On the suitability of the work system framework as a methodology for researching IoT implementations in developing countries

Myriam Raymond, Sherif Kamel, Rawy Iskander

Raymond, Myriam; Kamel, Sherif; Iskander, Rawy

Conference Paper

On the suitability of the work system framework as a methodology for researching IoT implementations in developing countries

2015 Regional Conference of the International Telecommunications Society (ITS): "The Intelligent World: Realizing Hopes, Overcoming Challenges", Los Angeles, USA, 25th-28th October, 2015

Provided in Cooperation with:
International Telecommunications Society (ITS)

On the suitability of The Work System Framework as a Methodology for researching IoT implementations in developing countries

Myriam Raymond*
Université d'Angers
GRANEM

Sherif Kamel
American University in
Cairo

Rawy Iskander
Spimesense

* *Corresponding Author*

Introduction

The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. In 2014, the total number of mobile-connected devices of all types has exceeded the world's population and is forecasted to reach 1.5 devices per human being in 2019 (Cisco, 2015). The pace of the emergence and mainstream adoption of new forms of ubiquitous computing devices such as smartphones, tablets and `phablets' has not ceased gaining momentum demarking an evolutionary step in the ubiquitous computing trend (Lyytinen et al., 2004). The main enabling factor of this promising paradigm is the integration of several technologies and communications solutions

By gradually blurring physical, social and temporal boundaries, ubiquitous systems allow to deliver new as well as existing online products and services through a multitude of interconnected channels, but also engender radically novel and unthought-of opportunities for the economies (Lyytinen & Yoo, 2002; Lindgren et al., 2008). Moreover, the Internet of things (IoT) represents a set opportunities for businesses but also a possible challenge in understanding each stakeholder's motives and activity in this fluid digital ecosystem (Ghose & Han, 2011).

Apprehending ubiquitous systems is a difficult challenge as the rules that govern its functioning keep being redefined each time a new form of connected device appears on the market (IDC, 2014; Oulasvirta et al., 2012). In addition, some environmental and strategic elements impact the IoT implementation. Differences, sometimes substantial, in the IoT implementation model and applications depend on many factors and elements and it becomes extremely challenging to understand the mechanics of the model, as well as the user's motivation and the ecosystem's configuration.

The authors of this article propose that the Work System Framework (Alter, 2008) could give an adequate lens for understanding the IoT models and their functioning. Particularly, the Work System Method could be considered for resolving the ubiquitousness aspect that is particular of the IoT innovations. Furthermore, through multiple examples, the authors show in this paper how the particular context of developing countries could be considered sometimes as enabling and in other situations as inhibiting the adoption of the IoT implementation.

To pursue this dual research objective, the authors propose to use Alter's Service System Innovation Framework (Alter, 2008a) which can explain how the different work system elements influence the course of the innovative IoT and the design of its IS. As a result of the complexity of the interdependencies between this framework’s multiple elements, such a situation typically calls for a case study methodology, especially when “the boundaries between phenomenon and context are not clearly evident” (Yin, 2009). Furthermore, the Work System Method approach when applied to service design enables systemic thinking in IS design as it points to the importance of considering all elements of the phenomena, in their diversity and implications for IS design. For this purpose, the authors use the SenseGeni TEMPO ® IoT innovation to highlight how the Work System Framework applies.

In this paper, the Alter’s Work System (WS) Method will be presented and defended with respect to why it could be a suitable lens for studying the IoT models and implementations. There will be a focus on the environment and the infrastructure, which are important elements in the WS to explain how the particular settings of developing countries could shape the adoption model of the IoT innovation.

The investigation in this research proceeds as follows. First, there is an examination of the particular case of IoT-and ecosystem innovation, presenting briefly how it has been treated in the literature, and highlighting its specificities. Second, there is a definition of the methodology used and in which we present Alter's Work System Framework and its elements. Third, there is an elaboration using an IoT case study context emphasizing its particular service system characteristics and present the results. A discussion and conclusion follow, including the limitations, contributions and practical implications of this research.

IoT in the literature

IoT-and Ecosystem Innovation

Innovation is at the heart of IoT services. If one wishes to understand its relative innovation dynamics, one should proceed with a methodology or framework. An ecosystem could be considered as: "*an economic community supported by a foundation of interacting organisations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders*" (Moore, 1996).

IoT and developing/emerging economies

Interconnectivity is changing the world. The opportunities enabled by the Internet have undoubtedly had huge implications on the global economy. Consequently, while the total value of transactions occurring online vary according to different reports, they represent a remarkable and growing volume of the world's economy. The digital economy; therefore, is continuously changing the rules, the business models and the way business is conducted. Moreover, it will reinvent and further globalize the world economy by connecting not only individuals but also organizations, businesses, and societies at large in real time. This will lead the world to becoming transformed into a fully-integrated and interconnected global community that is more operating on a timely, collaborative, intelligent, responsive, and efficient momentum yielding effective and positive implications on global productivity and economic value (Sharma, 2015). Pervasive connectivity between people and processes will gradually enable multiple services to be initiated and delivered automatically and contextually anywhere, all the time regardless of time or distance barrier (GSMA, 2014). This will render the communication platform and all the associated and connected building blocks such as individuals, buildings, machines, organizations and cities intelligently and timely connected.

There is no doubt that the lives of people around the world have changed dramatically by the evolution of information and communication technologies (ICT) and with the emergence of the Internet such impact was magnified affecting many aspects of life. Such developments characterized most of the last three decades. However, moving forward the next evolution will see equipment and machines rather than people getting connected and communicating with other. That will be the Internet of things. The required infrastructure needed to support the Internet of things is fast being developed and disseminated across different societies around the world. The next decades will see machines interact with other machines, which is increasingly being labelled machine2machine (M2M). The bulk of the mobile M2M connections are currently in the developing world as an attempt to leapfrog the technological advancements and developing in the world's least developed areas (Reuters, 2014).

Moving forward the vast majority of mobile and Internet users will be coming from the developing world. However, the impact will be felt around the world in the way people live, work, and study, get entertained, and travel among many aspects of their daily life. In the context of the developing world, the number of cellular M2M connections known as Internet of things will reach a total of 128 million or 52 percent of the global connections during 2015 and will rise to 575 million connections or 60 percent by 2020 (Reuters, 2014). Table 1 demonstrates the M2M connections by region.

Region	M2M % total connections (2013)	M2M CAGR* (2010-2013)	Connections CAGR (2010-2013)
Africa	1.0%	41.3%	15.0%
Asia	2.1%	55.0%	10.4%
Europe	5.1%	28.6%	2.4%

Latin America	2.1%	43.7%	7.8%
North America	9.3%	22.5%	3.6%
Oceania	5.1%	25.8%	5.5%
Global	2.8%	37.6%	8.8%

*CAGR = Compound Annual Growth Rate

Table 1 – M2M Connections by Region (GSMA, 2014)

Consequently, the developing world in Africa, Latin America, and Asia have the opportunity, through the proper deployment of the infrastructure and infostructure required to capitalize on the proper implementation and institutionalization of the Internet to increase their productivity by around 25 percent, which could result in an addition of 2.2 trillion US dollars in GDP growth which translates to about 72 percent increase and respectively leading to the creation of over 140 million new jobs during the next decade (Williams, 2014). Globally, the potential could reach anywhere between 4 and 11 trillion US dollars during the same period (Manyika et al, 2015).

In terms of the socioeconomic impact of the Internet of things on the developing world, it is expected that within five years, around 1 million lives through online health applications will be saved in sub-Saharan African; over 40 million people in developing economies have the opportunity to be fed on an annual basis due to the fleet telematics preventing food waste during transportation; and over 180 million children in developing economies will have the opportunity to stay at schools and get educated (GSMA, 2014).

The evolution of IoT is taking both the developed countries and the developing worlds by storm. Everyone is adopting, diffusing and adapting to the new emerging technology. In the context of developing economies, the Internet of things promises to contribute in meeting multiple development goals and objectives. The projected applications associated to the Internet of things virtually touches every economic sector including health, industry, trade, transportation, pollution, education, and many more. Examples already include the production and export of commodities where sensor technologies are being used to test the quality of food such as in the case of Brazil and Chile in Latin America as well as in Namibia in Africa. There are also cases from Bangladesh for the filtering of water. Kenya is already channelling 25% of its gross domestic product (GDP) through the nation's renowned mobile payment system known an mPesa (Hossain, 2015). Today, in Africa, there are 7 million M2M connections and the number could quadruple by 2020, most people in the continent access the Internet from mobile devices (Reuters, 2014).

What the next generation connectivity promises to offer is that as opposed to connecting every conceivable thing to the Internet, every rural village around the world will have wireless data access (Prestero, 2014). For example, in the case of South Africa, the continent's most advanced economy, the country has been the leader in rolling out Internet-connected devices. One of their main projects was smart meters for a power utility in the city of Johannesburg, more projects are being studied. Also in Africa, in Rwanda a country that until recently was devastated from local conflicts is currently using SIM cards to connect point of sale terminals in remote areas enabling merchants to accept credit or debit card payments. In many ways, in the context of developing economies, the newly emerging technologies are increasingly changing the traditional way of doing businesses, the functioning of public sector organizations, the way to get access to information and the platforms available and the growing opportunities to realize economic growth. The notion of M2M had started in the developed world much earlier than the developing world but now it has been overtaken by the developing world in an attempt to close the connectivity divide with developed nations.

Statistically, there are 2.3 billion mobile Internet subscribers in the world which represents 33% of the global population, the number goes up to 3 billion when the personal computers are also included in the mix. In the context of developing countries, based on a study conducted by Juniper Networks in 2014, the findings indicated 97 percent of people developing countries perceive mobile Internet access as a transformative element of their lives, 52 percent felt that it changed their work habits and norms 24 percent believe that it had major implications on their education (Gruman, 2014). With respect to the Internet of things, in the context of Africa, the focus has been mainly on vehicle tracking, mobile payments and smart cities. In general the Internet of things is becoming an important platform for mobile operators throughout the developing world. Moving forward, while more value could be created in advanced and developed economies, the number of deployment and implementation will surely be higher in the developed world (Manyika et al, 2015).

To sum up, there is huge potential through the deployment of the Internet of things in developing economies during the next decade where the estimation reflects higher potential value in advanced economies because of higher value per use yet the developing world can benefit from around 40 percent increase of value generated. It will depend on the business, industry and application and the readiness of both the technology infrastructure and the timeliness, accuracy and access of the infostructure. Accordingly, the level of impact will vary dramatically. For example, in the health sector healthcare spending in advanced economies is twice that in developing economies. In the retail sector, while higher adoption and values exist in advanced economies, there are large numbers of retail settings in developing markets and finally in the factory and establishments domain, while larger investments in automation prevail in advanced economies, there are a large number of factories in emerging markets (Manyika et al, 2015).

Methodology

The Work System Framework

In 2008, S. Alter (2008a, 2008b) proposed to use the work system framework to advance the understanding of interactions among the elements of service systems. The work system is defined as being "*a system in which human participants or machines perform work using information, technology, and other resources to produce products and services for internal or external customers*." He calls for the 'componentization' of service. The work system framework is extended in Alter's model by incorporating (a) the service value chain framework to account for service-related aspects of systems, and (b) the work system life cycle model to highlight possible planned and unplanned changes that may affect the system.

Service innovation is fundamentally about creating beneficial improvements (Alter, 2008a). Innovation in services is likely to differentiate the service provision of one company that of its competitors. The company with a stronger service provision can thus attract new types of customers or penetrate new markets and retain current customers. Companies can also better find innovative solutions to current problems, which will eventually contribute to their revenue growth.

The framework geared towards systems (Alter, 2008a, 2008b) is especially useful in answering our question regarding the impact of service innovation on IS design issues because it reconciles the social and technical views of information systems and focuses on a contextually anchored view of IS (Paswan, D'Souza, D., & Zolfagharian, 2009). Moreover, "*these frameworks* *can be used to organize many additional concepts related to each element of the frameworks*"' (Alter, 2008a)

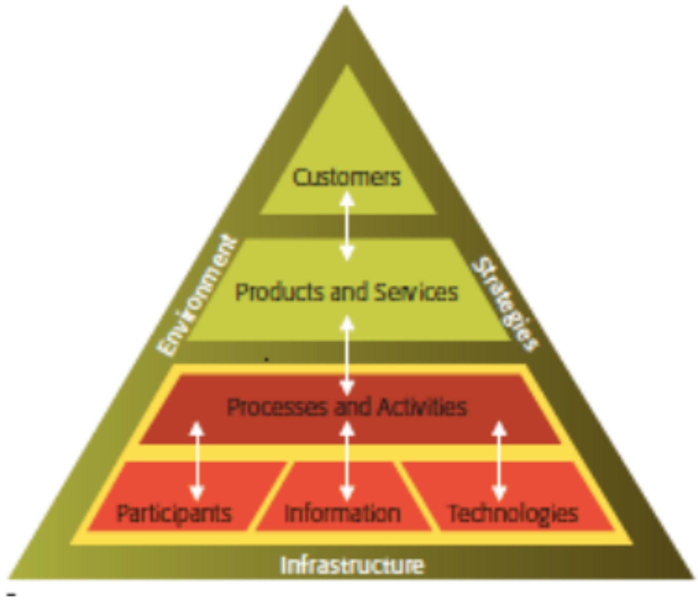

Figure 1: Work System Framework (Alter, 2008a)

Due to the complexity of this framework and the interdependencies between its multiple elements examining how they influence the course of an innovative IoT implementation calls typically for a case study methodology, specially when "*the boundaries between phenomenon and context are not clearly evident*" (Yin, 2009)

Case Study: SenseGeni TEMPO ®

Background

Spimesense Technologies is a venture company that specializes in IoT Applications. Although incorporated in the US, some of the founders of this company come from developing countries and hence target some of the most prominent developing countries challenges. The company is an integrator for M2M and IoT applications, managing the entire process and delivering complete solutions to market. The company promises to simplify controlling, monitoring and automating most business activities and assets.

Among the proposed SpimeSense Technologies and M2M applications, is the SenseGeni's TEMPO Cold Chain Pharmaceutical Solution.

Case Study Narrative

An effective and well-managed cold chain supply line is imperative to a pharmaceutical company and its consumers. Because the smallest change in temperature can adversely affect a product and cause a ripple effect in the supply line, managing the cold chain supply line properly is key. SenseGeni's Solution is a comprehensive ecosystem that could well be suited to the pharmaceutical sector but also to the food and beverages sectors.

The SenseGeni's Cold Chain Pharmaceutical Ecosystem is a comprehensive ecosystem. It is a new innovative cold chain technology that takes advantage of smartphones and the cloud to solve the cold chain technologies operations problem. SenseGeni ensures there are no costly gaps in the supply chain. The technology uses an ultra-thin, disposable sensor that goes on the packaging at the start of the supply chain journey. Using the SenseGeni smartphone application, anyone involved in the supply chain simply needs to stand near the shipment and the smartphone will automatically scan the sensors with zero intervention from the person. The information is then securely uploaded to the cloud where anyone can get up-to-date information on the temperature of the shipment. Because SenseGeni uses existing smartphone technology, it is very cost effective. This technology and its processes hold so many benefits for the pharmaceutical industry.

To sum up, the SenseGeni's ecosystem is composed of technology items

- An ultra thin cheap and disposable sensor
- A smartphone application
- A cloud platform.

But it also accounts for system actors and participants:

- Pharmaceutical companies
- Regulators (both national and foreign)
- Logistics and Transportation partners
- Patients
- Pharmacies, clinics and hospitals

This SenseGeni's TEMPO ecosystem is particularly suitable for developing countries because it addresses several specificities and challenges of such markets that we present henceforth.

First, the meteorological forecasts are generally unreliable in developing countries. Recognizing their vulnerability to extreme climatic variability, developing countries, especially in Africa, have been exposed to unpredicted heat waves. Because of the long lead-times involved in seasonal forecasts, the uncertainty in the forecast is substantial compared to that for weather forecasts and so it is important to communicate the degree of uncertainty in the forecast. To do so reliably, it is necessary to understand the sources of the uncertainty. The first source comes from the imperfect knowledge of the current state of the climate system. A forecast involves predicting the future evolution of the current state of the atmosphere; if we do not know what the current state is, the forecast will inevitably be imperfect (Ogallo, et al., 2008). Such an unreliable forecasts can render the planning of cold chain medicine transportation hard to plan and to control.

Second, refrigerated transportation means adapted for medicines are also expensive assets that pharmaceutical companies or their logistics partners find expensive to acquire and/or maintain. According to Pharma Pro, "If drug quality is compromised by exposure to inappropriate conditions during transport and storage, drug consumers may suffer adverse consequences." This means that a missed temperature change along the cold chain can end up hurting people.

Third, pharmaceutical companies and/or their logistics partners face operating conditions that are very typical of commercial fleets in developed countries. This implies a relatively high vehicle purchasing cost. Medicine transportation vehicles are usually driven in poor road conditions in rural areas of developing countries increasing the cost of maintenance and repair, and specific accounting rules may affect vehicle disposal and salvage value. The average age of active fleets sometimes goes above ten years. In addition, medicine transportation vehicles must have refrigeration possibilities and the technologies are sometimes obsolete and their upgrade costly.

Fourth, solving traffic and transportation problems is one of the chief tasks confronting governments in developing countries. Despite large expenditures on urban transport systems, ranging from 15 to 25% of their total annual expenditures, the current problems have not eased; on the contrary they seem to get worse. Developing countries, therefore, have a major crisis on their hands. The scale and nature of the traffic and transportation problem in the third world for the objectives of growing the economy especially in a geographically expanded industry such as pharmaceuticals seems a real challenge (Khisty, 1993).

Finally, the human resource element is an integral part of the cold chain challenges. Lack of training, control methods and ethical standards make it permanently difficult to enforce well-suited medical quality standards that ensure the medicine is kept under acceptable temperatures. In addition, pharmaceutical companies sometimes sign service level agreements with logistics and transportation partners, but it becomes very difficult to track what happens to medicine consignments once they leave the factory and to decide where exactly does the liability fall if the consignment is subjected to high temperatures and consequently damaged. The action becomes post-facto after it has reached the final customers (calling back the drug) and no preventive measures can therefore be taken.

Case Study Analysis

To test the suitability of the Work System Method, the authors operationalize the framework on the above-described SenseGeni's implementation describing the elements and the relationships between such elements. Following is a description of the SenseGeni's TEMPO elements:

Work System Element	Explanation in light of the Case Study
Environment:	The environment that contextualizes the solution includes the meteorological conditions, the road conditions, traffic and transportation.
Strategies:	The strategy is having a cost-effective solution that allows real-time tracking for manufactures or stakeholders
Infrastructure:	Part of the solution's infrastructure includes carriers, handling agents, forwarders, airports, warehouses and containerized and conventional ocean transport. It also includes the local active fleet handlers.
Customers:	Since this is a B2B service, the SenseGeni's customers could be grouped in two groups. On one side are the end medicine users (called patients) and on the other side are the pharmaceutical companies wishing to implement cold chain medicine tracking (called customers).
Products and Services:	The main product of the SenseGeni are tags that help verify temperature sensitive shipments with real-time tracking anytime to ensure that they have been kept within the proper temperature range throughout their journey from the point of manufacturing to the point of consumption/delivery using smartphones.

Processes & Activities:	Temperature and location data is unloaded automatically by any Smartphone with the SenseGeni app, within a 30 meters range. This requires zero-click intervention from the smartphone user, which ensures proper control and less tampering with data. The tags are typically placed in the shipment, in each individual container, box or package. The wireless functionality affords a continual data gateway for tracking temperature and location by shipment stakeholders. Multiple shipments can easily be tracked, and anomalies and corrected in real-time.
Participants:	The SenseGeni App can be installed with inspectors, truck drivers and delivery people and receiving personnel for maximum efficiency.
Information:	The solution is built around information about ambient temperatures surrounding cold chain goods. Real-time continuous temperature records stored on the tag.
Technology:	SenseGeni Tempo is a Smartphone-based disposable temperature monitoring solution for cold chain logistics. It incorporates state-of-the-art IoT sensors, synced with a mobile app and cloud technology.

Table 2 – The Work System Elements explained in light of the SenseGeni TEMPO Case study

Next are a description and a demonstration of the existing relationships between these elements. Arrows in figure 1 display these relationships.

Relation Between	**Nature of the relation**
Customers and Products and Services	Pharmaceutical companies have a rising need to monitor more closely the handling and transportation of their medicine. Such a trend will increase going forward: Chainlink Research states, "*Temperature-sensitive drugs will soon dominate the pharmaceuticals market. By 2016, eight of the top ten best-selling global drug products (and 83% of the top 10's revenue) will be biologics requiring 2 degree Celsius to 8 degree Celsius/do not*

	freeze storage and handling regime.” This means general guidelines of how to store and handle medication. This need will pave way for what is called in-storing Cold Chain Monitoring.
Products and Services and Processes and Activities	The main objective of the CCQI (Cold Chain Quality Indicators) is to improve the consistency of cool chains across the globe, that includes Perishables and Temperature Sensitive Products (PTSP) carriers (airlines, road haulers), handling agents, forwarders, perishable centres, airports, warehouses (long- and short-term cold stores) and containerized and conventional ocean transport. The CCQI has very similar requirements to any other quality management system in the sense that it must identify each operation in which it handles temperature sensitive products.
Processes and Activities and Participants:	The SenseGeni's TEMPO Solution is fully customizable. Participants decide on the solution parameters. They decide the interval of reporting of each package. They also decide the alerts and range of temperature for each item. With SenseGeni, build the analytics of the cold chain logistics history & reliability and reduce logistical errors. Show partners and clients your reliability with smart data that is easily downloadable into any format, e.g. CSV, Excel, PDF.
Processes and Activities and Information	The solution and mobile app fetches and displays real-time tracking data for manufactures or stakeholders. It makes the process easier and the data of the transportation process more readily available to meet stricter tracking criteria in the Food, Pharma, medical supply and other industries. Alerts, and temperature logs, can be checked at customized intervals and synced by mobile phones nearby who have the app installed and uploaded to the cloud automatically, right until the point of delivery. The app creates the big data analytics real-time tracking loop.
Processes and Activities and Technologies	By replacing proprietary hardware solutions such as RFID readers by a smartphone, inspection and data collection along the cold chain is made much more affordable, more frequent and by system usual participants. The solution now uses pervasive and ubiquitous technologies that need minimal technology deployment and investment.

Table 3 – The Relationships among the Work System Elements explained in light of the SenseGeni TEMPO Case Study.

Discussion

Through the SenseGeni TEMPO's case study, the authors have noted several important IoT implementation considerations that are a reflection of the particularities of the underlying economy. For example, unreliable meteorological forecasts, the complexity of acquiring expensive cold chain technologies, the conditions of the commercial fleets and their maintenance as well as traffic and transportation conditions (especially in rural areas) are all traits that characterize most developing countries and hence should be considered while implementing IoT.

One should not also overlook the significance of the human resource element. Since these are an integral part of the ecosystem. The case study shows how the IoT implementation model was developed to avoid any miss-manipulation or tampering (whether arising from lack of training, or intentional) with data to generate first hand reliable information. In sum, the solution was developed to allow a minimal human intervention.

With progressively blurred physical, social and temporal boundaries, which is the case of the Internet of things (IoT) technologies, the Work System Framework represents a clear and a straight forward method to understand where opportunities for businesses lie specially in particular context such as developing countries.

The case study revealed the complexity of the relationships that exist between innovative service system elements. The explicative elements in Alter's Service Innovation System (2008a) have served to formulate IoT implementation strategies, environmental conditions and underlying infrastructures. Put together they help understand how the IoT solution is designed, for which purpose and to meet with which conditions. The identification of the different customer groups as well as their distinct requirements and needs, will shape the service's features and metrics. These in turn will influence how the processes and activities are conducted.

Conclusion

The work system framework is well adapted to explain advanced technology implementation considerations. It provides a rigorous but non-technical approach that any manager or business professional can use to consider a particular technology's use case. It allows to decompose and analyse at the system element level and to show relationships with other work system elements. The effects of the boundary work system elements, namely, the strategy, the environment and the infrastructure, on the IoT implementations and adoption models are numerous and significant.

The authors have shown how interrelated system elements illuminate important aspects of IoT Implementations. Individually or in combination, these elements can help in describing, analyzing, and researching the nature of implementation innovations and the processes through which service innovation occurs.

Differences, sometimes substantial, in the IoT implementation model and applications depend on many factors and elements. The particular context of developing countries could be considered sometimes as enabling and in other situations as inhibiting the adoption of the IoT implementation. To explain such pre-dispositions it is useful to consider all system elements including environment and infrastructure.

In this paper we have focused on the environment and the work system infrastructure as two decisive work system elements to highlight the particular settings of developing countries in our particular IoT case study. This in itself could be considered as a study imitation since we did not expand our analysis to consider other work system elements. For instance, deeper analysis and formulation of customer segments, needs and behaviour could have helped figure out other implementation models. Therefore, in order to be rigorous, we propose to take this study further and analyse as we did with the environment and infrastructure other system elements from a holistic standpoint.

References

Alter, S. (2008a). Defining Information Systems As Work Systems: Implications For The IS Field. *European Journal of Information Systems*, *17*(5), 448-469.

Alter, S. (2008b). Service System Innovation. In *Information Technology In The Service Economy: Challenges And Possibilities For The 21st Century* (pp. 61-80). Springer US.

Alter, S. (2013). Work System Theory: Overview Of Core Concepts, Extensions, And Challenges For The Future. *Journal of the Association for Information Systems*, 72.

Cisco, C. V. N. I. (2015). Global Mobile Data Traffic Forecast Update, 2014–2019. *white paper*.

Ghose, A., & Han, S. P. (2011). An Empirical Analysis Of User Content Generation And Usage Behavior On The Mobile Internet. *Management Science*, *57*(9), 1671-1691.,"

Gruman, G. (2014). Mobile's Gift To The World: In Poor Countries, It's Life Changing. Info world, december, http://www.infoworld.com/article/2855602/mobile-technology/mobiles-gift-to-the-world-in-poor-countries-its-life-changing.html, website, retrieved 2 september 2015.

GSMA, (2014). Understanding The Internet Of Things, GSM Association, July.

Hossain, M. (2015). M2M In Developing Countries. *Proceedings of the 7th CMI conference on mobile communications in developing countries*, 17-18 November, Copenhagen, Denmark.

IDC, (2014) *A Future Fuelled By Phablets - Worldwide Phablet Shipments To Surpass Portable PCs In 2014 And Tablets By 2015, According To IDC*, Framingham, Massachusetts, 2014.

Khisty, C. J. (1993). *Transportation In Developing Countries: Obvious Problems, Possible Solutions* (No. 1396).

Lindgren, R., Andersson, M., & Henfridsson, O. (2008). Multi-Contextuality In Boundary-Spanning Practices. *Information Systems Journal*, *18*(6), 641-661.

Lyytinen, K. J., Yoo, Y., Varshney, U., Ackerman, M., Davis, G., Avital, M., ... & Sorensen, C. (2004). Surfing The Next Wave: Design And Implementation Challenges Of Ubiquitous Computing. *Communications of the Association for information systems*, *13*(1), 40.

Lyytinen, K., & Yoo, Y. (2002). Research Commentary: The Next Wave Of Nomadic Computing. *Information systems research*, *13*(4), 377-388.

Manyika, J., Chui, M., Bisson, P., Woetzel, J., Dobbs, R., Bughin, J., and Aharon, d. (2015). The Internet Of Things: Mapping The Value Beyond The Hype. *Mckinsey report*. June, McKinsey Global Institute.

Moore, James F. (1996). *The Death of Competition: Leadership & Strategy in the Age of Business Ecosystems*. New York: Harper Business.

Ogallo, L., Bessemoulin, P., Ceron, J. P., Mason, S., & Connor, S. J. (2008). Adapting To Climate Variability And Change: The Climate Outlook Forum Process. *Bulletin of the World Meteorological Organization*, *57*(2), 93-102.

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits Make Smartphone Use More Pervasive. *Personal and Ubiquitous Computing*, *16*(1), 105-114.

Paswan, A., D'Souza, D., & Zolfagharian, M. A. (2009). Toward a contextually anchored service innovation typology. *Decision Sciences*, *40*(3), 513-540.

Prestero, t. (2014). Emerging Markets And The Internet Of Things: Why Devices Designed For High-Income Countries Don’t Work And What To Do About It. *Proceedings of the SOLID conference*, 21-24 may, San Francisco.

Reuters. (2014). Africa Fast Off Blocks In Adopting Internet Of Things – industry group, reuters industries, november, http://www.reuters.com/article/2014/11/06/africa-tech-idusl6n0sw5o920141106, website, retrieved 30 august 2015.

Sharma, D. (2015). The Vast Implications Of The Networked Economy. Technology, 24 march, http://techonomy.com/2015/03/the-vast-implications-of-the-networked-economy/, website, retrieved 25 august 2015.

Williams, C. (2014). Value Of Connectivity. Deloitte, http://www2.deloitte.com/content/dam/deloitte/uk/documents/technology-media-telecommunications/deloitte-uk-tmt-value-of-connectivity-tmt.pdf, website, retrieved 26 august 2015.

Yin, R. K. *Case Study Research: Design And Methods*, 2009, Sage.