(5): e25183.

[13] Househ, M. (2016) "The role of short messaging service in supporting the delivery of healthcare: An umbrella systematic review." Health Informatics Journal 22(2): 40-150.

[14] Perkins, D.N., M. Drisse, and T. Nxele. (2014) "E-Waste: A Global Hazard" Annals of Global Health 80(4):286-295

[15] Julander, A., et al. (2014) "Formal recycling of e-waste leads to increased exposure to toxic metals: An occupational exposure study from Sweden." Environment International 73: 243–251.

[16] Fazzo, L., et al. (2017) "Hazardous waste and health impact: a systematic review of the scientific literature." Environmental Health 16: 2-11

[17] Huang, J., et al. (2014) "E-waste disposal effects on the aquatic environment: Accra, Ghana." Rev Environ Contam Toxicol 229: 19-34.

[18] Machete, F. (2017) "Environmental health risks associated with e-waste exposure in Badplaas, Carolina and Elukwatini landfills, Republic of South Africa." African Journal of Science, Technology, Innovation and Development 9(6): p. 679-684.

[19] Park, J.K., et al. (2017) "Effects of Electronic Waste on Developing Countries. Advances in Recycling & Waste Management" 2(2): 1-6.

[20] Hector, M.C. (2017) "Toxic Trade: E-Waste Disposal and Environmental Governance in West Africa, in Faculty of Arts and Social Sciences." Stellenbosch: Cape Town, South Africa

[21] Babatunde, O.A. (2017) "A legal appraisal of the challenges of management of electronic waste in Nigeria." International Journal of Law 3(2): 7-18.

BALANCED MAGIC SQUARES 6X6

Saleem Al-ashhab[2] and Walter Trump[3]

[1]*Department of Mathematics, Al-albayt University, Mafraq, Jordan, ahhab@aabu.edu.jo*

[2]*Department of physics, Gymnasium Stein, Stein, Germany, walter@trump.de*

Abstract: We study different types of magic squares 6x6, which we recently introduced. We present many results regarding the number and properties of these types of magic squares.

Keywords: magic square, enumeration.

I. INTRODUCTION

A semi magic square is a set of n^2 (n > 2) distinct natural numbers arranged in the form of an n by n array whose rows and columns sum up to the same number. This value is called the magic constant. A classical (natural) semi magic square consists of the integers 1, ..., n^2. The magic constant equals in this case n*(n^2+1)/2.

1	8	15	17	24
9	11	18	25	2
12	19	21	3	10
20	22	4	6	13
23	5	7	14	16

Table 1. A classical semi magic square

A semi magic square which represents its 8 rotations and reflections (known as variants) is a unique semi magic square. If the two main diagonals sum to the magic constant then the square is a magic square. It is well known that we have only eight 3x3 magic squares (with sum in all directions 15). All these squares have the number 5 as a middle entry and all these squares can be formed using the following transformations: rotations with angle and reflections about the middle column, middle row and both diagonals of the square.

8	1	6
3	5	7
4	9	2

A broken diagonal is a combination of two parallel diagonal lines to the same main diagonal. The two parallel diagonal lines must occur on opposite sides of the main diagonal and they can only be combined if the combination has the same number of entries as the main diagonal. Two examples of a broken diagonal line are 10, 3, 8, 13 and 7, 14, 9, 4 as shown in table 2. There are three broken diagonals corresponding to each main diagonal.

In some cases more transformations exist like exchanging some entries simultaneously. For each type there exist a different number of transformations.

While no natural pandiagonal magic 6x6 square exists (this is known in the literature), no pandiagonal magic 6x6 square exists. We introduce later the concept of semi pandiagonal square, which is a weaker concept. Such squares exists for order six.

II. SYMMETRIC AND PANDIAGONAL SQUARES

It's well known that pandiagonal magic 4x4 square matrix has the following structure (magic constant is 2s), where the capital letters represent independent variables.

A	B	C	2s–A–B–C
E	2s–A–B–E	A+E – C	B+C – E
s – C	A+B+C–s	s – A	s – B
s–A–E+C	s–B–C+E	s – E	A+B+E–s

Table 2. A general pandaigonal magic square

If we use the classical notation of a matrix of order 6

$A = (a_{ij})$ for $i, j = 1,\ldots,6$ (1)

then a magic 6x6 square matrix is called semi-pandiagonal if

a1,3 + a2,2 + a3,1 + a4,6 + a5,5 + a6,4 = 111,

a1,4 + a2,5 + a3,6 + a4,1 + a5,2 + a6,3 = 111.

Such squares do exist. In the case of even order n we mean by a symmetric magic square that the sum of every pair of opposite entries equals

$n^2 + 1$,

i.e. the following relations hold

$$a_{ij} + a_{n+1-i,n+1-j} = n^2 + 1 \quad \text{for all} \quad i, j = 1,\ldots,\frac{n}{2} \quad (2)$$

While symmetric magic squares of order four exist, they do not exist for the order six. Now, we introduce magic squares with weaker conditions, which do exist.

A. Balanced Squares

We will consider a subset of squares with better features than classical magic squares, which enables us to develop efficient codes. We call a matrix (aij) a balanced magic 6x6 square if

a11 + a61 + a16 + a66 = 2s

a22 + a25 + a52 + a55 = 2s

a33 + a43 + a34 + a44 = 2s

Compared with a general magic square we have 3 additional equations (the corner sum of the center 2x2, 4x4, 6x6 square), but only 2 are linearly independent in the whole set of equations. Hence, there are twenty-one independent variables for balanced magic 6x6 squares.

We present a general form of balanced magic 6x6 squares:

a	J	c	D	f	Q
h	N	K	l	m	M
b	r	u	v	t	N
q	p	z	B	y	L
g	o	i	x	W	F
T	Y	R	E	G	H

Table 3. A balanced magic square

Where

B=2s – u – v – z,
D = 3s – 2a – h – b – q – g – j – c – f + m + v + z + o,
E = s – D – l – x + u + z,
F= m + n + s – i – x – g
G = s – f – t – y + n + o,
H= m + v + z + o – a – s,
K = 4s – (l + p + r + t + x + y + i),
Q=3s – a – j – c – D – f,
L= s – q – p + u + v – y,
M=3s – K – l – m – n – h,
N=3s – u – v – x – r – b,
R = 3s – c – K– i – u – z,
T = 3s – a – h – b – q – g,
W=2s – n – o – m,
Y = 3s – j – n – o – p – r.

If we additionally require the following sums for 2 broken diagonals:

a31 + a22 + a13 + a64 + a55 + a46 = 3s
a41 + a52 + a63 + a14 + a25 + a36 = 3s

Then we call it a semi-pandiagonal magic square. If one of these equations is satisfied in a balanced magic square of order 6 then the other equation is satisfied, too. Therefore, we get only one additional free variable. From the equation

b + n + c + E + (2s – n – o – m) +
(s – q – p + u + v – y) = 3s

We determine one variable like

p = 2(a + b + c + u – m – o – s) + f + g + h + j – l – x – y.

By using this value for p we obtain a general form for semi-pandiagonal magic squares of order 6. It has 20 free variables, which coincide with the definition in alashhab (see [1]-[5]). A four corner magic square is a magic square of order six with magic constant 3s such that the equation

$$a_{ij} + a_{(i+3)(j+3)} + a_{i(j+3)} + a_{(i+3)j} = 2s$$

Hold for each i=1, 2, 3 and j=1, 2, 3 and

$$a_{33} + a_{44} + a_{34} + a_{43} = 2s.$$

It is easy to see that a four corner magic square is a semi-pandiagonal magic square. Alashhab and Trump computed in 2015 the number of natural four corner squares. It is

8 730 627 225 792.

The number of independent variables is for such type seventeen. This is useful by programming in order to reduce run time for counting such squares. We can parallelize computations by replacing these variables by nested loops, which are assigned different values and run simultaneously.

III. THE BASIC WAY OF CALCULATION

We use mathematical properties of magic squares, when counting any type of them. There are always eight classical transformations for all types. In this type we use more than these transformations. His will appear as a multiplication factor in the total summation.

We followed a strategy by counting the squares based on counting the two main diagonals first, and then testing the other values for fitness in the remaining entries. We illustrate this strategy by making some definitions. A magic vector of order 6 is a vector $(k_1, k_2, ..., k_6)$ with

(i) $k_1, k_2, ..., k_6 \in \{1, 2, 3, ... 36\}$

(ii) $k_1 + k_2 + ... + k_6 = 111$

Since we can permute the entries in a magic vector without losing its property, there exists

32 134 * 6! =23 136 480

magic vectors.

A general pair of magic diagonals (gPD) consists of two disjoint magic vectors. We imagine a gPD as the two main diagonals. For example, if the gPD consists of the two magic vectors $(k_1, k_2, ..., k_6)$ and $(l_1, l_2, ..., l_6)$ with

$\{k_1, k_2, ..., k_6\} \ \{l_1, l_2, ..., l_6\} = \{\}$

then they are distributed in a 6x6 grid as follows.

k_1	*	*	*	*	l_1
*	k_2	*	*	l_2	*
*	*	k_3	l_3	*	*
*	*	l_4	k_4	*	*
*	l_5	*	*	k_5	*
l_6	*	*	*	*	k_6

Table 4. A square with fixed diagonals

An unique pair of magic diagonals (uPD) is a gPD with

$k_1 < l_1 < l_6, \quad k_1 < k_6.$

Each uPD represents 8 different gPDs. Each gPD can be transformed in a uPD by transposition and 90° rotations. A normalized pair of magic diagonals (nPD) is an uPD with

$k_1 < l_2, ..., l_5, \quad k_1 < k_2 < k_3, k_4, k_5, \quad k_3 < k_4.$

The total number of 6x6 nPDs is

159 626 931 * 5 400,

Where 5400 represents the number of all possible permutations of the entries in each diagonal.

Balanced squares are invariant under 8 x 24 transformations. Thus, we can calculate the number of balanced magic squares for one normalized pair of diagonals and can multiply the result with 8 x 24. Therefore we first determine all possible balanced pairs of diagonals and describe them with 8 numbers (k_1, k_2, k_3, k_4, k_5, l_1, l_2, l_3), the other 4 numbers can be calculated.

For balanced magic 6x6 squares the total number of normalized diagonal pairs is 457 912 788. A successful pair of magic diagonals is a nPD for which at least one classical magic 6x6 square exists. The number of unsuccessful nPDs for balanced magic 6x6 squares is

25 853.

We get the complement of a gPD if each entry x is replaced by 37 – x. In this context we say 37 – x is the complement of x. A nPD is called self-similar if it is equal to its normalized complement. There are exactly two types of self-similar nPDs:

- Centrally self-similar nPDs are self-similar and each diagonal consists of three pairs of complementary numbers.
- Axially self-similar nPDs are self-similar and the entries of diagonal 2 are the complements of the entries of diagonal 1.

IV. SUBSETS OF BEALANCED PAIRS OF DIAGONALS

We consider now special types of balanced magic squares according to certain properties of their pair of diagonals. We consider now special types of balanced magic squares according to certain properties of their pair of diagonals:

First subset: Magic squares with a centrally symmetric pair of diagonals with the following structure

$$k_i + k_{7-i} = 37, l_i + l_{7-i} = 37, \quad i = 1,2,3$$

Second subset: Magic squares with an axially symmetric pair of diagonals with the following structure

$$k_i + l_{7-i} = 37, \quad i = 1,2,3,4,5,6$$

The total number of axially symmetric normalized diagonal pairs is 130 935. Further, we calculated the number of magic square matrices of this type. It is

8 * 24 * 2 355 312 270 384 = 452 219 955 913 728

The number of magic square matrices of this type, which are also semi-pandiagonal, is

8 * 4 * 214 648 415 648 = 6 868 749 300 736.

Number of balanced semi-pandiagonal magic 6x6 square matrices	
matrices with self-similar pairs of diagonals (PDs) 1 656 897 581 008 · 4 · 8	
matrices with centrally self-similar PDs 1 175 776 831 528 · 4 · 8	matrices with axially self-similar PDs 481 120 749 480 · 4 · 8
matrices with centrally symmetric PDs 981 649 863 504 · 4 · 8	matrices with axially symmetric PDs 214 648 415 648 · 4 · 8
centrally symmetric square matrices 0	axially symmetric square matrices 57 518 661 504 · 4 · 8

Table 5. Enumeration 1

Number of balanced magic 6x6 square matrices	
matrices with self-similar pairs of diagonals (PDs) 12 661 555 266 936 * 24* 8	
matrices with centrally self-similar PDs 7 411 859 115 784 * 24* 8	matrices with axially self-similar PDs 5 249 696 151 152 * 24* 8
matrices with centrally symmetric PDs 5 836 806 535 224 * 24* 8	matrices with axially symmetric PDs 2 355 312 270 384 * 24* 8
centrally symmetric square matrices 0	axially symmetric square matrices 705 251 529 216 * 24* 8

Table 6. Enumeration 2

V. GENERAL BEALANCED MAGIC SUARES

We distinguish between even and odd order for a magic square in the definition. A 2l by 2l magic square is called balanced if and only if

$a_{k,k} + a_{k,2l+1-k} + a_{2l+1-k,k} + a_{2l+1-k,\,2l+1-k} = 2s$, for all $1 \leq k \leq l$,

where $s = (2l)^2 + 1$. This means the four corners of the center squares sum up to 2s each.

In case of $2l+1$ by $2l+1$ magic square then we require that

$a_{k,k} + a_{k,2(l+1)-k} + a_{2(l+1)-k,k} + a_{2(l+1)-k,\,2(l+1)-k} = 4s$, for all $1 \le k \le l$,

$a_{l+1,l+1} = s, \quad s = 2l^2+2l+1.$

It is well-known that the following structure

h	i	j	2s – h – i – j
v	q	2s – v – q – l	l
6s – (l+g+i+j) –2(q+h+v)	2s – g – q	l+ v+ g+ q – 2s	2(h+q) +i+ j+ v + g – 4s
l+ v+ g+ h +i + j + 2q – 4s	g – i	2s – g – j	4s – h – 2q– l – v – g

is a general structure of the magic square 4 by 4. Here, the magic constant is 2s. So, we can say that all magic square 4 by 4 are balanced. Also, all natural magic square 3 by 3 are balanced, while there are according to our calculations just

830 396 * 4 * 8 = 26 572 672

balanced natural magic square 5 by 5. The number of balanced natural magic square of orders 6 and higher is still open.

Actually, it is well-known that the following structure

A	B	D	E	F	f	G
H	J	i	j	K	l	L
m	n	o	p	q	r	R
t	u	W	s	2s-W	2s-u	2s-t
2s-R	2s-r	2s-q	2s-p	2s-o	2s-n	2s-m
2s-L	2s-l	2s-K	2s-j	2s-i	2s-J	2s-H
2s-G	2s-f	2s-F	2s-E	2s-D	2s-B	2s-A

where

A = 2i+2j +6s+l+t − (2f+2r+4m+o+p+u),
B = n+q+r+o+j−(f +3s),
D = u+s+m+n–− (i+j+l),
E = 2f+6s+2m – (t+2i+2j+2n+q+o),
F = 3s +r + m − (l+i+t+j),
G=2i+l+t+j+o+p − 6s,
H=f+r+2m +o+p+u−(j+i+2s+l+t),
J=4s+2f +l−(q+o+j+u+2n),
K=3s+i +t+j+n – (2f+r+2m+p),
L= 2s+n+q −(l+f+i),

R=7s−(m+n+o+p+q+r),
W=6s+q+j − (2f+2m+o+p+u).

is the general structure of the symmetric pandiagonal magic square 7 by 7. Here, the magic constant is 7s. Of course, such magic squares are balanced. The number of natural symmetric pandiagonal magic square is

20 190 684.

How many natural balanced pandiagonal magic squares 7 by 7 are there? In order to solve this open problem we consider first the general form of such squares:

A	B	c	d	e	f	η
G	h	J	K	l	m	σ
n	o	p	q	R	i	ξ
u	v	ε	s	x	z	4s−t−u−d
Γ	τ	Σ	4s−q−x−χ	4s−p−R−ς	y	ϑ
Θ	δ	Φ	4s−K−v−z	ψ	4s−m−h− δ	α
λ	ρ	Π	t	w	μ	4s−A−λ−η

where

A =f−d−j+m−o−p−u+y+z+μ−ϕ+2s,
B =u−f−h−n−q−c−y+ϕ+5s
G =c+e+f+x+y+z−d−j+m−2o−p−u,
K =o−h−m−c+i−t−e+4s
R =c−d+h−j−l+m−2o−p−q−2i+t+e+5s,
w =i−d−t−u+y+z−e+2s,
Γ =d−f+j−n−i+t+u−v−y−z−μ+ϕ+3s,
Θ =j+2o+p+i +v −f−c−m −t −e,
ψ =d+u+3s −c−h−n−y,
ρ =d+j+l+q−v−z−μ,
τ =c+h+n+5s −d−j−l−o−i−u−ϕ,
ε =d+t+2s−v−x−z,
Σ =l+x+z +i +2s−h−c−n−p −t,
δ =f+i+y+z+μ−h−3s,
η =h+j+n+o+p+q−f−m−z−μ−e,
λ =d +o+p+2s−m −x−y−z,
Π =h+n+v+3s −d−j−l−i−ϕ,
ϑ =f+e+m+t+μ−j−o−2s,
σ =7s−G−h−j−K−l−m,
α =c+f+h+m+n+y+z−d−j−o−p−u−ϕ,
ξ =7s−n−o−p−q−R−i.

It has 21 independent variables. This seems to be a more difficult problem than counting the balanced squares 6 by 6. We shall note that we have now to consider a wider range of numbers, namely from 1 to 49, which requires also more calculations.

REFERENCES

[1] S. Al-Ashhab, "Magic Squares 5x5," the international journal of applied science and computations, 2008, Vol. 15, No.1, pp. 53-64.

[2] S. Al-Ashhab, "Even-order Magic Squares with Special Properties," Open Problems in Mathematics and Computer Science, 2012, Vol. 5, No. 2.

[3] S. Al-Ashhab, "Special Magic Squares of Order Six," Research Open Journal of Information Science and Application, 2013, Vol. 1, No. 1, pp 01-19.

[4] S. Al-Ashhab, "Special Magic Squares of Order Six and Eight," International Journal of Digital Information and Wireless Communications (IJDIWC) 2012, 1(4): pp. 769-781.

[5] S. Al-Ashhab, "Negative four corner magic squares of Order Six with a Between 1 and 5," Qatar Foundation Annual Research Conference [ARC 2014 conference].

[6] S. Al-Ashhab, "The Number of Four Corner Magic Squares of Order Six," British Journal of Applied Science and Technology 7(2): 2015, Article no BJAST. 2015. 132. pp. 141-155.

[7] S. Al-Ashhab, "The Complete Number of Four Corner Magic Squares 6 by 6," International Journal of Conceptions on Computing and Information Technology, Vol. 3, Issue 2, 2015.

[8] S. Al-Ashhab, "The Problem of Counting Semi Pandiagonal Magic Squares", Proceedings of the International Multi Conference of Engineers and Computer Scientists 2016, Vol II, IMECS 2016, March 16 - 18, 2016, Hong Kong.

[9] P. Loly, I. Cameron, W. Trump, D. Schindel, "Magic square spectra," Linear algebra and its applications.

[10] www.trump.de/ magic-squares/

[11] B. Rosser, J. Walker, "On the Transformation Group for Diabolic Magic Squares of Order Four," Amer. Math. Soc., Bult. XLIV, 1938, pp. 416-420.

e-AGE18 | Amman, Jordan 2-3 December 2018

"CAPACITY FOR TRANSFORMATION"

For More Information, Please Contact Us:

info@asrenorg.net

asrenorg.net/eage18/

asrenorg.net

Twitter @ASRENorg

Facebook @ASRENOrg

Silver Sponsors

orange™

Internet Society

Sponsors

International Networks at Indiana University

RIPE NCC RIPE NETWORK COORDINATION CENTRE

ICANN

Technical Sponsor

IEEE Jordan Section

Media Partner

DIGITAL MEETS CULTURE .net

www.digitalmeetsculture.net

Partners

EUMEDconnect3

AfricaConnect2

GÉANT

INTERNET2

TAG-Org

Talal Abu-Ghazaleh Organization

This project is funded by the European Union