WEB PRESENCE IN MANAGING HEALTH OUTCOMES: A COUNTRY LEVEL ANALYSIS

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Abstract

This cross-national study examines the relative importance of contextual factors facilitating e-health development in a nation. Moreover, this study examines the relationship between web presence and health development. Technology-Organization-Environment (TOE) framework and PEST factors of a firm are used as the guiding theoretical lens. Publicly available data from more than 50 countries are collected to examine the proposed model. Dependent variable, health outcomes are measured via Life Expectancy Rate (LER) at birth. As TOE contextual factors (1) ICT expenditure; (2) human capital; (3) institutions; and (4) macroeconomic stability are used. Results indicate that TOE contextual factors of a nation are important enablers of web presence and in turn lead to national health development. Post hoc analysis demonstrates that web presence partially mediated the association of ICT expenditure with health development and human capital with health development. Implications of the findings to theoretical discourse and practical application, and future directions are discussed in this paper.

Keywords: TOE, web presence, health development.
1 INTRODUCTION

During the last few years, importance of maintaining health information technologies like electronic health records and computerised provider order healthcare experts have highlighted entry, policy makers and users (America 2001; Smith 2004; Wu, Chaudhry et al. 2006). E-health, defined as the use of ICT for health (World-Health-Organization 2006) has become critical in transforming healthcare industry in developed countries as well as in developing countries. Though most of information communication technology (ICT) systems are implemented to support administrative and financial activities, ICT could be applied in to managing complex large volumes of transaction data (e.g. medical records). Due to fragmented nature of healthcare industry, it is important to integrate these data with new scientific findings (Wu, Chaudhry et al. 2006).

Despite extent of research carried out in e-health context, most of them focus on issues at micro level considering only a particular characteristic related to a particular country or section (Rodrigues & Risk 2003). Hence, as highlighted in literature (Mithas, Khuntia et al. 2009; Ahangama & Poo 2012) it is important to consider issues in e-health development at macro level as well, addressing research questions at cross country levels. There is a dearth of cross country level studies related to e-health as (1) there is a shortage of cumulative theoretical development in e-health research to conduct an empirical study to respond at macro level; and (2) there are resource constraints in collecting primary data from loads of countries to test the empirical models devised (Krishnan & Teo 2011). Hence, this study aims to address above-mentioned issues in conducting a macro level study related to e-health.

Most of the cross sectional studies had addressed the contribution of IT on economic growth (Kauffman & Kumar 2008) and only a few studies had considered contribution of ICT on health development. In reviewing prior literature, it could be noted that the most frequently considered issues are, the influence of ICT on health development or factors relevant to improve e-health usage (Bagchi, Udo et al. 2005; Kauffman & Kumar 2008; Mithas, Khuntia et al. 2009). This indicates the dearth of studies in identifying factors that combine web usage or web presence to health development in various contexts. Web presence of a nation is its capability to deliver online services to its populace.

We address this by using Technology-Organization-Environment (TOE) framework of Tornatzky et al. (1990). Even though there can be various aspects influencing web presence and health development, we consider PEST (political, economical, social and technological) factors as key factors capable of influencing any development or improvement strategy in any nation. Institutions will represent political aspect; macroeconomic stability will represent economic aspect; human capital will represent social aspect and ICT expenditure will represent technological aspect. As per TOE framework, we will be using 4 aspects namely, ICT expenditure for technology context, human capital for organization context, and institutions and macroeconomic stability for environment context.

To measure the health development in a nation, life expectancy rate (LER) at birth is used which is considered to be a prime indicator of quality of a health care system (Mithas, Khuntia et al. 2009). TOE contexts will be modelled using archival data from 55 countries (See Appendix). These 55 countries were chosen only if there are no missing values for independent variables, dependent variables (LER) and control variables. A number of countries had to be eliminated from the dataset due to non-availability of data for one or more variables (See ‘Conclusion’).

**RQ1:** How do ICT expenditure, human capital, institutions and macroeconomic stability of a country affect web presence?

**RQ2:** How does web presence in a country contribute to health development?

This paper is organised as follows. Conceptual framework (using TOE framework explicating the contexts required to aid in improving web presence and develop health) and hypotheses developed using theory are explained in section (2). A description on research design, and analysis (hypothesized model developed using cross sectional data is tested) and results are dealt with, in the section (3) and (4). Sections (5) and (6) will deal with discussion and conclusion respectively.
2 CONCEPTUAL FRAMEWORK AND HYPOTHESES

The Technology-Organization-Environment (TOE) Framework introduced by Tornatzky et al. (1990), describes the process of technological innovation, adoption and implementation in a firm, which are influenced by the three aspects categorised as, technological context, organizational context and environmental context. Technological context refers to both internal as well as external technologies (equipment and processes) available for adoption by a firm (Depietro, Wiarda et al. 1990). Organizational context refers to resources such as, human resources, amount of slack resources and existence of innovation enabling processes (e.g. top management behaviour) and organisational characteristics like firm size (Depietro, Wiarda et al. 1990). Environmental context refers to macroeconomic conditions and regulations to support implementation of innovative technologies (Depietro, Wiarda et al. 1990). TOE framework has been widely used in IS research (Zhu, Kraemer et al. 2006; Srivastava & Teo 2007). Even though, TOE framework is proposed to describe the process by which a firm adopts or deploy innovative technology, some studies had extended its applicability to study various factors within TOE contexts in various units of analysis like country level studies in addition to firm level investigations. For example, TOE has been applied in cross country level studies by Zhu et al. (2006) in e-business development and; Srivastava and Teo (2007) and Krishnan and Teo (2011) have utilized the same, to study e-government and e-business development. Similarly, we extend TOE framework to evaluate the development of e-health in a country level study.

TOE framework has been often criticized for not being able to provide theoretical rationality to establish causal relationships (Mishra, Konana et al. 2007). However, individual theories do not deal with a wide range of variables as in TOE framework. Thus, recent studies have attempted to integrate best attributes of TOE framework with other theories. For example Mishra et al. (2007) had linked TOE framework with Resource Based View (RBV) to study the usage of internet for procurement in manufacturing industry. Consistent with literature, we link TOE framework with PEST framework (Aravossis, Panayiotou et al. 2006). PEST analysis evaluates political, economical, social and technological environments of an establishment. While, political environment considers the extent of government intervention in development or implementation process, economic environment deals with economic growth and stability of a business. Trends and involvement of human resources on the development are considered as social factors and technological incentives and factors leading to technical innovations make the technological environment. These 4 factors in PEST could be combined with TOE as (1) ICT infrastructure (Technological); (2) Human capital (Social); (3) Macroeconomic stability (Economical); and (4) Institutions (Political). Thus, with respect to TOE framework, ICT infrastructure, human capital and macroeconomic stability along with institutions will represent technological context, organisational context and environmental contexts respectively.

2.1 Technological Context

Web presence of a country is the ability to deliver online services to its citizens. E-Health is the form of web presence that uses ICT for health. Proper maintenance of interaction between healthcare personnel, patients, general public etc. is of great importance in health related activities starting from treating a patient to monitoring public health. This is possible only if there is internet and related ICT infrastructure and thus, establishment of proper ICT infrastructure is essential for realization of maximum benefits from eHealth (Bankole, Kweku et al. 2011). It will be possible to meet the growing need of public for e-tools and e-services only if more and more investments are made to develop and sustain a quality ICT infrastructure in a country.

According to a study done by the United Nations (2008), availability of reliable ICT infrastructure will allow better e-participation (better web presence) among citizens. The public will be actively involved in e-Health activities (e.g. personal healthcare management) with better facilities. Thus, we postulate the following hypothesis:

**H1:** The quality of ICT infrastructure in a country is positively associated with the level of its web presence.
2.2 Organizational Context

In organizational context, human capital is an important resource. When the public becomes more knowledgeable they tend to care more about their health and will take actions to mitigate health related risks. A higher level of healthcare standing among the population can be achieved with better educated and trained citizens (Ackerson & Viswanath 2009). The education level and knowledge of public who are using the e-health system is an important indicator of the active engagement with e-health activities. By public being more educated and computer literate, they tend to identify the use of web based healthcare systems and they will continue to use such systems in an advanced manner (e.g. group support systems, online discussion forums, e-channelling) to manage their health and protect themselves from diseases and will provide feedback to improve systems too (Bagchi, Udo et al. 2005; Wu, Chaudhry et al. 2006). Further, having educated and trained citizens in healthcare sector allows implementation of various e-health initiatives. Thus, we postulate the following hypothesis:

H2: The quality of human capital in a country is positively associated with the level of its web presence.

2.3 Environmental Context

Factors such as macroeconomic stability and public institutions are considered under environmental context. Based on global competitive index (Porter & Schwab 2009), the institutional environment shapes up the way individuals, firms and governments interact. In other words, it considers how societies share benefits and bear the burden of development strategies. Potential benefits of e-health are considered to be significant to governments and public health policy makers have taken actions such as (1) encouraging education, training and national planning capacity; (2) implementation of standards; (3) maintaining privacy and security; and (4) overcoming jurisdictions barriers to cooperation (Rodrigues & Risk 2003). When there is better legal framework, security and privacy protection even in eHealth activities, many people will trust the systems and will be involved in the systems. Patients will not be reluctant to seek and get their medical investigations carried out and obtain treatments, as there is an assurance of better protection. Quality institution will lead to a higher participation. Thus, we postulate the following hypothesis:

H3: The quality of institutions in a country is positively associated with the level of its web presence.

Macroeconomic stability is achieved by low inflation rate with declining budget and trade deficits (Porter & Schwab 2009). With stable economies, advanced countries are more likely to carry out eHealth initiatives effectively (Ahangama & Poo 2012). Having a stable macro economy will allow governments to provide better healthcare facilities to public as well as quality of life of public will be improved. In the absence macroeconomic stability of a country, the governments will not carry out e-health initiatives and will focus only on providing basic healthcare facilities. The public will be more interested in meeting their daily needs rather than focusing on maintaining a healthy life style (wellness). When the economy is stable e-health initiatives will be implemented to provide better healthcare service effectively. It has been found that with higher incomes, people tend to increase the use of e-health (Diaz, Griffith et al. 2002; Bagchi, Udo et al. 2005) as health concerns raise with economic development (Furnée, Groot et al. 2008). Therefore, macroeconomic stability will lead to higher participation. Thus, we postulate the following hypothesis:

H4: The macroeconomic stability in a country is positively associated with the level of its web presence.

Relationship between Web Presence and Health Development

A major issue related to e-health system implementation is the public participation. In research on European nations, it is found that individuals search internet for health related information (1) to get life style information (e.g. diets and fitness); (2) to get details on a specific disease and its treatments; and (3) to get details on health services (Bagchi, Udo et al. 2005). Success and sustainability of an online system depends on the willingness of the public to use the system continuously. To attract and maintain many users it is important to invest (Bankole, Kweku et al. 2011) and introduce value added
services. Even in e-health, many will identify benefits of such services and will make use of e-health systems for their health development. Furthermore, providers will be interested in getting feedback from users and in their propaganda, they will emphasize the importance of using such e-health systems to manage daily health and prevent health problems. Thus, we postulate the following hypothesis:

**H5: The level of web presence in a country is positively associated with the level of its health development.**

### 2.4 Control Variables

Two control variables that could explain the variance of dependent variable (LER) are taken into consideration. Firstly, as an indicator of quality of healthcare infrastructure of a nation we controlled number of hospital beds per 10,000 of the population. Number of hospital beds includes beds in public, private, general and specialized hospitals (World Health Organization 2011). Secondly, we control the population of a country. Mithas et al. (2009) and Bagchi et al. (2005) had shown that they will influence LER and thus it was controlled in our study too.

### 3 RESEARCH DESIGN

A cross-country analysis of 55 countries (See Appendix) is used for testing the hypothesis. 2011 is used as the base year for dependent variable and the other construct values are captured in preceding years (Mithas, Khuntia et al. 2009). Retrospective data are used as it is (1) not feasible to gather primary data (Kiecolt & Nathan 1985). Moreover, common method bias could be avoided as data from different sources are used (Wosczynski & Whitman 2004). The main data sources are (1) World health statistics 2011 (World Health Organization 2011), (2) WEF Global competitiveness report 2008-2009 (Porter & Schwab 2009) (3) Digital Planet Report (WITSA 2008); (4) World Bank report on estimated population and (5) UN e-government survey (United Nations 2008).

Many authors have used these reports as they are considered to be reliable. These data collection organizations maintain reliability and validity by following rigorous procedures. Data quality is ensured by (1) collecting from high ranked officials (i.e. CEO or equivalent official); (2) allowing respondents to answer in their preferred language; (3) using several methods to administer the surveys (e.g. face to face, telephone, online surveys or interviews); and (4) carefully editing data before aggregating depending on country level (Porter & Schwab 2009). For instance, Mithas et al. (2009) and Ahangama and Poo (2012) had used Digital Planet Report to study the influence of IT expenditure on quality of healthcare system. Similarly, many studies in various areas had used Global Competitiveness Report and e-Government survey (Srivastava & Teo 2007; Krishnan & Teo 2011; Ahangama & Poo 2012).

#### 3.1 Operationalization of Constructs

Dependent variable, health development is measured using life expectancy at birth. Many previous studies (Ngwenyama, Andoh-Baidoo et al. 2006; Mithas, Khuntia et al. 2009) used LER, to measure the quality of healthcare systems. LER is the average number of years of life remaining at a given age. According to World Population datasheet, LER at birth (most commonly used) is “the average number of years a newborn is expected to live under current mortality levels”. LER values are obtained from the World Bank estimated statistics for 2011.

Web presence index obtained from UN e-government survey (United Nations 2008) indicates a numeric value having citizen-friendly portals, online applications and back office integration. ICT expenditure on healthcare by a country for 2008 (data obtained from Digital Planet (WITSA 2008)). It includes expenditure for computer hardware, software and services. Human capital resource is indicated using education index and it is formulated using adult literacy and gross enrolment (United Nations 2008).
Macro-economic stability index is taken from WEF Global competitiveness report 2008-2009 (Porter & Schwab 2009). This is formulated using (1) government surplus/ deficit; (2) national savings rate; (3) inflation; (4) interest rate spread; and (5) government debt. Similarly, Institutions index is obtained from the same report mentioned above and it is developed using (1) intellectual property rights; (2) ethics and corruption; (3) undue influence; (4) government inefficiency; and (5) security. These three indices had been used in past studies to understand the e-government development (Srivastava & Teo 2007).

4 ANALYSIS AND RESULTS

4.1 Descriptive Statistics

According to Table 1, most correlations between variables are significant at $p<0.001$. The correlations among independent variables are less than the threshold value of 0.8 (Gujarati 2003; Gujarati 2009). Even though multicollinearity may not be an issue as correlations are less than the threshold, we performed the diagnostic statistical collinearity test to measure Variance Inflation Factor (VIF). According to VIF results for all the independent variables ($VIF<5$), there is no significant indication of multicollinearity problem (Pedhazur 1997).

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<td>3</td>
<td>4</td>
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<td>2. Pop\textsuperscript{b}</td>
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<td>0.64</td>
<td>-0.28</td>
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<td></td>
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<td></td>
<td>3.61</td>
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<td>3. ICTExp\textsuperscript{a}</td>
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<td>4. Edu</td>
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<td>5. Instu</td>
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<td>2.92</td>
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<td>6. MS</td>
<td>5.03</td>
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<td>0.28</td>
<td>-0.23</td>
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<td>0.42</td>
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<td>-</td>
<td>1.53</td>
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<td>7. Web</td>
<td>0.57</td>
<td>0.19</td>
<td>0.43</td>
<td>-0.06</td>
<td>0.65</td>
<td>0.63</td>
<td>0.68</td>
<td>0.47</td>
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<td>3.19</td>
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<td>8. LER\textsuperscript{a}</td>
<td>1.87</td>
<td>0.05</td>
<td>0.58</td>
<td>-0.18</td>
<td>0.58</td>
<td>0.72</td>
<td>0.59</td>
<td>0.57</td>
<td>0.70</td>
<td>-</td>
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N=55; M=mean; SD=Standard deviation; Beds= Hospital beds; Pop=Population; ICTExp=ICT expenditure; Edu=Education index; Instu=Institutions; MS=Macroeconomic stability; Web=Web presence; LER=Life expectancy rate; All correlations equal or greater than 0.20 are statistically significant at $p<0.05$; \textsuperscript{a}Log transformed variables

Table 1. Descriptive statistics and correlations

4.2 Hypothesis Testing

Structural Equation Modelling (SEM) was used in this study, as all the paths can be analyzed simultaneously in a single analysis (Chin 1998). Partial Least Squares (PLS) was utilized for SEM analysis over covariance based SEM techniques as PLS (1) has placed minimal restriction on measurement scales, sample size and residual distributions; (2) has more reliable results as it is distribution free and true independence of variables are not assumed; (3) is robust in structural problems like skew distributions and omission of regressors; and (4) is useful at exploratory theory development stage (Tobias 1995; Chin 1998; Gefen, Straub et al. 2000). For this study SmartPLS version 2.0M3 was used (Hansmann & Ringle 2004; Hubona 2009).

According to Figure 1, there is a positive association between ICT expenditure related to healthcare with web presence ($\beta= 0.30$, $t= 6.56$, $p<0.001$). Therefore, H1 is supported. Similarly, there is a positive association between human capital and web presence ($\beta= 0.36$, $t= 7.89$, $p<0.001$); and between institutions and web presence ($\beta= 0.34$, $t= 6.38$, $p<0.001$). Therefore, H2 and H3 are supported. However, there is no significant association between macroeconomic stability and web presence ($\beta= 0.04$, $t= 0.76$, n.s.). Thus, H4 is not supported.
4.3 Mediation Effect

As shown in Figure 2, a post hoc analysis is performed to examine the mediation effect. According to PEST factors, an organisation’s performance could be influenced by these four factors. Similarly, by considering the four independent variables as resources (RBV) of a firm, the organisation’s performance can be influenced (Bharadwaj 2000). Mithas et al. (2009) indicated that health development is positively associated with resources (ICT expenditure of a nation). However, as can be noted in Figure 1, we have avoided the direct linkage between 4 independent variables and health development as we consider this relationship is not necessary for the definition of resources and not necessary for theorizing how these four resources lead to web presence. A similar method has been used by other researchers too (Gold, Malhotra et al. 2001; Ravichandran & Lertwongsatien 2005).

To understand whether there is any mediation effect from web presence, we performed a PLS analysis again after adding direct paths from four independent variables to health development. As illustrated in Figure 2, we could note that the paths between ICT expenditure and health development ($\beta = 0.30$, $t=3.70$, $p<0.01$) and web presence and health development ($\beta = 0.18$, $t=2.36$, $p<0.05$) are significant. Thus, it could be said that relationship between ICT expenditure related to healthcare and health development is partially mediated by web presence. The paths between human capital and health development ($\beta = 0.33$, $t=2.72$, $p<0.01$) and web presence and health development are significant. Thus, it could be said that relationship between ICT expenditure related to healthcare and health development is partially mediated by web presence. However, the path between institutions and health development is not significant ($\beta = -0.02$, $t=0.25$, n.s) and the path between macroeconomic stability and health development is not significant ($\beta = 0.21$, $t=1.85$, n.s.). Hence, the effect of institutions with health development is not mediated by web presence and the effect of macroeconomic stability with health development is not mediated by web presence.
Results to analyze mediation effect

Model in Figure 6 (included model) was compared with model in Figure 5 (excluded model) based on change in $R^2$ for health development using Cohen’s (1988) formula ($f^2 = [R^2_{\text{included}} - R^2_{\text{excluded}}]/[1 - R^2_{\text{included}}]$). The measure $f^2$ is used to detect whether the impact of an independent variable on dependent variable is substantive. In the included model $R^2$ increased from 0.584 to 0.697 ($f^2=0.37$). Based on $f^2$ value, suggest that the new model does not have a significantly better predictive power than the initial model (Chin 1998). In addition, we performed the Preacher and Hayes’ (2004; 2008) bootstrapping approach to mediation and found that there is no significant improvement in the new model compared to initial model (confirm findings from PLS mediation analysis).

5 DISCUSSION

Through this study, there are several findings that need to be discussed. Firstly, it is identified that with (1) higher the ICT expenditure related to healthcare (Bagchi, Udo et al. 2005); (2) higher the level of human capital (Ackerson & Viswanath 2009) and (3) higher the level of institutions in a nation, the higher is the web presence among them. This result highlights that by improving TOE contexts; an improvement can be reached in presence of e-health initiatives. However macroeconomic stability does not affect web presence. This may be due to the fact that, though a country is economically stable, the benefits of it may not have reached the common public uniformly. The benefits may have been reaped only by a certain group of the population thus, creating a digital divide (Ackerson & Viswanath 2009). Thus, to diffuse e-health tools among public infrastructure, education and regulations should be improved irrespective of the level of macroeconomic stability of a country.

Secondly, higher the web presence in a country, higher is the health development among its population. As indicted by prior studies (Bagchi, Udo et al. 2005; Mithas, Khuntia et al. 2009) having a better e-health system will enhance the health standards of citizens and they will be more concerned on impending health risks (Ancker, Carpenter et al. 2009).

Thirdly, findings of post hoc analysis (mediation effect) indicate that web presence partially mediated the relationship between (1) ICT expenditure and (2) human capital with health development. However, web presence did not mediate the relationship between (1) institutions and (2)
macroeconomic stability with health development of a nation. Since the macroeconomic stability does not have a significant relationship with web presence, it will not be considered for mediation effect as well. On the other hand, institutions may not be satisfied due to the fact that individuals may not perceive personal benefits they would receive by carrying out and maintaining various health frameworks and standards (Ahangama & Poo 2012). Though it has been identified that to achieve potential benefits of e-health it is required to carry out several actions by policy makers (Bagchi, Udo et al. 2005), they may not have been properly implemented.

6 CONCLUSION

6.1 Limitations

Use of archived data obtained from various sources can be considered as a limitation. However, due to budgetary, time and labour constraints, it is not possible to collect primary data from more than 50 countries. Since these data are collected from reputable organizations like WHO, UN, WEF, it could be ensured that these data are reliable and valid. They follow stringent methods and statistical methods to ensure the quality of the data. Moreover, researchers had used these data for their studies (Srivastava & Teo 2007; Mithas, Khuntia et al. 2009; Ahangama & Poo 2012).

In this study we considered only the countries having data for all the constructs. Hence, in this cross sectional study we were only able to consider 55 countries. For instance, many African countries had to be ignored for this reason. In this study we considered 5 independent variables (including mediator). Thus, a sample size of 50 is adequate to detect fairly small R² values at a significant level of 0.05 (Hair Jr 2006). Moreover, PLS places minimal restrictions on sample size (Chin 1998). Regardless of these two limitations, the results are useful in assessing the association of TOE contexts on health development with web presence.

6.2 Implications and Future Research

There are several theoretical implications of this study. Firstly, we integrated best attributes of TOE framework with PEST framework of a firm (micro level) and applied them in macro level for better realization of the influence of e-health on national health development. By using publicly available archive data, we studied association between e-health and health development in a nation. Secondly, we examined why different levels of health development continues in a nation, even though there is health infrastructure to facilitate medical needs of a country. Thirdly, we tried to understand the contribution made to ICT knowledge base in related to health in assessing the influence of various contexts at national level.

Practical implications of this study can be described as (1) assisting policy makers, practitioners and administrators to understand the reasons for various levels of health outcomes and make use of these findings in development of policy and standards related to e-health (Rodrigues & Risk 2003); and (2) directing countries trying to advance their health standards to understand aspects to centre their resources and capabilities.

Several future research works can be identified from the findings of our research. Firstly, while we demonstrate 3 factors in TOE context having influence on web presence and then on health development, new factors to the context could be introduced into the model. For example, technological innovation and ethics could be introduced. Secondly, rather than using only a cross sectional data set, a panel data set could be used to detect the lag effect between predictors and dependent variable. Thirdly, mobile usage for e-health too could be considered rather than considering web usage alone. However, more complete national level health data is required to carry that out.

In conclusion, this study provides a new perception to association between TOE contexts to web presence and then web presence on to LER. By this study it is found that, TOE contexts; namely, ICT expenditure, human capital and institutions have an impact on the web presence in a country. However, only a partial mediation effect is found in the relationship between ICT expenditure and health development via web presence and human capital and health development via web presence.
This will be useful to understand how TOE contexts should be managed and how TOE influence web presence and in turn, the health development of a country.

References


Hubona, G. S. (2009). Structural equation modeling (SEM) using SmartPLS software: Analyzing path models using partial least squares (PLS) based SEM.


Appendix: Countries considered in this study

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<th>Argentina</th>
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