Role of Mobile Phone Penetration and the Health Index in Human Development

Full Paper

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Abstract

Studies have shown that global development efforts need to address the ability of people to achieve better livelihoods using information and communication technologies. The challenge remains one of understanding what development efforts lead to better livelihoods. As the relationship between mobile phones and health remains elusive, this paper investigates health wellbeing in the light of increasing mobile phone penetration. A simple cluster analysis of the data used on mobile phone penetration and the United Nations Development Program (UNDP) Health index revealed five clusters. In order to understand the effects on human development, the relationship between these variables and the Human Development Index (HDI) was carried out. The contribution of this paper is in uncovering a positive significant correlation between both mobile phone penetration and the health index as well as both variables and the HDI. This has implications for the use of mobile phones for the provision of healthcare and human development

Keywords

Human Development Index (HDI), Health Index (HI), United Nations Development Program (UNDP), Millennium Development Goals (MDGs).

Introduction

While there are multiple notions of the term “development”, it is most frequently discussed by major world organizations such as the United Nations and the World Bank while there is no direct interpretation introduced for the word development. In most cases, people interpret development as modernity. So if something is modern, it means it is developed (Willis, 2006). But, what is modern now will be old in the future. Modernity has its geographical effect as well. What is modern in one place could be considered old in a different location (Willis, 2006). The modernization debate lead as to whether a society has to be ‘modern’ or technologicall advanced to be developed, led Escobar (2011) to define the development as “anthropology of modernity”. While for some people modernity means development, for some other it is something that negatively affects their culture, natural environments, and quality of life (Willis, 2006, Escobar 2011).

Development can have significant positive outcomes such as social, economic, human development in general. Industrialization, material production, and fighting poverty are some of the economic outcomes (Escobar, 2011). Human development outcomes are a long healthy life, knowledge and a decent standard of living (Willis, 2006). In this research, the outcome of human development is investigated. Various factors exist that help a society develop. Information technology is one of the major factors that influence development. These dimensions are included in the Human Development Index (HDI), which includes life expectancy, education and Gross National Income (GNI) aggregated into a normalized composite index. The HDI simplifies and captures only part of what human life entails, which does not include inequalities, poverty, human security, and empowerment (UNDP HDI, 2017).

The United Nations has given health the highest priority in their millennium development goals. Three of the eight United Nations Millennium Development Goals (MDGs), to reduce child mortality, to improve maternal health, and to combat HIV/AIDS, Malaria and other diseases, are directly related to health. Lack

of availability of healthcare professionals and access to remote areas are two of many obstacles to achieving these goals in the developing world. In this paper, health well-being is assessed in terms of the United Nations Development Program (UNDP) Health Index (HI). This comprises life expectancy at birth expressed as an index using a minimum value of 20 years and a maximum value of 85 years (UNDP, 2017).

Meanwhile, mobile phone usage is growing exponentially all over the world. Mobile phones, the most broadly used technology, can be leveraged to promote health awareness where traditional healthcare is difficult or impossible. Usage of mobile phones is exponentially increasing in the developing world. There is no doubt that it is the easiest and one of the most affordable means of communication presently. Affordability and availability of mobile phones in low-income and lower-middle income countries result in the technology being the mostly used and reachable communication mean in these geographical locations. Donner (2008) found mobile phones as a "powerful tool for exchanging ideas at a distance, and for managing daily life" (p. 146). Sridhar and Sridhar (2006) discuss the active role of mobile phones in ICTD implementation, enabling economic growth and general well-being. In this paper, mobile phone penetration is measured in terms of Mobile Phone Subscriptions (MPS) per 100 people (UNDP, 2017).

Déglise et al. (2012) studied more than four thousand sources to find out the role of Short Message Service (SMS) in disease control. They found that using SMS improves the healthcare process. They also found that the professionals, as well as the care receivers, welcomed this process as the SMS service in mobile phones can be used as a medium for spreading health awareness and a good data collection tool. In another study, (Danis et al., 2010) analyzed two SMS-based education systems in a quiz format among two target population, mobile phone users, and factory workers. They found that the literacy was not a major issue in delivering health education through SMS. There still needs to be known if the popularity of mobile phones and their usage in communities have a direct impact on the health well-being in human development. In order to investigate this gap in the literature, we investigate the following questions:

RQ1: What is the relationship between mobile phone penetration and health well-being?

RQ2: What is the relationship between mobile phone penetration and health well-being on human development?

In this paper, a key resource, health well-being is investigated in the light of increasing mobile phone penetration. Following a review of the literature in the field of ICTD and mHealth (mobile health), this paper investigates the relationships between mobile phone penetration and the health index. We conducted a cluster analysis to identify the relationship between the Mobile Phone Subscription (MPS) and the Health Index (HI). In order to answer the second research question, further analysis was carried out to discover the relationship between these indexed variables and the Human Development Index (HDI). The following sections describe the theoretical background and research methodology that are used to analyze the above research questions.

Theoretical Background

Researchers have developed many frameworks and models to address the challenges in implementing ICT, with each focusing on a particular aspect of development. Kleine (2010) studied several Information and Communication Technology (ICT) implementation frameworks i.e. Alop & Heinsohn's Empowerment Framework, The Sustainable Livelihood Framework. She discusses operationalizing Sen's approach and recommends using the Choice Framework for a successful implementation of Information and Communication Technology for Development (ICTD). According to (Kleine, 2010) the Choice Framework facilitates using ICT in a systematic and procedural manner, offers an approach for operationalizing Sen's Capability approach, introduces significant aspects of existing frameworks, and acts as a 'living tool' that links ICT to different elements.

ICTD implementation has proven to have fruitful positive outcomes in the developing world. Qureshi (2005) discusses access to information and knowledge, access to market and competition, administrative efficiencies, learning and labor productivity, and contribution to poverty reduction as several of many key outcomes of ICTD. If we recall the MDGs, we realize that the ICTD outcomes discussed affect the MDGs either directly or indirectly.

Even though countries of the world were categorized after World War 2 as developed and developing, Third World, and Majority World, the categorizations often fail to represent the characteristics of these countries today. Developed countries were the ones that had reached a particular economic level. The term "developing" was preferred than the "undeveloped" because it indicates that the countries under the identified standard of living or economic status are trying to reach the standard (Willis, 2006). Third World, referring to Africa, Asia, Latin America and the Caribbean, were the countries which did not officially follow either the capitalist USA or the communist USSR during the cold war (Willis, 2006). Some political activists named the so-called "Third World" countries as the Majority World for the sake of being fair and global justice. They referred to the rest of the world as Minority World (Willis, 2006). Regardless of the term or name being used for these nations, it was more important for them to develop by systematic, detailed in comprehensive interventions in their societies (Escobar, 2011). They had to overcome with several significant issues such as overpopulation, poverty, and illiteracy issues, which they were already stereotyped for (Escobar, 2011).

International organizations such as the United Nations and the World Bank work on identifying the development level of countries based on economic and human well-being. There are several indicators set by the United Nations and the World Bank to identify the level of development in a country. The World Bank focuses on the economic development. They divide countries into low-income, lower-middle income, upper-middle-income and high-income categories. The World Bank categorizes the countries based on Gross National Product (GNP).s UNDP follows a non-economic approach to categorizing countries into high, medium and low categories based on Human Development Index (HDI). HDI was developed by the UNDP in the 1980s. The HDI reflects on human well-being, which is measured by the length of healthy life, education and standard of living (Willis, 2006).

While the HDI implemented by UNDP and the economic categorization by the World Bank identify human development in countries, both approaches carry some concerns. Firstly, HDI and GNP are quantitative. By not considering the qualitative data in measuring the development level we exclude the feeling and opinions of individual and groups of people. Secondly, the results vary spatially in the same country where data is represented from. For example, the level of education or healthcare differ in urban and rural areas in a country; however, the HDI shows a single result representing both types of location.

It is believed that because the Internet and the MDGs took place in the same decade, the 1990s, the intersection of the two gave birth to ICTD (Heeks, 2008). The rise of the internet reinitiated the need for using ICTs to support development efforts (Heeks, 2008). Heeks (2008) also claims that the ICT would not only act as a technology service in the developing world but also a facilitator for addressing the MDGs. Walsham and Sahay (2006) argue that it is not a question if developing countries can benefit from ICT. How can developing countries benefit from ICT is the question. New technologies may have positive impacts on economic sectors, overcoming issues with dysfunctional administration, and improving the quality of services and may enable economic growth (Avgerou, 2008).

However, it is hard to convince the funding organizations and legitimize the positive outcomes of ICTD in changing people's lives (Kleine, 2010). ICT impacts societies positively, however, the approach of implementing it can be complicated in some cases. It is argued that "Information Technology for Development (ITD) entails the implementation, use, and management of Information Technology infrastructures to stimulate social and economic development" (Qureshi 2005, p.503) ICT has a significant value in public and private sector, from business in the urban area to healthcare in rural regions (Walsham & Sahay, 2006). While ICT might be implemented in the public sector for the socio-economic development purposes, global industries having agencies in the developing countries might apply ICT for the sake of standardization and homogeneity among all their offices and meeting the customer expectations (Avgerou, 2008). ICT implementation may not always be successful. Resistance to change, lack of awareness, and not being ready for the change are some of the challenges. ICTD plays an important role in healthcare, education, and poverty reduction, the three most important areas of MDGs.

Given the above, the high usage of mobile phones in daily lives of individuals gave birth to a new field, mHealth or Mobile Health. One main reason that mHealth is the most suitable approach to address primary needs such as healthcare in the developing world is their availability. Mobile phones are the most available and accessible communication mean regardless of the geographical location and economic status of individuals. While some areas might not have infrastructural facilities such as roads, they do have access to mobile technology. Donner (2008) found that ICTD literature demonstrates high optimism

regarding the mobile phones' positive role in livelihood and well-being in a geographical area with limited access to traditional facilities and services. Freifeld et al. (2010) found mobile phones promising in healthcare since they can be used as "point-of-care devices". They also believe that the usage of mobile phones for healthcare is a growing field. Besides benefiting the users, mHealth can be a good a data collection tool for the healthcare providers (Loudon, 2016).

Methodology

The research method used to investigate the research questions follows two steps. First, in order to investigate RQ1, a cluster analysis is carried out to discover the countries and characteristics of the countries as they group together. The data used for this analysis is from the UNDP's Mobile Phone Subscription (MPS) and the Health Index (HI). MPS indicates the number of mobile phone subscribers per 100 people in the country. The health Index is selected for this analysis because it offers a measure of "Life expectancy at birth expressed as an index using a minimum value of 20 years and a maximum value of 85 years" (UNDP 2017). We use cluster analysis to find the correlation between the two clusters of our data, Mobile Phone Subscriptions (MPS) and Health Index (HI). Cluster analysis is an exploratory data analysis technique that helps to identify relationships between two or more variables. We used K-means cluster analysis using Statistical Package for the Social Sciences (SPSS) version 24 (Kanungo *et. al,* 2002). As mentioned before we completed our analysis based on the two following variables:

- Mobile Phone Subscriptions: the country ranking for this variable based on subscriptions per 100 people. MPS data ranged from the year 2000 to 2014.
- Health Index: the life expectancy at birth having a minimum value of 20 and maximum 85 years. HI covered a longer time span, 1980 to 2014.

The dataset downloaded from UNDP HDI had data from 188 countries. After cleaning the data, we had 180 countries for cluster analysis. We calculated the average of MPS and HI for the years of reported data for each of the 180 countries. We then conducted a K-Means analysis dividing the countries into 2-5 cluster solutions repetitively. Hong Kong was the only country that appeared in a single cluster by itself. We removed Hong Kong and ran our analysis again. So, we ran the analysis again on the remaining 179 countries. A detailed cluster-wise analysis and comparison among clusters are discussed in the following section.

The second stage of this analysis to investigate RQ2 is carried out through a regression analysis of the two variables, MPS and HI, indexed to identify their relationship with the HDI.

Results

We identified that in the 5-cluster solution, countries were fairly distributed and it addressed the research question better than the other solutions. Both MPS and HI variables were significant in the 5 cluster analysis The K-means 5-cluster solution demonstrated a perfect grouping of the 179 countries based on the MPS and HI variables. Both variables were significant for the 5-cluster solution. Table 1 shows the effect of the variables and Table 2 demonstrates the distribution of the countries in respective clusters.

ANOVA	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
MPS	4.710	4	.006	174	811.659	.000
HI	.479	4	.009	174	55.677	.000

Table 1. Effect of MPS, HI on 5-cluster solution

Table 1 indicates that both MPS and HI are significant in 5-cluster solution. Also, distribution of the countries in the 5-cluster solution made it most suitable solution to be considered for

Cluster	Countries
1	18
2	37
3	44
4	43
5	37
Total	179

Table 2. Number of countries in each cluster

further analysis. Besides, the similarity of countries in each cluster was higher than the other solutions. As can be seen from Table 2, the distribution is normal with cluster 1 containing the fewest countries (18) and cluster 3 with the most (44).

We analyzed the characteristics of each country and conducted a cluster-wise analysis in order in order to find the key characteristics of each clusters. A Detailed discussion of each cluster is presented below.

Cluster 1: Very Low MPS, Low HI

The countries in this cluster have both low average of mobile phone penetrate and health index. This cluster has the lowest MPS and lowest HI among all the clusters. The average MPS penetration for all the countries in our sample is 79% compared to 19.2% for countries clustered in this first group. The average HI for all the countries is 73.3% and only 56.2% for countries in this cluster. Figure 1 offers a view of the countries in Cluster 1:

14 out of 18 countries in this cluster are from Africa. Korea (Democratic People's Rep. of), Kiribati, Myanmar and Papua New Guinea are non-African countries in this cluster. Djibouti, being the country closest to the center, represents this cluster. It has an average mobile penetration of 19% and health index of .59 which means 59% of this country's population are healthy. Other representative countries in this cluster include Ethiopia with an average MPS of 15% and an HI of 0.54 or 54%. The numbers in the figure starting from 0 and ending in 0.35 indicate the distance from the center of the cluster.

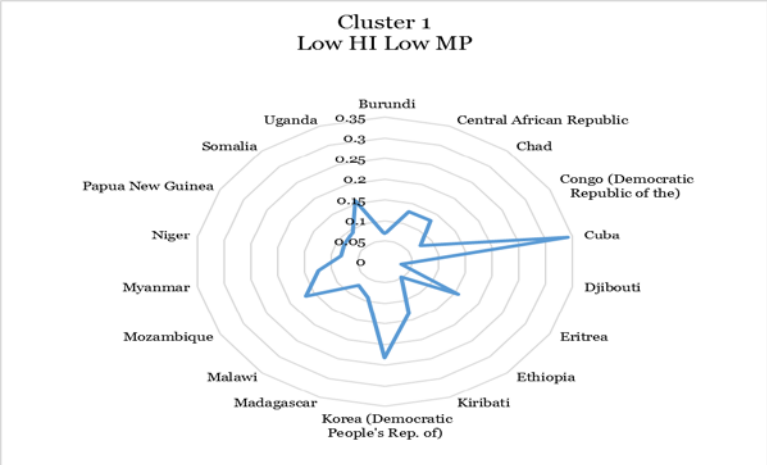

Figure 1: Countries in Cluster 1

Cluster 2: Very High MPS, High HI

This cluster consists of 37 countries. The appearance of countries from several continents makes this cluster quite diverse. The MPS for this cluster is very high at more than 120% compared to the 79% of the entire set of countries. Average HI for the countries in cluster 2 is 81% compared to the 73.3% of the average of all the countries. The countries in this cluster have very high mobile phone penetration rates. As can be seen from the above cluster diagram, the countries closest to the center are Austria 135% with mobile phone penetration, United Arab Emirates with 131%, Bahrain with 124%, Oman 122%, Argentina 120%, Russian Federation 121%, Seychelles 118%, Bulgaria 114%, United Kingdom 114%,

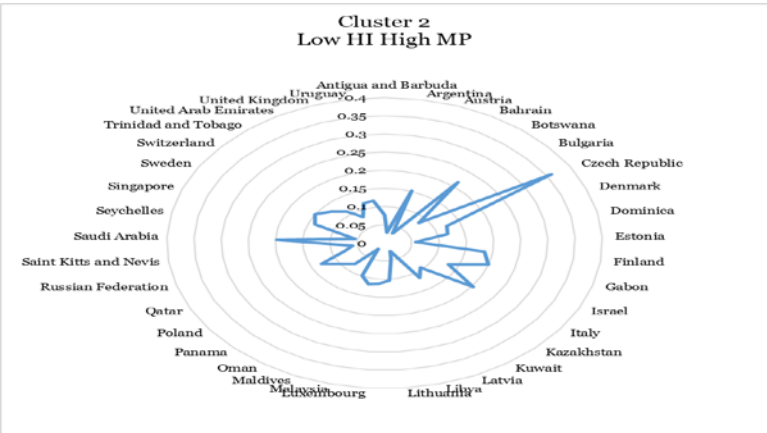

Figure 2: Countries in Cluster 2

Trinidad and Tobago 114%, Botswana 112%, Sweden 112.5%, and Switzerland 117%. The numbers in the figure starting from 0 and ending in 0.4 indicate the distance from the center of the cluster**.**

Cluster 3: Below Average MPS, Above Average HI

Cluster 3 has the most countries. With 44 countries that belong to several continents i.e. Asia, Africa, Europe, Latin and North America, this is the only cluster in which the MPS and HI are almost identical to each other. The MPS of cluster 3 countries is an average of 74% compared to 79% average for all 179 of the countries in this dataset. The average HI for the countries in cluster 3 is almost 74% compared to 73.3% for the rest of the world. Figure 3 illustrates the diagram for the countries in cluster 3.

The countries nearest to the center of this cluster are the Republic of Moldovia which has an MPS of 71% and an HI of 75%, Turkey which has an MPS of 77.7% and an HI of 76.6%, Honduras has an MPS of 76% and an HI of 76%, Georgia has an MPS of 81.4% and an HI of 81%, Fiji has an MPS of 71% and an HI of 73%, Dominican Republic MPS of 70% and an HI of 77.4%, Ecuador has an MPS of 81.4% and an HI of 80%, and Egypt has an MPS of 82% and an HI of 73%. Further from the center of this cluster are countries such as China which has an MPS of 62% and an HI of 80.5% and Canada which has an MPS of 68%v and an HI of 91.5%. The numbers in the figure starting from 0 and ending in 0.4 indicate the distance from the center of the cluster.

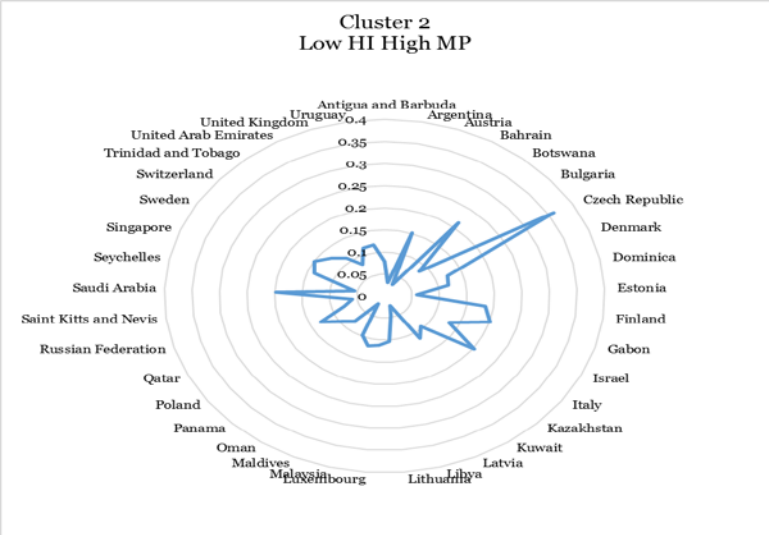

Figure 3: Countries in Cluster 3

Cluster 4: High MPS, High HI

There are 43, mostly European, countries in Cluster 4. Countries in this cluster have high MPS and HI. The average MPS for the countries in cluster 4 is 97% compared to the 79% average for all 179 of the countries. The average HI for the countries in this cluster is 84%. The countries and their distance from the center of the cluster are illustrated in figure 4. Countries closest to the center of this cluster are Slovakia with an MPS of 96% and an HI of 83%, Australia with an MPS of 98% and an HI of 92%, France with an MPS of 87% and an HI of 91%, Germany with an MPS of 100% and Hi of 90%, Greece with an MPS of 100% and an HI of 90%, Grenada with an MPS of 94% and an HI of 78%, Brazil with an MPS of 97% and an HI of 77%, Brunei Darussalam with an MPS of 92% and an HI of 85.5% and Barbados with an MPS of 96% and an HI of 82%. Further from the center of this cluster are countries such as South Africa with an MPS of 100% and an HI of 57% and the

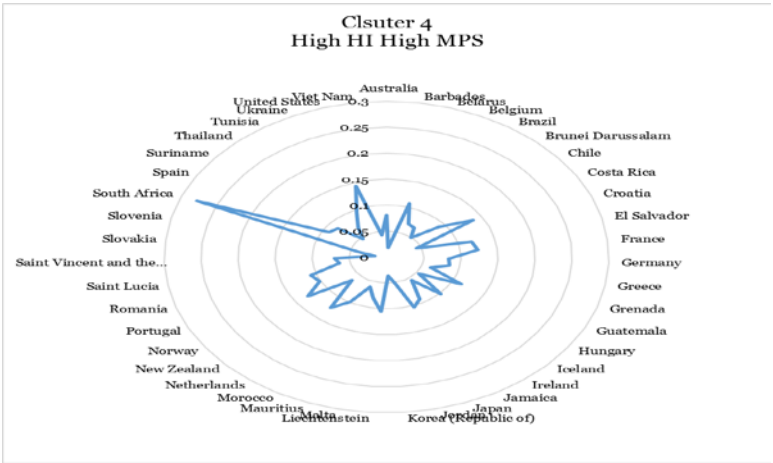

Figure 4: Countries in Cluster 4

United States which has an MPS of 83% and an HI of 88%. The numbers in the figure starting from 0 and ending in 0.3 indicate the distance from the center of the cluster.

Cluster 5: Low MPS, Low HI

The remaining 37 countries fall in this cluster. Asian and African countries have the highest number of presence in this cluster. Sudan is the nearest to the center and Angola, the furthest. The average MPS is 47% compared to 79% of the total, and the average HI is 60% for the countries in this cluster compared to 73.3% for all the countries in this dataset. The countries in cluster 5 are illustrated in figure 5:

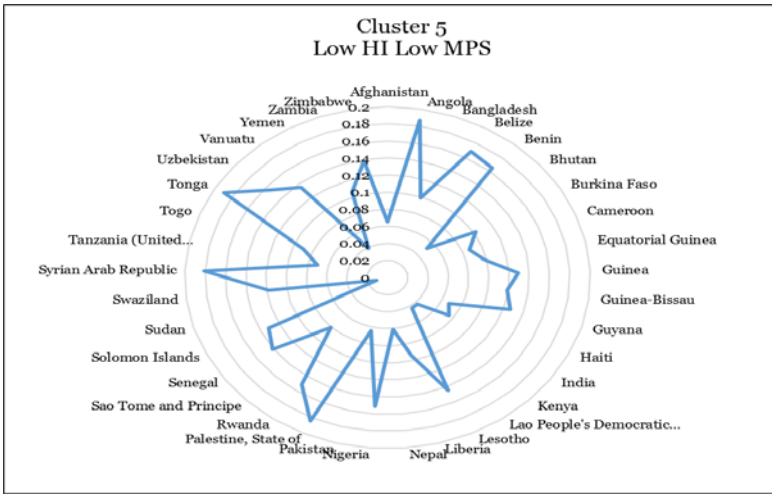

Figure 5: Countries in Cluster 5

Countries close to the center of this cluster are Afghanistan with an MPS at 46% and an HI of 53%, Sudan with an MPS at 48% and an HI of 61%, Bhutan with an MPS of 51% and an HI of 63%, Haiti with an MPS of 40% and an HI of 59%, India with an MPS of 51% and an HI of 66%, Pakistan with an MPS of 48% and an HI of 66%, Kenya with an MPS of 51% and an HI of 58%, Tanzania with an MPS of 41% and an HI of 56.4% and Togo with an MPS of 39% and an HI of 55.7%. Further from the center of this cluster are countries such as Zimbabwe with an MPS of 57.7% and an HI of 50% and Rwanda with an MPS of 35% and an HI of 50.5%. The numbers in the figure starting from 0 and ending in 0.2 indicate the distance from the center of the cluster.

Analysis

In this section, we compare the differences in clusters and identify the significant characteristics of countries residing in each cluster. The countries in cluster 1 have the lowest MPS and HI among all clusters. Cluster 2 countries have the highest MPS and the second highest HI. The MPS and HI in cluster 3 are almost identical to each other. They are the nearest to the average of all clusters. Cluster 4 has the second highest MPS and highest HI. Cluster 5 has the second lowest place in both MPS and HI. These are illustrated in Table 3 below:

Cluster	**1**	**2**	**3**	**4**	**5**
MPS	19%	123%	74%	97%	47%
HI	56%	81%	75%	84%	60%

Table 3. Average MPS and HI comparison among clusters

When considering the ratio between MPS and HI for each cluster, the MPS in cluster 1 is almost one-third of HI. Cluster 1 MPS is lower than its HI. The MPS in this cluster is approximately 0.80 of its HI. Countries in cluster 1 have significantly higher HI than their MPS. Djibouti is placed in the center of this cluster. Djibouti's MPS being 32.4 and its HI being 62 confirms the similarity of having a large difference in the MPS and HI among the countries in this cluster (UNDP, 2017). Cluster 5 is similar to cluster 1 in terms of comparing the MPS to HI. However, all the countries in cluster 5 have higher HI average than MPS and cluster 5 countries' MPS is twice as large as that of cluster 1. Sudan is closest to the center of cluster 5. Its most recent HI is 72.2% and MPS 63.5 (UNDP, 2017), which confirms the characteristics of this cluster.

In cluster 2, MPS is 1.5 times the HI. The characteristic that brings all of the countries in cluster 2 together is their extremely high MPS rate. The average MPS for every country in this group is higher than 100%. The lowest MPS in this cluster is 111% (Malaysia) while they have as low HI as 46% (Czech Republic). The country in the center of this cluster is Oman. It has an MPS of 157.8% and HI of 76.8% (UNDP, 2017). Figure 6 illustrates the relationship between the clusters.

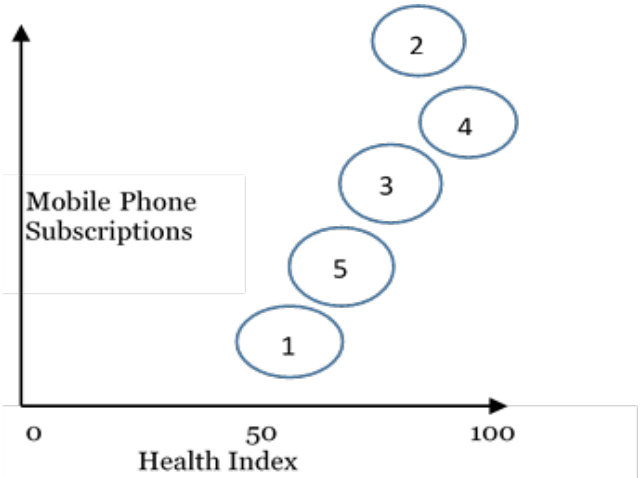

Figure 6: Relationship between Clusters

The MPS and HI in cluster 3 are almost the same. Cluster 3 has the nearest MPS and HI average to the overall average of the countries. The average MPS for this cluster almost equal to the average HI. It is quite interesting that out of 44 countries grouped in this cluster, exactly 22 of them have higher MPS than the HI and the remaining 22 have Higher HI than MPS. Republic of Moldova marks its spot in the center of this cluster with having an average MPS of 72% and an average HI of 74%. Surprisingly, the most recent MPS for Moldova is 108% and the most recent HI 71.6% (UNDP, 2017).

Cluster 4 MPS and HI are close to each other with MPS 1.15 times the HI. Most of the countries in cluster 4 have higher MPS than HI. Only four countries from all 43 in the group have higher HI than MPS i.e. Costa Rica, France, Lichtenstein, and United States of America. Slovakia is the closest country to the center of this cluster. Slovakia's current MPS is 116.9 and HI 76.3 (UNDP, 2017).

The above analysis illustrates a connection between mobile phone penetration and the health index. This suggests that increased penetration of mobile phones may in fact enable people to lead healthier lives. There might be a correlation between the two indicators as is explored in the following section.

Implications for Human Development

The above connection between mobile phone penetration and the health index has important implications for human development. In order to discover the effects of the two variables on human development, we created an index of MPSHI and tested it against the HDI. As we have two variables, we carried out a linear regression to help us answer RQ2. The correlation with MPSHI as the predictor and HDI the dependent variable was significant at an adjusted R square of .769. The regression is illustrated in Table 4 below:

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.411	1	3.411	586.309	.000[b]
	Residual	1.018	175	.006		
	Total	4.429	176			
a. Dependent Variable: HDI						
b. Predictors: (Constant), MPSHI						

Table 4: Relationship between MPSHI on HDI

The MPSHI has a significant relationship with the HDI. Our analysis suggests that using mobile phone subscriptions to promote healthcare and health well-being will affect the HDI because well-being is one of the three key dimensions of human development. The use of mobile phone for health and well-being has some profound implications for human development.

Provision of healthcare: Government and international agencies can connect their health services through mobile phones especially in rural villages. Through mobile phone infrastructures, needed healthcare services can be accessed by people who need the information, assistance and even medical care. Mobile Health (mHealth) is an emerging concept in healthcare in which mobile communications devices are used in health services and information. mHealth has been defined as the use of portable electronic devices for mobile voice or data communication over a cellular or other wireless network of base stations to provide health information (Kahn, et. al. 2010).

Containment of epidemics: With the help of governments, the World Health Organization has started using mobile Global Positioning System (GPS) tracking systems to contain epidemics across continents. Qureshi (2016) report on how Nigeria was able to contain Ebola through concerted efforts in identifying,

isolating and interviewing victims while using mobile signals to track potential threats. In addition, the cell phone records to track suspected cases, social media, SMS platforms and radio played a key role in the sensitization of the public.

Equitable distribution of healthcare and services: The equitable provision of healthcare is central to achieving human development. The need for health equity arises from inequalities in health status, healthcare utilization, and healthcare financing. Equity in healthcare is an ethical concept which ensures that people are not prevented from becoming healthy because of their socioeconomic circumstances. Inequities can prevent large segments of a population from being engaged in pursuing better livelihoods. (Qureshi 2016). The potential for the equitable distribution of healthcare by expanding mobile phone usage to areas that are in need of healthcare access is significant.

Improve care through data collection and analysis: In order to ensure that people get the treatments they need, mobile phones can be used to improve care through targeted collection and analysis of data. This offers opportunities for public health. The use of mobile health services appears particularly advantageous for conditions that require intense and ongoing monitoring, such as diabetes, and where people are of working age and not disabled. With mHealth systems, glucose data can now be automatically collected, transmitted, aggregated with other physiologic data, analyzed, stored and presented as actionable information (Qureshi 2016).

Patient-centered poverty reduction: Mobile healthcare provision is becoming more equitable in enabling care to become more patient-centered. Outcomes of patient-centered care have reported better recovery from their discomfort and concern, better emotional health, and fewer diagnostic tests and referrals. At the same time, healthcare and poverty are inversely related. Human development efforts need to target mHealth to people who are most in need. They will then use the mobile phones to care for themselves. The increased popularity of smartphones has led more patients to proactively manage their care while on the go using specific mobile applications containing functionalities such as GPS tracker for Alzheimer's patients, not available on desktop computers (Qureshi et. al. 2015)

Summary, Contributions, and Conclusions

While much has been written about the promise of mobile phones and healthcare provision in remote and underserved communities, little research has actually been carried out to discover this relationship. In this paper, the relationship between health well-being is investigated through the UNDP's health index, and mobile phone penetration. The initial cluster analysis of 179 countries of the world carried out to identify the relationship between the two variables Mobile Phone Penetration (MPS) and the Health Index (HI) revealed five unique clusters. The countries in these clusters revealed the characteristics unique to their adoption of mobile phones and health outcomes. Further analysis revealed a significant correlation between the two variables.

The contribution of this paper is twofold: first following an initial analysis, we found a significant correlation between mobile phone penetration and health well-being. A cluster analysis of the two variables revealed five different clusters of all the countries in the world for which we had complete data. These clusters illustrate the characteristics of countries with similar mobile phone penetration and health index. The second contribution is in a further analysis that was carried out to discover the relationship between these indexed variables and the Human Development Index (HDI). The analysis reported in this paper uncovers a positive significant correlation between both mobile phone penetration and the health index as well as both variables and the HDI. This has implications for the use of mobile phones for the provision of healthcare and human development.

The limitation of this research is in that we only used two variables and carried out simple linear regression to analyze the correlation between them. Future research will include other indicators related to development and ICT for the clusters identified. There may be some issues which are common for the clusters discovered that need to be analyzed further using multiple health and HDI indicators. This may lead us to discover additional issues that play an important role in mHealth and development.

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