Journal of International Technology and Information Management

Volume 28 | Issue 3 Article 5

2019

Mobile IoT adoption as antecedent to Care-Service Efficiency and Improvement: Empirical study in Healthcare-context

Samyadip Chakraborty
IBS Hyderabad, samyadip@ibsindia.org

Vaidik Bhatt
IBS Hyderabad, vaidik.bhatt@ibsindia.org

Mobile IoT Adoption as Antecedent to Care-Service Efficiency and Improvement: Empirical Study in Healthcare-Context

Samyadip Chakraborty
Vaidik Bhatt

Department of Operations & IT,
ICFAI Business School (IBS), Hyderabad,
The ICFAI Foundation for Higher Education (IFHE) (Deemed to be university u/s 3 of the UGC act 1956)

ABSTRACT

Internet of things (IoT) is the buzzword and pioneering breakthrough approach highlighted in today's industry 4.0, where the devices are seamlessly integrated with each other, sharing vital information in real-time sync. With the wearable IoT devices, the diagnostic readings and physical measurements of the patients can be shared with the physician on the go and suitable diagnosis can as well be shared with patient in the real-time on their own mobile devices through IoT applications. This study empirically examines the importance of m-IoT adoption on the information pervasiveness across the network and patient stakeholders and in turn investigating how efficiency of healthcare services and care process improvement got affected. Study outcomes based on 221 completed responses from the healthcare professionals concludes that, m-IoT adoption opens new opportunities and challenges with the process innovation in the healthcare services and increases the efficiency of services.

Keywords: Mobile IoT, Service Efficiency, Service Improvement, Healthcare, Information Pervasiveness

INTRODUCTION

The field of healthcare is one of the most highlighted and evolving sector in the current societal perspective. Immense pressure to provide superior quality of care service in synchronized perspective and also in real-time aspect on the go has led the sector leaders to introduce and practice varied digital platforms and tools connecting the disparate healthcare stakeholders, predominantly, physicians, doctors and care giving staff. IoT (Internet of things) platform and its adoption has attracted a lot of attention and found mention in terms of usage and immense utility in today's dynamic and changing business sector. Though healthcare sector was not among the early movers to adopt IoT, however quest towards superior healthcare efficiency at affordable pricing and ensuring utmost technological integrity and connectivity have led the healthcare sector embrace IoT on a large scale and it has become the need of the hour. IoT has been changing the industry dynamics with its tremendous capabilities of connecting and integrating the devices since its inception over the last decade and become the stepping stone to industry 4.0 (Gudwani et al., 2012), characterized by capabilities of orchestration often in wireless modes (Darwish et al., 2019). Most technology driven sectors have already invested highly in IoT platforms and healthcare sector has rather proved to be a late entrant in the arena of tech-adoption, but the annualized growth rate of adoption and integration of IoT enabled devices and platforms for healthcare service delivery on app-enabled platforms and even in physical hospital setups are pretty steep and impressively high.

The need for synchronized, efficient, on-time and on the go care delivery prompted major healthcare service players to rely on IoT platforms; connected to devices having superior capabilities of data collection and synchronized decision-making in more effective, fast and error free manner (Laplante and Laplante, 2016). Industry expert reviews and surveys by McKinsey & Company has highlighted and predicted IoT having a bright future and manifold increase in the investment for IoT in the coming decade (Manikya et al., 2016). Though isolated white-papers and case-based practitioners literature exist, a consolidated framework and empirical validation regarding how IoT adoption is perceived and how its adoption has impacted care-service efficiency and improvement in patient care delivery remains largely theoretical and case-driven rather than being validated based on large-scale empirical outcomes.

In the current healthcare sector context, marked by stringent Government regulations, extremely critical and high patient expectations and neck to neck competition among care service providers characterized by wafer thin margin and even medical third party payer driven pressure, every patient and care-receiving stakeholder expect high quality of healthcare services at affordable cost and wishes to stay connected on the go through benefits of synchronous care service and care connectivity seamlessly across platforms, especially through wearables and mobile hand-held devices. IoT-enabled platforms offer silver-lining towards fulfilling this dream of high quality of healthcare-services at pocket-friendly expense (Karahoca et al., 2018; Qi et al., 2017).

With increase in sensor-enabled devices, a higher level of patient monitoring can be observed and also physicians and care-providers can stay connected and diagnose on the go; thereby enhancing efficiency of service delivery and reduced chances of service interruptions and cancellations and further expected to bolster care-delivery integrity, marked by fewer check-ups and unnecessary appointments with the doctor.

The main objective of the study is to address how mobile-IoT (m-IoT i.e. wearables) adoption is affecting care-service efficiency and subsequent improvement in care delivery. This paper aims at empirically establishing m-IoT adoption as antecedent to care delivery consequences.

LITERATURE REVIEW

The review section is segregated as theoretical component with underpinnings and subsequently discusses the construct specific extant literature linkages.

Cybernetic Control Theory

Cybernetic control theory provides a view on how the digital assets (m-IoT as depicted in the study) offers a method by which managers can successfully built their various strategies and authoritative capabilities (Vancouver, 1996). Cybernetic control theory undergoes on the idea of getting a timely feedback, breaking down the deviations from the expectations and taking important choices to address the deviations (Green and Welsh, 1988). With this theory, the advanced digital assets like m IoT provide means by which institutions can catch, process and convey ongoing real time data and information in order to increase integration and coordination in the system. This technology encourages the improvement in quality and agility of the entire process.

Temporal Displacement of Care

Data Technology and Analytics passed through the data innovation are significant for human services. When IT and analytics combines, it creates the value. With the help of the technology, real time data can be obtained (Yerpude and Singhal, 2018). Real time data can displace the time where physician and patients make their interactions. This displacement of the time is called as temporal displacement of time and better outcome can be obtained with cost reduction (Thompson et al., 2019). Also, organization can create the value from analysing the events as an when it takes place (Lee and Tang, 1997).

Internet of Things (IoT)

IoT (Internet of things)is a platform which connects and synchronizes the different computer-technology enabled devices in a synchronous interaction platform. IoT is a term which is comprehensively utilized (Wortmann and Flüchter, 2015) and a basic standardized definition however remains largely lacking. In an acceptable terminology, IoT can be defined as "a system of gadgets, for example, vehicles, home machines, hardware, programming, sensors, actuators which create the transaction and interaction interfaces, and help to collaborate and sync in information with several linked components" (Lom et al.,2016). Diazet et al., (2016) has characterized IoT as "set of the interconnected things over the web, which can quantify, convey, and act everywhere throughout the world." ThusIoT is a stepping stone to industry 4.0 because of its ability and potential to change existing business processes (Dutton, 2014).

IoT is also useful for the forecasting of an event, as data generated and transmitted by the sensors are accurate and analysed without any manipulation (Yerpude and Singhal, 2017). CISCO revealed enormous development in IoT and its application to the business networks by 2023 (Bradley et al., 2015). There are modest savvy sensors utilized in different spaces like home, coordination's, plant computerization, and so on… which creates immense information and speak with one another by trading the information (Ju et al., 2016).

Because of IoT's capacities of higher productivity, viability, security, and basic leadership utilizing free interchanges between traditional gadgets, it is seen as an outlook changing thought. With the assistance of IoT gadgets are flawlessly coordinated, interconnected, and discussed over the conditions and physical articles (Atzori et al., 2010). With the unavoidable collaboration, things cooperate and arrive at a shared objective with cutting edge administrations. (Atzori et al., 2010; Lee, 2000). According to Gupta and Hridesh (2007) Things and system both turned out to be increasingly important when associated and collaborated with one another.

IoT use in Hospital

With the tremendous capabilities of IoT linked wearable devices, patient can measure many physiological measurements like Heartbeat, Blood Pressure, Body temperature, Exercise, Calorie burnt etc. Modern and newly developed IoT devices also measures sleep cycle and gives the indication for Rapid Eye Movement (REM) Sleep and deep sleep. With the help of the wearable IoT devices, patient can

monitor physiological symptoms which give the access to the personal attention to the patient. IoT is also helpful for the elderly patients who are living alone. With the fluctuation in physiology of patient, IoT devices trigger alarms and send notification to connected platforms to family members of the patient.
Apart from measuring the individual patient's health, it is also useful for the hospitals. IoT can create the well-orchestrated platform for monitoring the hospital's internal operations also (Chakraborty et al., 2019).IoT enabled patient hygiene monitoring system helps in preventing the patients from the micro bacterial infections in the hospitals. Hospitals can widely use IoT systems for pharmaceutical product management, surgical equipments management, patient waiting queue management, Patient Health and Readmission rate monitoring etc. IoT are the self-regulatorysystem, and generates a negative feedback loopit can be used to monitor and control the environmental temperature and humidity in Intensive Care Units (ICU), and Intensive Critical Care Unit (ICCU).

In hospitals, IoT is used not only for keeping patients' life safe, but also used to provide better care-delivery with remote monitoring using smart sensors. With the help of integrated IoT devices commercial healthcare organization can deliver care topatient with enhanced engagement and satisfaction,as patient can spend more time with physicians and medical expert through online and synchronous technology mediation; aptly referred to as the displacement of time conjugated by intervention of patient–physician interactions (Ghani, 2019).Thus through well-integrated IoT platforms, hospital can increase their flexibility and agility of extending commercial healthcare service delivery as providers, as all the information are seamlessly transporting to and fro from different types of devices and administrator as well as doctors know the location of staff, equipment and medicines on real-time basis. These practices thusadd value to the care providing systems by quicker responses, treatment-time-optimizations and acts as defences against over-crowding of the hospital (Chakraborty et al., 2019).

Information Pervasiveness

Information pervasiveness emphasizes on the transparent information flow. With the help of the sensors in the IoT devices, accurate information can be transformed on the real time basis, to the physician, where with the prior algorithmic programming, with the accurate and reliable data, physician can suggest suitable treatment to the patient (Chakraborty et al., 2014; Prahalad and Ramaswamy, 2004). Information Pervasiveness in the current study context has been defined as an extent to which network actors in healthcare supply chain reveal their true motivations, goals and agenda through regular exchange and update relevant information regarding vital business aspects. (Chakraborty et al., 2014; Prahalad and Ramaswamy, 2004 ; Lamming et al., 2005). The study focuses on the physician and patient, however, hospital administrator, pharmacist and other medical and paramedical staff also get the relevant information as per their work profile.

Care Service Efficiency

Efficiency means the effectiveness with the minimization of the cost. With the help of the sensors in IoT, accurate and real time information being transmitted and due to the transmitted information, physician can accurately analyse and monitor the disease and patient's health condition and prescribe the course of medicine as per the same. On the other end, IoT will increase the monitoring; decreasing the unnecessary appointments and lab tests, thus, reduction in a cost can be achieved. Care Service Efficiency refers to the extent to which hospital achieves high quality of services at the minimal cost in the process of patient care (Nyaga et al., 2010).

Care Service Improvement

With the help of sensors, normal routines of hospitals can be changed. Patients do not have to come physically for the check up and follow up. There will be no unnecessary visits of the patients. Physician can treat the patient with the help of the ICT technology. Process Improvement refers to the extent to which daily routine process are improvised based on new knowledge and innovation (Yoon et al., 2011).

HYPOTHESES DEVELOPMENT

Linking m- IoT adoption to Information Pervasiveness

With the increase in sensor based IoT technology used for the healthcare in the hospital set up or in the personal setup by wearable IoT devices, it brings the real time monitoring. IT systems have the immense capabilities to share and transfer the data irrespective of the place, time and formats (Bharadwaj, 2000). With increase in adoption of mobile IoT, more data about the patient can be transferred to the physician in order to generate the real-time monitoring systems (Chakraborty et al., 2019). Also, m-IoT will disrupt the traditional healthcare systems, where there is a scarcity of accurate medical data of the patient. So it can be hypothesized that:

Hypothesis 1: m-IoT adoption positively impacts the information pervasiveness

Linking Information Pervasiveness to Care Service Efficiency

With the help of pervasive information, input cost can be reduced with the much more exiting user experience without much efforts. On the other side, users are benefited from the context and data sharing (Hong et al., 2005). Continues information sharing of the physiological data with the physician, will be helpful in treatment time optimization as doctors can get the regular updates of the patient. On the other end, patient's visit to the hospitals for the follow ups also reduces with the continuous and real-time information sharing with the doctors (Zois, 2016); thereby offering more time for doctors to treat newer patients and efficiently complete the care service of the existing patients. So, it can be hypothesized that:

Hypothesis 2: Information pervasiveness positively increases the care service efficiency

Linking Information Pervasiveness to Care Process Improvement

With the pervasive computing and information systems, information about the locations, software agents, user, devices and their relationship can be defined (Gu et al., 2004). A pervasive healthcare system seeks to respond to the verity of pressure in the healthcare service systems, including the chronic, acute and life style diseases. It shows that there is a high potential for pervasive information in the care process improvement (Kitsios et al., 2009). Apart from the patient monitoring and disease management, pervasive information also assists in improvement of the process of other administration related tasks as enhanced clarity and unambiguous decisions can easily be made (Bohn et al., 2004). So it can be hypothesized that:

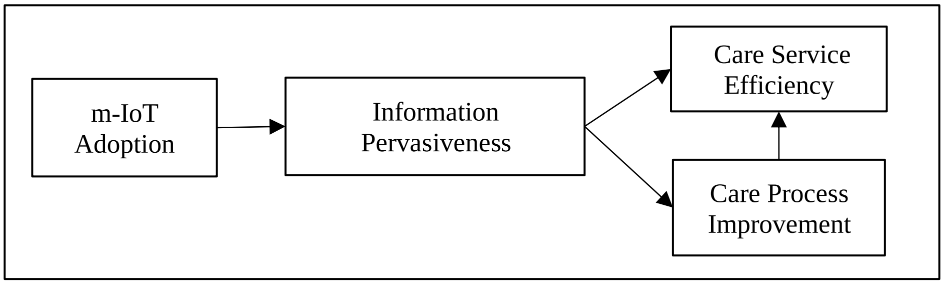
Hypothesis 3: Information Pervasiveness positively increases the care process improvement

Linking Care Process Improvement to Care Service Efficiency

When the innovation in the process properly implemented with the continuous improvement in the process, the streamlining of the work will take place with the with the improve in the quality, decrease in the cost and increase in the customer satisfaction (Larson, 1998). With resigned and the improved process, patient room turnover time and the cost also decreases, as most of the physiological information already transmitted to the doctor. So it can be hypothesized that:

Hypothesis 4: care service improvement will positively increase the care service efficiency

Figure 1 – Proposed Model



RESEARCH METHODOLOGY

Data Collection and Sample Demographics

As examination intended to survey effects of m-IoT adoption on the process improvement and efficiency of care service foundations, the assessment expected to meld specialists, administrators, and other helpful staff for supporting the proposed relationship. The review developed a database of crisis facilities and specialists'across the country, concentrating on the urban regions. Online data-baseis created using the information and respective hospital website provided details of the doctor with the address and area of consultancy. Identical information collected from online websites like Sehat.com and Practo.com are used for validation. Contacts were further cross-confirmed through checking on the web interfaces. The assessment and validation was filtered with the criteria that the professional should have minimum of two years of work experience in their specific fields.

An email containing the initial request letter with survey questionnaire for participating in the survey-study was sent to 1289 contacts, trailed by two reminders as updates. The basic letter exhibited the, characterization affirmation, which means of basic terms related with the assessment and the inspiration driving the survey. The survey returned 221 completed responses after validating the authenticity of the proposed affiliations. Table 1 shows the demographic profiles of the respondents in terms of Age, year of experience and area of expertise.

Table 1 - Respondent Demographics (In the Table)

	No.	Percentage
Age		
Less than 35 Years	28	12.6
35 – 45 Years	78	35.2
50 – 60 Years	87	39.3
60 years and above	28	12.6
Experience		
Less than 5 Years	25	11.31
5 – 8 Years	85	38.46
8 – 12 Years	79	35.74
12 years and above	32	14.47
Specialization		
Cardiologist	52	23.5
Diabetologist	58	26.2
Nutritionist	31	14.0
Internal Medicines	34	15.3
Others	46	20.8

Measures

The study involves four constructs. The measures for all the four constructs were chosen based on established scales from extant literature and adapted to the context for usage in this assessment. The assessment went through stages: pre-pilot study, pilot study and final large-scale examination. The pre-pilot study was through focused group study based examination and assessment. A common meeting for experts and investigators (10 professionals and 4 researchers) were organized and based on their advice and prescribed suggestions changes in the measurement items of the constructs for the assessment were done. Subsequently based on the suggested outcomes from the experts after pre-testing, pilot study was carried out using 6 experts through sets of 2 experts in each round till all the Q-sort measures of raw agreement score, Cohen's Kappa and inter-rater reliability values were above 0.9.

Such procedure and techniques ensured rigour of the investigation. With such experienced respondents as pre-test individuals; the pre-test score ensured the estimation things have enough faceauthenticity. An exploratory factor analysis was moreover conducted with the final large scale study responses.The entireset of item loadings were found to stack on expected factors after the exploratory factor assessment results was gained using SPSS 20 software using varimax rotation; further adding to the proof of concept, ensuring thatthe constructs and the measures can be utilized for theory testing. Each construct had three to four items and the responses were captured using scales that were assessed on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).Care service efficiency has 3 items whereas; all the other constructs have 4 items. The measurements are given in Table: 2.

Non-response Bias

The assessment of nonresponse bias was tested based on early and late wave of respondents (Armstrong and Overton, 1977). No Significant difference was recognized among the responces. The test used was Mann–Whitney U-test. It was performed for the two waves of responses and the results revealed no significant differences ($p>0.05$); thereby suggesting non-appearance of any major non-response bias.

Common Method Bias

Investigation of Hermann's single factor trial estimation technique was performed, which indicated 4 clear factors with eigen value > 1. 40 percent variance was observed for the main factor (Flynn, et al., 2010). Next, a supportive factor assessment using Harman's single-factor showed no single factor explained more than 50% of variance; thereby suggesting absence of single factor and thus meeting the standard procedure and expected outcome.

Table 2 - Construct, Definition and Measurement Items

Construct	Definition	Measurement (Items)	References
m- IoT Adoption	m- IoT adoption is an extent to which a hospital is using the integrated and orchestrated systems for monitoring the internal and	• Our hospital is using IoT devices to obtain real-time data • Our hospital is using IoT devices to increase the mobility	Gosink et al., (2019), Chakraborty et al.,)2019)

	external resources for the said purposes	• Our hospital is using IoT for the patient reporting • Our hospital is using IoT devices for the remote Patient Monitoring	
Information Pervasiveness	Information Pervasiveness can be defined as an extent to which network actors in healthcare supply chain reveal their true motivations, goals and agenda through regular exchange and update relevant information regarding vital business aspects	• Our hospital clarifies the principle supplier(s) about hospital's true motivations, goal and agenda • Our hospital clarifies the principle supplier(s) about hospital's strategies and economic situation • Our hospital clarifies the principle supplier(s) about hospital's policies • Our hospital clarifies the principle supplier(s) about hospital's technical skills	Prahalad and Ramaswamy (2004), Lamming et al., (2005)
Care Process Improvement	Process Improvement refers to the extent to which daily routine process are improvised based on new	• Our hospital Pursues continuers innovation in core process • Out hospital Focuses on innovation to reduce cost	Yoon et al., (2011)

	knowledge and innovation	• Our hospital pursues effectiveness in process	
Care Service Efficiency	Care Service Efficiency refers to the extent to which hospital achieves high quality of services at the minimal cost in the process of patient care	• Our hospital has achieved reduction in patient care cycle time • Our hospital has achieved accuracy in patient service (Care) processing • Our hospital has achieved improved on time delivery of patient service • Our hospital has reduced cost for providing the services with high quality	Nyaga et al., (2010)

RESULT AND ANALYSIS

Measurement Model

Each latent variable (construct) was measured by multiple measurement items, which is described in Table 2. The rational flow of the study was as follows.

a. Questionnaire development based on extensive literature review
b. Adaption of measurement items within the research context and establishment of the scale for better understanding of the construct
c. Q – sort methodology, for removal of unwanted or irrelevant item / scale
d. Construct wise Exploratory Factor Analysis conducted and reliability checked by measuring the value of Cronbach's alpha
e. Confirmatory Factor Analysis was performed to confirm the measurement model
f. Path analysis of Structural Equation Modelling (SEM) was performed o test the hypotheses

The questionnaire were responded by the hospital side from the medical and paramedical staff, which was measured on the 7 point Likert scale with 1 = Strongly disagree and 7 = Strongly agree. Convergent, Discriminant validity and reliability has been checked (Table 3 and Table 4). While convergent validity highlights items which are expected to be related are actually related, whereas discriminant validity highlights the independence of the dimensions. The outcome of the EFA shows that, all the items loaded on their respective factors with the item loading of more than 0.70.

From table 3 and table 4, it is observed that, AVE for each of the constructs is higher than the square of the inter-construct correlation, which indicates the items of the construct, is significantly different from the items of the other constructs; thereby indicating for the discriminant validity. Construct reliability also assessed with the Cronbach's alpha, and the values calculated are >0.70, which can be considered as accepted.

Table 3: AVE, Composite reliability, and Cronbach's alpha

CONSTRUCT	**Item no.**	**Item Loadings**	**Composite reliability**	**AVE**	**Cronbach's Alpha**
m-IoT adoption	4	0.861 0.827 0.809 0.793	0.871	0.75	0.869
Information Pervasiveness	4	0.878 0.828 0.799 0.712	0.907	0.69	0.883
Care Process Improvement	3	0.824 0.792 0.841	0.845	0.53	0.821
Care Service Efficiency	4	0.912 0.856 0.719 0.611	0.893	0.74	0.887

Table 4: Discriminant validity

Constructs	m-IoT adoption	Information Pervasiveness	Care Process Improvement	Care Service Efficiency
m-IoT adoption	**0.75**			
Information Pervasiveness	0.02	**0.69**		
Care Process Improvement	0.12	0.17	**0.53**	
Care Service Efficiency	0.09	0.03	0.02	**0.74**

As, a part of SEM, Confirmatory Factor Analysis (CFA) has been performed, to verify the measurement model. And overall fit was measured, which indicates the acceptability of the model. with all the factor loadings significant, the model indicates the convergent validity among the items and the constructs with an indication of model fit.

The path model is analysed, which shows three out of four hypotheses supported with the high significance. The structural model is combined with the measurement model (Figure 1), and the model fir is indicated.

Table 5: Structural model: SEM results for direct effects

Relationships	Coefficient	t-value	Remark/status
M-IoT Adoption→Information Pervasiveness	0.423	3.218	Supported
Information Pervasiveness →Care Service Efficiency	***-0.066***	***0.647***	***Not supported***
Information Pervasiveness → Care Process Improvement	0.376	3.702	Supported
Care Process Improvement → Care Service Efficiency	0.288	2.654	Supported
Model fit indices: CMIN/DF=2.351, GFI=0.901, IFI=0.928, TLI-0.914, RMSEA=0.05			

Hypothesis 1, Supported**:** H1 proposed a positive relationship between the m-IoT adoption and information pervasiveness, which is supported at $p<0.05$, $t=3.218$.
Hypothesis 2, Not Supported**:** H2 proposed a positive relationship between the Information Pervasiveness and Care Service Efficiency, which is not supported, $t=0.647$
Hypothesis 3, Supported**:** H3 proposed a positive relationship between the Information Pervasiveness and Process improvement, which is supported at $p<0.05$, $t=3.702$
Hypothesis 4, Supported**:**H4 proposed a positive relationship between the Care Process improvement and Care Service Efficiency, which is supported at $p<0.05$, $t=2.654$
These results are summarized in Table 5

DISCUSSION AND CONSLUSION

IoT is very vital in the current context of the healthcare services. More learned patients are aware of their rights and responsibility towards their own good health. On the other end, patientsneeds high quality of healthcare services with the lower cost with the maximum participation in the process. Patients wants to be in the constant touch with their physician. In the competing sector of healthcare, where best doctors are clustered in the urban area, patient demands for the best services from their specialists, which motivated the hospital administrators to use new and state of the art technology for providing the efficient healthcare services. The study outcomes validate a fact that m-IoT adoption for the care services will increase the efficiency in the process of care. The empirical evidences taken from the hospital administrators confirm the proposed outcomes.

Three out of four hypotheses have been significantly accepted, which shows the positive relationship between m-IoT adoption, Information Pervasiveness, Care process improvement and Care service efficiency. One hypothesis for the positive relationship between Information Pervasiveness and Care service efficiency did not support, which suggests that, only with the pervasive information only, the outcome of the efficient healthcare cannot be achieved. For an efficient healthcare, only the pervasive information is not important, as the information is alone of no use, if the proper steps not taken on the policy designing and at the implementation stage. Thus, the study outcomes emphasized that m-IoT adoption leads to the efficient healthcare, besides reducing the cost of healthcare with increased patient satisfaction; thereby adding to the servicing capacity of the hospitals and fostering continuous innovation and effectiveness of the health service organization. Hospital can be future ready with the more readiness to serve the patient in various types of acute and chronic disease.

Thus, the study validates and provides the important managerial implications as the outcome of the study highlights the importance of m-IoT adoption in healthcare service sector and empirically validates the to the fact that, organizations which has adopted m-IoT and motivating patients also to use the wearable devices has more transparency in the information from the patient side as well as, more information for their internal operations.

This study has immense managerial as well as the research implications. From the theoretical perspective, the study aims to the understanding of how m-IoT adoption leads to the superior and efficient care service. From the business point of view also, study gives a pivotal motivation to the business managers with an understanding of whether they have to shift from their traditional practices to the new and state of art practices in their organization or not. The study highlights how m-IoT adoption in the healthcare sector increases the efficiency of the service provided.

LIMITATION AND FUTURE RESEARCH

Like any other study, this study also suffers on the issue of generalizability as the focus of the study is limited to the healthcare sector only. Moreover, the study has a perception based cross sectional methodology, the time series study has not be performed. It may be the case that, adoption of m-IoT is a time dependent event and after some time, because of the change in the external factors, the adoption of IoT might have a different perceptual indication. These factors might affect the outcomes of the study. However, precaution was taken towards the common and non-response bias.

The future scope lies in further analysis of the adoption and implementation of m-IoT in the healthcare sector, with the advancement in the technology, maturity of the technology and stage of implementation of the technology with the time series model to understand the perception of the respondents.

However, despite of its limitation, the study opens up new horizons to research, academia and managerial field for assessing the health service sectors' efficiency in providing the better healthcare. The study also suggests that, adoption of newer and state of the art technology in healthcare service sector context can play an important and pivotal role towards the superior and efficient care delivery.

REFERENCES

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. Journal of marketing research, 14(3), 396-402.

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer networks*, *54*(15), 2787-2805.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS quarterly, 169-196.

Bohn, J., Gärtner, F., & Vogt, H. (2004). Dependability issues of pervasive computing in a healthcare environment. In Security in Pervasive Computing (pp. 53-70). Springer, Berlin, Heidelberg.

Bradley, D., Russell, D., Ferguson, I., Isaacs, J., MacLeod, A., & White, R. (2015). The Internet of Things–The future or the end of mechatronics. *Mechatronics*, *27*, 57-74.

Chakraborty S., Bhatt V., Chakravotry T. (2019). Impact of IoT adoption on flexibility and agility of healthcare organization. International Journal of Innovative Technology and Exploring Engineering (IJITEE). 8(11), 2673 – 2681.

Chakraborty, S., Bhattacharya, S., &Dobrzykowski, D. D. (2014). Impact of supply chain collaboration on value co-creation and firm performance: a healthcare service sector perspective. Procedia Economics and Finance, 11, 676-694.

Darwish, A., Hassanien, A. E., Elhoseny, M., Sangaiah, A. K., & Muhammad, K. (2019). The impact of the hybrid platform of internet of things and cloud computing on healthcare systems: Opportunities, challenges, and open problems. *Journal of Ambient Intelligence and Humanized Computing*, *10*(10), 4151-4166.

Díaz, M., Martín, C., & Rubio, B. (2016). State-of-the-art, challenges, and open issues in the integration of Internet of things and cloud computing. *Journal of Network and Computer applications*, *67*, 99-117.

Dutton, W. (2014). Putting things to work: social and policy challenges for the Internet of things. *info*, *16*(3), 1-21.

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of operations management, 28(1), 58-71.

Ghani, A. (2019). Healthcare electronics—A step closer to future smart cities. *ICT Express*, *5*(4), 256-260.

Gosink, L. J., Burtner, E. R., Obradovich, J. H., & Dowson, S. T. (2019). *U.S. Patent No. 10,497,071*. Washington, DC: U.S. Patent and Trademark Office.

Green, S. G., & Welsh, M. A. (1988). Cybernetics and dependence: Reframing the control concept. *Academy of Management Review*, *13*(2), 287-301.

Gu, T., Wang, X. H., Pung, H. K., & Zhang, D. Q. (2004, January). An ontology-based context model in intelligent environments. In Proceedings of communication networks and distributed systems modeling and simulation conference (Vol. 2004, pp. 270-275).

Gudwani, A., Mitra, P., Puri, A., & Vaidya, M. (2012). India Healthcare: Inspiring possibilities, challenging journey. *India: Mckinsey & Company*.

Gupta, S., and A. Hirdesh, "Overview of m2m," tech. rep., University of Florida, 2007

Hong, D., Chiu, D. K., & Shen, V. Y. (2005, August). Requirements elicitation for the design of context-aware applications in a ubiquitous environment. In Proceedings of the 7th international conference on Electronic commerce (pp. 590-596). ACM.

Ju, J., Kim, M. S., &Ahn, J. H. (2016). Prototyping business models for IoT service. *Procedia Computer Science*, *91*, 882-890.

Karahoca, A., Karahoca, D., &Aksöz, M. (2018). Examining intention to adopt to internet of things in healthcare technology products. Kybernetes, 47(4), 742-770.

Kitsios, F. C., Angelopoulos, S. P., &Zannetopoulos, J. (2009). Innovation and e-government: an in depth overview on e-services. In Handbook of Research on Heterogeneous Next Generation Networking: Innovations and Platforms (pp. 415-426). IGI Global.

Lamming, R., Caldwell, N., Phillips, W., & Harrison, D. (2005). Sharing Sensitive Information in Supply Relationships:: The Flaws in One-way Open-book Negotiation and the Need for Transparency. European Management Journal, 23(5), 554-563.

Laplante, P. A., &Laplante, N. (2016). The internet of things in healthcare: Potential applications and challenges. *It Professional*, *18*(3), 2-4.

Larson, C. A. (1998). Customers first: Using process improvement to improve service quality and efficiency. Reference Services Review, 26(1), 51-60.

Lee, H. L. (2000). Creating value through supply chain integration. *Supply chain management review*, *4*(4), 30-36.

Lee, H. L., & Tang, C. S. (1997). Modelling the costs and benefits of delayed product differentiation. Management science, 43(1), 40-53.

Lom M, Pribyl O, Svitek M. Industry 4.0 as a part of smart cities. In2016 Smart Cities Symposium Prague (SCSP) 2016 May 26 (pp. 1-6). IEEE.

Manyika, J., Chui, M., Bisson, P., Woetzel, J., Dobbs, R., &Ahua, D. (2016). Unlocking the Potential of the Internet-of-Things. McKinsey Global Instititute.

Nyaga, G. N., Whipple, J. M., & Lynch, D. F. (2010). Examining supply chain relationships: do buyer and supplier perspectives on collaborative relationships differ?. Journal of operations management, 28(2), 101-114.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. Journal of interactive marketing, 18(3), 5-14.

Qi, J., Yang, P., Min, G., Amft, O., Dong, F., & Xu, L. (2017). Advanced internet of things for personalised healthcare systems: A survey. *Pervasive and Mobile Computing*, *41*, 132-149.

Thompson, S., Whitaker, J., Kohli, R., & Jones, C. (2019). Chronic Disease Management: How IT and Analytics Create Healthcare Value Through the Temporal Displacement of Care. *MIS Quarterly, Forthcoming.*

Vancouver, J.B. (1996), "Living systems theory as a paradigm for organizational behavior: understanding humans, organizations, and social processes", Behavioral Science, Vol. 41 No. 3, pp. 165-204.

Wortmann, F., &Flüchter, K. (2015). Internet of things. Business & Information Systems Engineering, 57 (3), 221-224.

Yerpude, S., & Singhal, T. K. (2017). Impact of internet of things (IoT) data on demand forecasting. *Indian Journal of Science and Technology*, *10*(15), 1-5.

Yerpude, S., & Singhal, T. K. (2018). Internet of Things based Customer Relationship Management–A Research Perspective. International Journal of Engineering & Technology, 7(2.7), 444-450.

S. Yoon, W. Ye, J. S. Heidemann, B. Littlefield, and C. Shahabi, "Swats: Wireless sensor networks for steamflood and waterflood pipeline monitoring," IEEE Network, vol. 25, no. 1, pp. 50–56, 2011

Zois, D. S. (2016, December). Sequential decision-making in healthcare IoT: Real-time health monitoring, treatments and interventions. In 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT) (pp. 24-29). IEEE.