Technology Readiness Index 2.0 as Predictors of E-Health Readiness among Potential Users: A Case of Conflict Regions in Libya

Ibrahim Mohamed Yosser, Syed Zulkarnain Bin Syed Idrus, Amani Ali Elmetwaly Ali

1 School of Human Development and Technocommunication
Universiti Malaysia Perlis, Malaysia.

ibrahemyoser23@gmail.com

Abstract. The use of various e-health products to improve health care services delivery is a viable solution to health challenges all over developing countries and more importantly the regions battling with conflict. This is important considering the damages to the health record and the risk of attack during transit to healthcare facilities among several other challenges. While the sustainability of e-health is an issue that still poses a challenge to the developing world. That is, implementation framework to support the long-term sustainability of E-Health systems in conflict regions and generally the developing countries faces enormous challenges. Accordingly, evidences abound among developing countries that several E-Health pilot projects could not progress to full-scale implementation. Several studies have indicated that the success of E-Health implementation is linked to the acceptance of such technology by end-users (Michel-Verkerke, Stegwee, & Spil, 2015; Fanta & Pretorius, 2018). This indicates that, while the adoption and implementation of innovative technology such as e-health is paramount, evaluating the effect of behavioral characteristics of potential users can be related to its success. Identifying those intrinsic individual factors responsible for technology readiness among potential users is paramount, so also is the evaluation of the likelihood of assigning users into distinct category base on the individual’s perception about e-health readiness. The TRI approach principally developed for evaluating people’s readiness is a prerequisite for systematically addressing these issues. Extant literature concerning the adoption of innovative technologies strongly recommends that a consumer concurrently poses favorable and unfavorable factors that shape their perception about using any technological products or services. Analysis was performed using SMART-PLS, to assess the TRI 2.0 constructs in e-health domain Thus, determining the significance of the variables of the current research. The outcome is that insecurity was the only constructs that showed a significant and positive effect on e-health readiness. Other constructs innovativeness, optimism, and discomfort were found not to be statistically significant in determining E-health readiness for the case of Libya.

Keywords. TRI, E-health, Conflict Zone, Technology Readiness, Potential Users, Libya

1. Introduction
The application of information and communication technologies (ICT) in delivering healthcare services has evolved as a veritable strategy that assures improvement in access and quality of health care service. Using ICT is projected to present the health sector with better service efficiency, wider
coverage of people and places and better time efficiency (Zayyad & Toycan (2018)). No wonder that electronic health service (E-Health) is gaining importance across the world, as revealed in the rising cases of E-Health application in developing countries (Luna et al., 2014: Fanta & Pretorius, 2018). E-health according to the WHO definition is “a cost-effective and secure use of Information and Communications Technologies (ICT) in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research” (Blaya, Fraser & Holt, 2010). Notable among e-health systems are: “Electronic Medical Records (EMR), Hospital management information systems (HIS), Internet-based telemedicine and mobile health (m-health)”.

Especially now that the Government and other stakeholders are showing a strong desire to use ICT in the health sector. Most government has realized that essentially e-health systems will improve efficiency in delivery of healthcare, promote patient’s security and lessen healthcare cost (Shekelle et al., 2006). Among the generality of developed countries investment towards acquisition of the most recent e-health systems and tools is enormous. This is meant to pave the way for provision of better access, effectiveness and efficiency in healthcare for all the populations in the countries (Zayyad & Toycan, 2018).

Extant studies indicate that the long-term sustainability of E-Health rely not just on technological factors, but as well on economic, social, and organizational factors. Developing countries are constrained by limited basic amenities especially quality healthcare which is weakened by factors like inappropriate government policies, political unrests, and no access to latest technological facilities (Luna et al., 2014). Especially considering the peculiar situation of most Middle Eastern countries such as Libya today, where conflict with political unrest has become the order of the day. Therefore, there is need to examine the peculiar cases of conflict regions such as Libya. The very situation of the health sector in conflict regions call for innovative approach such as ICT to proffer appropriate solution to the escalated health challenges. Accordingly, these technologies will bring forth major implications on users such as health service providers, patients and other health staffs.

Accordingly, the success of implementation of this new technology depends on individual attitudes of the potential or targeted users towards new technologies. Therefore, prior to implementing innovative technology like the case of e-health, requires a readiness assessment of all the categories of potential users. Readiness assessment of users of e-health will give insights to potential threat to the system and possible solution to address such threat before implementation. Studies suggest conducting readiness assessment at the early phase of development and occasionally after implementation so as to assess its success or challenges (Kgasi & Kalema, 2014). Parasuraman (2000) introduced the 36-item “technology readiness index” (TRI) that has been generally used in various fields in measuring an individual’s attitude against new technologies. There are four dimensions in the TRI scale which are; “optimism, innovativeness, insecurity and discomfort”.

The first “Technology Readiness Index” (TRI) is a scale composed of 36-items employed to assess technology readiness. Technology readiness measures people’s tendency to accept and use innovative technologies for the accomplishment of various task and life goals (Parasuraman, 2000). In another study, Parasuraman and Colby, (2014) relied on the statistical records of the U.S “National Technology Readiness Survey” (NTRS), argues that the effect that new technology has on service sectors such as health sector, is evident in the increasing trend of the percentage of people adopting these new technologies. As advancement on the first TRI scale the new scale was developed containing only 16 items Parasuraman and Colby, (2015).

Readiness is very important to all aspects of technology adoption across the world. In several cases evaluation studies for the healthcare context were done after implementation stage (Ammenwerth et al. 2001). Although post-implementation assessments are vital to understanding the advantages, value and how successful an e-health system is. It also contributes to evidence-based adoption and use (Alexander, 2007). While more importantly pre-implementation assessment such as readiness assessment will help to direct investors in decision making and identify challenges that might hinder long time sustainability, leads to failure and loss of huge investments (Brender, 2006). Therefore, this
study proposes to apply the new TRI 16 scale items to the context of healthcare in conflict zones of Libya.

2. Literature Review

2.1. Technology Readiness
Technology readiness assesses peoples’ propensity to accept as well as use an innovative technology for the accomplishment of his or her goals in life (Parasuraman & Colby, 2015; Parasuraman, 2000). Parasuraman (2000) introduced the four-dimensional TRI scale with 36-items, these dimensions are: “optimism, innovativeness, insecurity and discomfort”. Extant researches that applied the previous version of TRI 1.0 links the perception of individual’s on technology to adoption of any ICT product (Walczuch et al., 2007; Lin et al., 2007). The four-dimensional TRI 1.0 scale comprises of 36 items: the dimensions are “optimism, innovativeness, discomfort, and insecurity”. Optimism and innovativeness are regarded as motivators for technology readiness while discomfort and insecurity are considered inhibitors. Different people can be faced with either motivator or inhibitor sentiment towards technology (Parasuraman & Colby, 2015).

Optimism is regarded as a general positive perception on technology; it involves believing that technology helps people to have better control, alternatives and improved efficiency in lives. Also, innovativeness is considered a motivator for technology readiness; it is the tendency to be a pioneer in adopting technologies. Discomfort shows a skeptical perception about new technology and also the lack of confidence. Insecurity on the other hand depicts the lack of trust for new technologies. This could be as a result of the fear about the inability of technologies to perform accurately and also concerns on the possible harmful effects of technologies. Therefore, following these narrative individuals are said to differ in terms of tendency of adopting new technologies. Thus, technology readiness index could be related to e-health acceptance and use by its potential uses.

Ever since the development of the TRI, it has received a wide range of application across various fields notable examples are in the areas of self-services (Gelderman, et al., 2011; Lilljander, Gilberg, Gumerus, & van Riel, 2006), mobile technology and service (Chang & Kannan, 2006; Sophonthummapharn & Tesar, 2007; Chen et al., 2013). Also, researchers have integrated the TRI model alongside other models of technology adoption this includes the “unified theory of acceptance and use of technology” (UTAUT) (Kgasi & Kalema, 2016; Helena et al., 2010). Others integrated the TAM (Lin, Shi, & Sher, 2007; Walczuch, Lemink, & Streukens, 2007), while Chen et al., (2013) integrated TRI with the “expectation-confirmation” model.

Considering the wider use of the initial TRI 1.0 scale and the issues with the large number of scale items, in 2015 Parasuraman and Colby introduced an updated and streamlined TRI 2.0. this also is in line with the assertion that technologies phase out over time and new technological innovations are rapidly developed; this resulted to the improvement and simplifying of the TRI 1.0 to evolve the new TRI 2.0 (Parasuraman & Colby, 2015). The TRI 2.0 scale has been updated to match with the recent changes in the technology environment and has relatively limited application in academic or empirical research.

2.2. E-health Technology
Notwithstanding the enormous challenges confronting most developing countries, a few existing studies reveals there are cases of adoption and implementation of a number of e-health in some regions (Blaya, Frasser & Holt, 2010). A comparative investigation of four developing nations involving Saudi Arabia, Egypt, Turkey and UAE by Uluc and Ferrman (2016) to establish the issues encountered by healthcare workers for e-health. Their study acknowledged policy regulations, ICT infrastructure, finance, and managing the supply-chain as critical difficulty encountered by healthcare staffs. Generally, the framework on sustainable E-Health implementation in extant literature is linearly model and disregarded the nonlinear and dynamic complexity of E-Health systems implementation.
Verbeke, Karrara and Nysen (2013) examined the effect of ICT innovations on healthcare provision in Sub-Saharan region of Africa and evaluated the degree to which the system can influence the effectiveness in healthcare delivery services. The outcome of the study showed that clinical services notably recognition of patients, reporting, alongside managing financial is significantly enhanced post implementation of e-health technologies across the 19 health institutions in Africa. Their study linked ICT usage to a decrease in the average time spent waiting in 15 of 19 surveyed healthcare facilities. Similarly, for the hospital using “real-time financial management metrics” they were much faster in the identification of dishonest practices and faulty invoicing transactions.

Qureshi (2016) in a similar approach carried out a study on the creation of an improved world by deploying ICT, the study involves application of technologies notably phone records, GPS, data analysis in tracking alleged 2014 incidences of Ebola virus outbreak in some parts of Libya. Another common application of ICT can be traced to the world of social media has evolved a new channel of raising awareness and reaching out to the public on eminent danger and precautionary measures from any disease outbreak.

Burney, Mahmod & Abbass (2010) carried out an assessment of new innovative technologies on e-health across the developing countries. The outcome revealed that safety of patient, managing documents and diets, were all significantly enhanced by several innovative e-health technologies notably mobile health, telemedicine, the bar code application, and “decision support systems” for clinical assessment, picture storage & communication system. Dietary as well as document management, usually advances quality of healthcare delivery to patients. A different study by Malaquias, et al., (2017) also examined how ICT influences development in the context of Brazil. The study also focuses on IT advancement in the health sector. Their outcome revealed a direct effect on social and human development applications of e-health like telemedicine used for cancer and prescription practice, “electrocardiogram in the clouds, and remote tele-monitoring of chronic patients”.

2.3. E-health Technology Readiness among Developing Countries

Anderson (2007) affirms that, though there are heterogeneous problems associated with e-health implementation among developing nations, problems are homogeneously experienced globally. The notable ones are; “high implementation costs, uncertain payoffs of physicians, privacy and trust concerns, legal and ethical implications of using health information technologies, and the widening gap of digital divide” (Ross et al., 2016; Kgasi & Kalema 2014; Pagliari, 2007). Libya’s case is like that of other technologically developing nations where challenges of skilled manpower, funds, infrastructures, are inherent. Therefore, the efficient allocation and use of these limited resources calls for proper pre-implementation plan to avoid failure and loss of investment fund.

The first step towards this is the understanding of how the potential users of such technology perceive technological innovations. Several studies have applied the TRI 1.0 in different aspects of the society in the developing countries with variations in terms of outcome (Kgasi & Kalema, 2014, Jannet et al., 2011, Qureshi et al., 2016). While applying the TRI scale, Venkatesh et al., (2012) showed in his study of Business 2 Business (B2B) channel of Finnish healthcare services that decision makers do not entirely agrees with the existing findings that the construct affects readiness. Similarly, the hypothesized relationship among technology readiness, perceived usefulness and perceived ease of use were not statistically significant. Therefore, the extant researches recommended that socio demography factors notably age and gender play a path in technology adoption (Venkatesh et al., 2012). More recently a second variant of TRI 2.0 has been developed to examine individual characteristics effect on technology readiness (Parasuraman & Colby, 2015). Current studies therefore employ the TRI 2.0 scale to the case of e-health readiness in conflict zones in Libya.
2.4. Hypothesis Development

H1: Optimism (OPT) has a positive influence on E-health technology readiness in Libya
H2: Innovativeness (INN) has a positive influence on E-health technology readiness in Libya.
H3: Discomfort (DISC) has a negative influence on E-health technology readiness in Libya
H4: Insecurity (INS) has a negative influence on E-health technology readiness in Libya

3. Materials and Methods

3.1. Study Design
A cross-sectional design was employed to assess and explore the individual factors (TRI 2.0 constructs) that affect healthcare professionals’ readiness towards the use of e-health technology applications in regions plagued by conflict, with particular focus on hospitals in Libya.

3.2. Sampling and Population
The population involves 5 hospitals in western region of Libya. A stratified random sampling method was applied for hospital selection. The sampling of representatives of the potential users was done by employing random sample of healthcare professionals and patients. Unlike many of the previous studies that only focused on specific potential users of E-health technology (Mostly Doctors), without according due consideration to others. This basically leads to introduction of a selection bias in the research results. Contrarily this study undertakes a balance of sampling by considering a wider category of potential users of E-health in Libya.

3.3. Data Collection Tools
The study applies a quantitative survey method in the form of a close-ended questionnaire to collect data from different categories of potential E-health users in the selected hospitals of western Libya. The questionnaire items were adopted from the TRI 2.0, which is an improved version of the earlier TRI 1.0.

There are two sections in the questionnaire: the demographic section and E-health readiness section. The questions elicited information as regards participants’ opinions and perception of E-health technology applications. The survey questions were rated on a 5-point Likert scale, where (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. A total of 131 copies were successfully retrieved however, 16 questionnaires were considered invalid due to incomplete or blank response, and thus were not reported in the analysis. Therefore, only 115 surveys were included for further analysis using PLS-SEM software version 3.2. The findings are discussed in the following section below.

4. Results and Discussion

4.1. Demographic Characteristics of the Sample.
The demographic characteristics of the sample showed that 65 percent of the respondents were male, while 35% were found to be female. Similar majority about 80% of the respondents were above 30 years of age. This shows one of the challenges of the conflict zones as most of the young and resourceful people are migrating leaving the old. The demographic characteristics are presented in Table 1.

| Factor | Frequency | Percentage |
|--------|-----------|------------|
| Gender |           |            |
| Male   | 75        | 65         |
| Female | 40        | 35         |

Table 1. Demographic characteristics of the sample.
4.2. Reliability and Validity of the Model

A measurement model with 5 latent constructs and 20 observed variables (16 TRI items and 4 E-health items) was created in PLS 3.2. Results of the path analysis with the total dataset show that all the items employed in measuring the four TRI dimensions of Discomfort, Optimism, Innovativeness, and Insecurity were all strongly reliable see Figure 1.

The construct reliability (CR) and Cronbach’s alpha (α) values showed an acceptable internal consistency of the constructs. Each has a Cronbach’s alpha value that is higher than 0.7. This result is summarized in Table 2 below.

| Age (years) | 18–23 | 20 | 17 |
|-------------|-------|----|----|
|             | 24–29 | 15 | 13 |
|             | 30 and above | 80 | 70 |
| Profession  | Nurse | 39 | 34 |
|             | Doctor | 15 | 13 |
|             | Admin | 21 | 18 |
|             | Patient | 40 | 35 |

Figure 1. PLS Path model for the study.
Table 2. Measurement Items Reliability

| Constructs            | Cronbach's Alpha | rho_A | Composite Reliability | AVE  |
|-----------------------|------------------|-------|------------------------|------|
| Discomfort            | 0.944            | 0.947 | 0.964                  | 0.899|
| Optimism              | 0.932            | 1.037 | 0.94                   | 0.798|
| E-health readiness    | 0.91             | 0.922 | 0.938                  | 0.791|
| Innovativeness        | 0.895            | 0.929 | 0.914                  | 0.688|
| Insecurity            | 0.8              | 0.809 | 0.87                   | 0.628|

Furthermore, the discriminant validity was also assessed in turn to determine the degree by which the constructs used in the study actually differ from each other (Hair, et al., 2010). The outcome of “discriminant validity was supported; this indicated by the square root of the average variance extracted (AVE). The value of each construct was found to be greater than the correlations between the constructs (Fornell & Larcker, 1981) (see Table 3). In addition, composite reliability values of the variables varied from 0.87 to 0.96, this further indicates that convergent validity is supported (see Table 2). In terms of AVE, they were also found to be higher that the threshold value of 0.50” for every construct in the model.

Table 3. Discriminant Validity

| Construct               | Discomfort  | E-health Readiness | Innovativeness | Insecurity | Optimism |
|-------------------------|-------------|--------------------|----------------|------------|----------|
| Discomfort              | 0.948       |                    |                |            |          |
| E-Health Readiness      | 0.64        | 0.89               |                |            |          |
| Innovativeness          | 0.031       | 0.106              | 0.83           |            |          |
| Insecurity              | 0.767       | 0.754              | 0.133          | 0.792      |          |
| Optimism                | -0.055      | -0.033             | 0.622          | 0.072      | 0.893    |

Results of the path analysis with the total dataset showed that out of the four TRI dimensions Insecurity is the only TRI dimension influencing E-health Technology readiness in Libya, supporting hypotheses H3 of this study. The effects of optimism, innovativeness and discomfort are not statistically significant, therefore the hypotheses H1, H2, and H4 in this study are not supported as indicated in shown in Table 4.

Table 4. Relationship Between Constructs

| Hypothesized Relationship | Original Sample Mean (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics (O/STDEV) | P Values |
|---------------------------|--------------------------|-----------------|----------------------------|------------------------|----------|
| Discomfort                | E-Health Readiness       | 0.132           | 0.151                      | 0.164                  | 0.807    | 0.42     |
| Innovativeness            | E-Health Readiness       | 0.098           | 0.049                      | 0.127                  | 0.776    | 0.438    |
| Insecurity                | E-Health Readiness       | 0.649           | 0.633                      | 0.145                  | 4.466    | 0.000    |
| Optimism                  | E-HEALTH                | -0.134          | -0.087                     | 0.098                  | 1.363    | 0.174    |
Table 4 presents the results of the hypothesized relationships in the study. It confirms a highly significant positive effect of insecurity on E-health readiness in Libya. This result confirms the a priori expectation of this study, since conflict situation is expected to create insecurity among the people in conflict regions. The long time conflict situation in Libya could instil fear, distrust and high insecurity among citizens, therefore influencing their perception on insecurity of innovative technologies, this explains the significance of this factor in influencing the readiness for e-health in Libya region.

5. Conclusion and Recommendation
This study investigated the relationships between TRI 2.0 constructs and the E-health Technology readiness in Libya as a conflict Zone. The study contributed to Technology Readiness and acceptance research by using the latest TRI 2.0 items and testing whether the items are applicable to E-health in conflict regions. Similarly, the non statistical significance of other factors could as well be attributed to the long duration of conflict which could re-shape perceptions and behaviors of people. This could also be a sign of possibility of mediation effect that was not taken into consideration in the current study. Thus, further research may consider the possibility of a mediation effects on the tested relationships in this study.

References

[1] Michel-Verkerke, M.B., Stegwee, R.A. & Spil, T.A. 2015. The six P’s of the next step in electronic patient records in the Netherlands. Health Policy and Technology, 4(2), pp 137–143. https://doi.org/10.1016/j.hlpt.2015.02.011.

[2] Isabalija, S.R., Mbarika, V. & Kituyi, G.M. 2013. A framework for sustainable implementation of e-medicine in transitioning countries. International Journal of Telemedicine and Applications, pp 615-617. https://doi.org/10.1155/2013/615617.

[3] Mettler, T. 2015. Anticipating mismatches of HIT investments: Developing a viability-fit model for e-health services. International Journal of Medical Informatics, 85, pp 104–115. https://doi.org/10.1016/j.ijmedinf.2015.10.002.

[4] Hallikainen, Heli and Laukkanen, Tommi, "How Technology Readiness Explains Acceptance and Satisfaction of Digital Services In B2B Healthcare Sector?" (2016). PACIS 2016 Proceedings. 294. http://aisel.aisnet.org/pacis2016/294.

[5] Parasuraman, A., & Colby, C. L. (2015). An updated and streamlined technology readiness index TRI 2.0. Journal of Service Research, 18(1), 59-74.

[6] Parasuraman, A. (2000). Technology readiness index (TRI) a multiple-item scale to measure readiness to embrace new technologies. Journal of Service Research, 2(4), 307-320.

[7] Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1), 39-50.

[8] Gelderman, C. J., Paul, W. T., & van Diemen, R. (2011). Choosing self-service technologies or interpersonal services - The impact of situational factors and technology-related attitudes. Journal of Retailing and Consumer Services, 18(5), 414-421.

[9] Geyskens, I., Steenkamp, J. E., & Kumar, N. (1999). A meta-analysis of satisfaction in marketing channel relationships. Journal of Marketing Research, 36(2), 223-238.

[10] Grewal, R., Lilien, G. L., Bharadwaj, S., Jindal, P., Kayande, U., Lusch, R. F., Mantrala, M., Palmatier, R.W., Rindfleisch, A., Scheer, L. K., Spekman, R. & Sridhar S. (2015). Business-to-business buying: Challenges and opportunities. Customer Needs and Solutions, 3(2), 1-16.

[11] Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (cop. 2010). Multivariate data analysis: A global perspective (7th ed.). Upper Saddle River (N.J.): Prentice Hall.

[12] Helena Chiu, Y., Fang, S., & Tseng, C. (2010). Early versus potential adopters: Exploring the antecedents of use intention in the context of retail service innovations. International Journal of Retail & Distribution Management, 38(6), 443-459.
[13] Janita, M. S., & Miranda, F. J. (2013). The antecedents of client loyalty in business-to-business (B2B) electronic marketplaces. Industrial Marketing Management, 42(5), 814-823.

[14] Michel-Verkerke, M.B., Stegwee, R.A. & Spil, T.A., 2015. The six P’s of the next step in electronic patient records in the Netherlands. Health Policy and Technology, 4(2), pp.137–143. Available at: http://linkinghub.elsevier.com/retrieve/pii/S2211883715000258.

[15] Fanta, G. B., & Pretorius, L. (2016). A System Dynamics Model of E-Health Acceptance: A Socio technical Perspective, (May).

[16] M. A. Zayyad and M. Toycan (2018) “Factors affecting sustainable adoption of e-health technology in developing countries: An exploratory survey of Nigerian hospitals from the perspective of healthcare professionals,” PeerJ, vol. 6, p. e4436, Mar. 2018.

[17] Blaya, J. A., Fraser, H. S. F., & Holt, B. (2010). E-Health technologies show promise in developing countries. Health Affairs, 29(2), 244–251.

[18] Shekelle P, Morton SC, Keeler EB. 2006. Costs and benefits of health information technology. Evidence Reports/Technology Assessments, No. 132. Rockville, Agency for Healthcare Research and Quality

[19] Kgasi, M. R., & Kalema, B. M. (2014). Assessment E-health Readiness for Rural South African Areas. Journal of Industrial and Intelligent Information, 2(2), 131–135. https://doi.org/10.12720/jiii.2.2.131-135

[20] Ammenwerth E., Eichstadter R., Haux R., Pohl U., Rebel S. and Ziegler S. (2001) A randomized evaluation of a computer-based nursing documentation system, Methods Inf Med 40, pp. 61–68.