ENHANCING SERVICE ENGAGEMENT AND COLLABORATIVE DECISION MAKING THROUGH WEARABLE DEVICE ADOPTION

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ABSTRACT

With the aid of IoT (Internet of Things) powered wearable sensors, it is possible to measure the pulse, blood pressure, and other body functions by the physicians in real-time. The study highlighted that use of wearable tracker eventually leads to improved health for patients through improved medical service engagement. Survey-based approach was implemented to collect primary data from 131 respondents using wearable devices. The statistics were evaluated using partial least squares-structural equation modeling (PLS-SEM) approach with smartPLS 3.0 software. The results revealed that information pervasiveness has no major effect on collaborative decision making, However, Patient-Provider interaction are found to be positively impacting collaborative decision-making. Key outcome came out to be an important finding as collaborative decisions did not exert significant impact on service engagement.

Keywords: Healthcare; Service Engagement; patient-Provider Interaction; Collaborative Decision making; Internet of Things; Information Pervasiveness; Wearable Health Devices; PLS-SEM.

INTRODUCTION

Unlike any other industry, healthcare as a promising sector is also using the technological progressions to generate competitive advantage. Healthcare transformed itself by adopting Electronic Health Record (EHR) for a patient's record-keeping and Enterprise resource planning (ERP) for enhancing efficiency in internal operations (Chakravorty et al., 2019). Now, in the era of industry 4.0, where all devices are connected seamlessly and integrated. Healthcare sector uses such tools for enhanced flexibility and agility. Sensor empowered IoT enabled wearable health device (WHD) have the enormous potentiality to disrupt healthcare services with data integration and transmission power and opens up a new era of service delivery, which is more flexible, affordable and efficient (Chakraborty & Bhatt, 2019). Wearable devices transmit the physiological data to the provider by cloud services (Rahmani et al., 2015). With integrated and real-time monitoring system provider and other medical professionals can have early intervention and reduces unnecessary patients' visit to the emergency room (*Internet Of Healthcare Things In India: Changing The Landscape*, n.d.; *Riding Technology: The Role of IoT in Healthcare Surveillance - The Economic Times*, n.d.; Thompson et al., 2020).

Most of the literature is focused based on the antecedent to the adoption of WHD. The research includes the study of the adoption models like UTAUT 2 (Talukder et al., 2020), TAM (Papa et al., 2020), TRA and TBP (Mital et al., 2018) which measures the antecedents to adopt WHD. However, mainstream literature focuses on efficiency and effectiveness of WHD for health monitoring for chronic as well as acute disease (Godinho et al., 2016; Kekade et al.,

2018). However, adoption studies did not study the outcome of adoption like better services, and the other stream of research was able to find out the result. Yet, to the best of the knowledge, no study has been performed, which includes the outcome as a service disruption.

This empirical study focuses on the patients' adoption of wearable devices and establishes a scenario of healthcare service delivery disruption. The study investigates the importance of wearable device adoption and its impact on service engagement as well as collaborative decision making. The study tries to understand and analyze the influence of patient-provider interaction and how wearable device adoption enhances patient-provider communication, collaborative decision making and ultimately leads to service engagement.

Theoretical Framework and Hypotheses Development

Emotional bonding and attachment theory

Humans tend to attach with person and objects which fulfils their need (Hudson et al., 2018). Adults are likely to make an affectionate bond with the family and friends as they provide security and comfort to grow in a better way (Shaver & Mikulincer, 2010). In the same way, a patient feels helpless during illness and may start to experience fatigue, stress or loneliness they tend to make an affectionate bond with the medical care provider, family members and even technology (Li et al., 2020). With its capabilities, WHD offers self- monitoring of physiological symptoms and disrupts the traditional healthcare delivery system. This modern care delivery system empowers patient and makes them responsible for their health (Iverson et al., 2008). WHD adoption enables physicians also to provide universal care (Sodhro et al., 2018) and because of the ubiquitous care patient feels provider is always there to help. This feeling enables emotional bonding towards provider and attachment towards technology.

Service-Dominant Logic (S-D Logic)

Opposed to the goods dominant (G-D) logic based on the push philosophy, service-dominant (S-D) logic theorizes the value creation by intervention and works on the philosophy of 'Value-in-Use' (Lusch & Vargo, 2006; Vargo & Lusch, 2008). Healthcare value is created when the provider interacts with the patient to give relief from pain (Vargo & Lusch, 2008). Thus, value is jointly produced by the provider and the patient. With WHD adoption enabled ubiquitous healthcare delivery system; the provider is empowered to monitor the patient remotely. WHD also empowers provider to intervene early, which leads to early interaction with the patient to avoid dared consequences as for specific disease management becomes easy if identified at an early stage.

Wearable Health Device (WHD) Adoption

WHD is a combined IoT enabled cloud systems which can connect pervasively and interacts in a synchronized habitat defined as 'a system of gadgets, sensors, devices, actuators, hardware, software and programming which creates the interface for the interaction and helps in collaborating, synchronizing and transmitting the vital information with the liked components' (Lom et al., 2016). WHD enables the patient to self-monitor vital symptoms (*Fitbit Versa 2 / Health & Fitness Smartwatch*, n.d.) and shows a healthy way to live life by sending a regular notification about health status and how to improve it (*Samsung Galaxy Watch Active 2 - Specs*

& Features | Samsung India, n.d.). For chronic as well as acute disease WHD can be useful as it can measure body fat, female health, calorie, heart rate (Deshkar et al., 2017). WHD tracks daily activity and exercise and enables youngsters to stay healthy (Lunney et al., 2016). With its enormous capabilities, WHD transmits real-time data with complete serialization to the provider for decision making based on analytical frameworks (Bhatt et al., 2019) through the cloud-enabled platform (Hassan et al., 2014). The capability of capturing and transmitting the raw signals in real-time enables pervasive computing and provides ubiquitous information (Konstantinidis et al., 2015). Therefore, it can be hypothesized that,

> H_1:   *WHD adoption is positively related with the Information Pervasiveness*

Information Pervasiveness

Real-time data must be transmitted transparency to the provider and other stakeholders. Physicians can provide sufficient attention as data is readily available to them (Lulembo & Silumbe, 2016). The patient can discuss important things about health and wellbeing during the consultation (online or offline), and the interaction session is not just a question-answer (Q&A) session, which creates value for the healthcare service provider (Osei-Frimpong et al., 2018). WHD adoption also enables time-independent consultation session as every time patients' visit to the provider is not necessary (Plageras et al., 2016). Pervasive information systems enable ubiquitous healthcare delivery, where the provider can give equal attention to the entire patient, and the patient also feels that the provider is just a click away.

> H_2:   *Level of information pervasiveness is positively related to the provider-patient interaction.*

Information pervasiveness helps provider in decision making during the treatment cycle. On the other side, it also helps in the prevention of medical conditions (Portela et al., 2014). Patient, as well as provider, has access to the same data and patients are empowered to gain knowledge. When the patient can observe their health conditions, they tend to actively participate in the decision-making process as the patient is aware of their health and studies the pros and cons of treatment.

> H_3:   *Level of information pervasiveness is positively related to the collaborative decision making*

Provider-Patient Interaction

Interaction requires collaborative relationships and mutual trust (Alam, 2013). Cooperation between provider and patient is vital for value creation (Blumstein, 1994). Patient- provider interaction is all about satisfying the patient by identifying the health issue and effectively respond to it (Bove & Johnson, 2000). Although pervasive information obtained by WHD adoption enables the patient to self-monitor medical conditions (Appelboom et al., 2014; Lupton, 2013; Vera-Aguilera et al., 2019), and find related documents over the internet, it is essential that provider also discuss available alternatives, potential threat and outcome of each substitute and values (monetary value) of each (Deber, 1994). Which means that collaborative decision making is not possible without mutual understanding and interaction between provider and patient.

H₄: *Level of Provider-Patient Interaction is positively related to the level of collaborative decision making.*

On the other hand, "*service engagement is an extent to which care service is delivered and received between provider and patient with the consideration of all factors influencing patients' experience*" (Osei-Frimpong et al., 2018). WHD adoption enables remote consultation and remote interaction between provider and patient. Thus, universal care can be provided, and physicians are in a better position to consult patient, which ameliorates patients' confusion due to the overload of information obtained from WHD as well as internet search. Delivery of healthcare services enhances only when patient satisfaction is achieved by fulfilment of the need for disease management (Polese et al., 2016). Self-monitoring patients tend to feel responsible for their health and tend to improve their approach for care delivery by improving engagement with the provider (Jamal et al., 2015).

H₅: *Level of Provider-Patient Interaction is positively related to the level of Service Engagement*

Collaborative Decision Making

It has been identified that when a patient is empowered enough to take part in the process of decision making along with the provider, it enhances patient trust in treatment and satisfaction (*Digital Health Ecosystems: A Payer Perspective | McKinsey*, n.d.). With the help of self-monitoring, patients are now more informed about their health and desired to be a part of the decision making process (Osei-Frimpong et al., 2018). An informed patient must be involved in the decision-making process (McColl-Kennedy et al., 2012) as a non-involved patient might not adhere to the treatment protocols and does not shows the engagement (Britten et al., 2000). Involved patients tend to research on their own also for finding the alternatives of treatment and for asking the queries related to wellbeing, which enhances patients' engagement in healthcare service delivery. Service engagement is all about co-creation between patient and provider when a patient is a part of the decision making process better service engagement can be created.

H₆: *Level of collaborative decision making is positively related to the level of service engagement*

RESEARCH METHODOLOGY

Data Collection

For assessing the proposed relationships, this empirical study uses a survey-based questionnaire, which was sent to the group of WHD users via email. The research involves WHD users and selects the respondents on the criteria that the respondent must have at least six months of experience with WHD. An email along with the cover letter describing the study was sent followed by one reminder after twenty days. Total of 131 usable responses was received, indicating as an accepted sample size in Table 1.

Table 1 RESPONDENT DEMOGRAPHICS		
	No.	Percentage
Age		
Less than 25 Years	28	21.4%
25 – 30 Years	40	30.5%
30 – 35 Years	32	24.4%
35 – 40 Years	20	15.3%
40 Years and above	11	8.4%
Gender		
Male	74	56.5%
Female	57	43.5%
Income Level		
Less than 5 LPA	21	16.0%
5 to 10 LPA	36	27.5%
10 to 15 LPA	41	31.3%
15 to 25 LPA	23	17.6%
25 LPA and above	10	7.6%

Measures

The study includes five different constructs. Developed scales have been used and adapted to the present context of the study. For assessing the initial validity of Q sort methodology (Moore & Benbasat, 1991) was applied with the help of six academicians having publications in a similar area. Inter judge score, items placement ratio and Cohen's kappa value above 0.90 indicated acceptable initial validity of constructs. With the development of face validity, exploratory factor analysis was conducted with varimax rotation. Table 2 describes items in detail that has been considered in the study.

Table 2 CONSTRUCT AND MEASUREMENT ITEMS		
Construct	**Items**	**Reference**
Wearable Health Device Adoption	WHDA1- I intend to use wearable health device daily WHDA2- I intend to use wearable health device at every possible opportunity in my day to day life WHDA3- I plan to increase the usage of wearable health device in the future	(Mital et al., 2018; Talukder et al., 2020)
Information Pervasiveness	INPV1- Wearable health device updates me regarding events that may affect my health INPV2- It is easy to share health regarding data with the physician from a remote location INPV3- Wearable health device shares notifications to the provider when needed	(Prahalad & Ramaswamy, 2004; Prajogo &Olhager, 2012)
Patient Provider Interaction	PPIN1- provider provided enabling environment for me to actively participate in consultation PPIN2- provider has a good rapport with me PPIN3- Provider discusses vital things which are important to me PPIN4- interaction was more conversational	(Daniel & Darby, 1997; Osei- Frimpong et al., 2018)
Collaborative Decision Making	CODM1- Provider asks me to suggest treatment options CODM2- Provider encourages my suggestion on a treatment plan CODM3- Provider discusses the prescription with me CODM4- We together plan for my wellbeing	(Hausman, 2004; Osei- Frimpong et al., 2018)
Service Engagement	SREN1- The level of care service provided to me is excellent SREN2- Provider is empathetic to my health condition SREN3- a combined effort by my provider and me is improving the level of care I am receiving	Salanova et al., 2005)

Non-response Bias

Non-response bias was examined for assessing the significant difference between the early respondents and slow-wave of responses (Armstrong & Overton, 1977). No significant difference was observed among the two streams of responses: this way suggesting non- existence of any substantial non-response bias.

Common Method Bias

Hermann's single factor test has been used to test common method bias. With the five apparent factors emerged, 38.32 per cent variance explained by the first factor below the benchmark of 50 per cent (Flynn et al., 2010). The factor structure did not show any single factor explaining more than 50 per cent of variance; thereby confirming non-appearance of an only factor and thus satisfying the guideline techniques.

DATA ANALYSIS AND FINDINGS

Data Analysis

PLS-SEM has been used utilizing using Smart PLS 3.0. As the study aims to evaluate the improvement in healthcare services engagement, use of PLS-SEM has been found the appropriate and logical for the perception-based study (Leguina, 2015). As PLS-SEM is free from the normality assumption, complex models with a smaller sample size efficiently estimated. As a common practice, the PLS-SEM was used to evaluate measurement and structural model.

Measurement Model

In measurement model reliability measured using Cronbach's alpha whereas, validity measured using Average Variance Extracted (AVE) values and item loadings. Value of Cronbach's alpha above 0.7 suggested the internal consistency (Henseler et al., 2009). In contrast, AVE>0.5 (Fornell & Larcker, 1981) and composite reliability>0.7 (Hair et al., 2010) suggested acceptable convergent validity for constructs in Table 3. Acceptable discriminant validity also assessed using Fornell - Larcker criterion (Henseler et al., 2014) as indicated in Table 4.

Table 3 ITEM LOADING, COMPOSITE RELIABILITY, AVE AND CRONBACH'S ALPHA					
Construct	**Items Coding**	**Item Loadings**	**Composite Reliability**	**AVE**	**Cronbach's Alpha**
Wearable Health Device Adoption	IoTA1 IoTA2 IoTA3	0.698 0.765 0.790	0.801	0.575	0.797
Information Pervasiveness	INPV1 INPV2 INPV3	0.841 0.791 0.709	0.801	0.579	0.790
Patient- Provider Interaction	PPIN1 PPIN2 PPIN3 PPIN4	0.730 0.839 0.774 0.797	0.897	0.690	0.895
Collaborative Decision Making	CODM1 CODM2	0.771 0.759	0.871	0.633	0.867

	CODM3	0.738			
	CODM4	0.778			
Service Engagement	SREN1	0.752			
	SREN2	0.780	0.807	0.593	0.789
	SREN3	0.826			

Table 4 DISCRIMINANT VALIDITY–FORNELL-LACKER					
	CODM	INPV	PPIN	SREN	WHDA
CODM	0.796				
INPV	0.593	0.761			
PPIN	0.682	0.554	0.830		
SREN	0.434	0.377	0.509	0.770	
WHDA	0.596	0.535	0.62	0.637	0.758

Structural Model

The structural model assessed with bootstrapping using 1000 subsamples (Li et al., 2020) which tested the relationship by path coefficient and t-statistics. As shown in Figure 2, four hypotheses are significant at 1% level of significance, whereas two hypotheses found to be insignificant. As we hypothesized, results revelled significance importance of WHD Adoption on information pervasiveness. It also revealed that Provider-Patient interaction has a significant positive impact on collaborative decision making and service engagement. However, no direct relationship has been established significantly between Information Pervasiveness and Collaborative decision making and Collaborative decision making to service engagement.
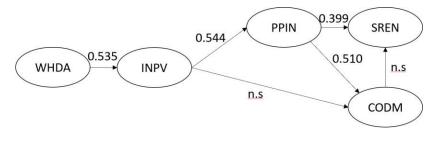

Figure 1
MODEL WITH PATH COEFFICIENT

DISCUSSION

Unlike other studies on IoT wearables and WHD (Mital et al., 2018; Papa et al., 2020; Talukder et al., 2020) present study concentrates on the consequences of WHD adoption and provide deep imputes to understand and validate how service engagement can be improved with WHD adoption. Wearable Health Device Adoption has a significant positive impact on information pervasiveness. WHDA, which highlights the user's intention to use wearable health device daily, for all possible opportunity instances of the day and also which attempts at capturing whether the user wants to increase its usage in the future, indicate and highlight the enormous amount of related data being gathered through those devices which foster availability of data of all instances that may affect patient health and seamlessly connecting and sharing with the physician from a remote location, facilitating superior care delivery and care-oriented

diagnosis, besides giving alarm notification on the go regarding specific health inputs to the provider, enabling an informed care decision environment. As per the rationale and also as expected from the existing literature, the pervasiveness of information positively and significantly impacts patient-provider interaction. Pervasive information environment enables the patient to actively participate in a consultation with the physician; facilitating the development of a good rapport between the patient and physicians, which in turn helps discuss many trivial yet vital things which are instrumental for superior patient care planning and delivery of quality care. This available information pervasiveness creates a platform for high- frequency interactions which are more conversational.

Information pervasiveness has a positive impact on collaborative decision making. With the available plethora of information, the provider gets enough information to plan alternative approaches to patient treatment. Information pervasiveness gives the patient-provider with all possible support and treatment alternative regarding various available treatment options, which comes very handy and as encouragement regarding treatment plans. With all available information and knowledge of other options, the provider can discuss the prescription with the patients and primary patient care providing attender; thereby enabling a constructive planning environment aimed at patient wellbeing. So information pervasiveness and patient-provider interaction create the platform conducive for collaboratively deciding on treatment plans and alternatives.

Further in this study, the empirical investigation highlights that patient-provider interaction and collaborative decision making, both together and individually have positive impacts on the concept of service engagement which is pivotal for any service-centric environment in creating a pleasant and enjoyable service encounter experience. Service engagement which in the current context, encompasses the level of care service provided to the patient in an empathetic way aimed at improving the standard of care experience received for the patient or principle caregiver for the patient. Thus the nuanced underlying nexus helps build a synergistic understanding regarding the antecedent consequent linkages towards care service engagement and experience for patients.

Implications

The study empirically examines the micro-level interaction process between provider-patient dyad. It describes how WHD adoption enhances data availability and help provider to improve patient engagement in healthcare services. The finding supports the theory of S-D logic (Lusch & Vargo, 2006; Vargo & Lusch, 2008) in the context of WHD adoption and service engagement. The study reveals the understanding that it is the interaction between provider and patient, which empowers the patient to take part in the collaborative decision making. The research empirically shows the importance of technology adoption in healthcare service management and states that WHD adoption enhances patients' engagement and interest in the healthcare process. This finding is in line with (Iverson et al., 2008). The investigation adds the consequent of WHD adoption in healthcare service delivery context, from the patients' point of view, which was not studied by eminent scholars.

The study develops a rich understanding of the robustness of technology with the help of a construct 'Pervasiveness'. Patient, as well as provider, adopts WHD when it provides secure access and data policy is robust, which complies with the national law. A developer can look for big data-enabled cloud-based data retrieval system by which personalized care can be provided (Bhatt & Chakraborty, 2020). The investigation also helps the healthcare administrators to understand the changing scenario of care service delivery and patients' readiness to adopt novel

technology. The provider may think about providing patient-oriented and patient-centric healthcare involving the patient into the decision making process.

LIMITATION AND FUTURE SCOPE

The current empirical study is experiencing the issue of generalizability like any other study. On the other hand, the study collected data in a cross-sectional manner, where the learning curve of the user is not captured. However, it is possible that with spending more time user becomes equipped for utilizing such innovatively propelled gadgets, and self-efficacy can be improved. Time-series study has not been conducted to capture the improved user engagement into healthcare service delivery process. However, significant importance was given to the non-response bias and standard method bias. In the future, the investigation can be done by incorporating the time series model.

CONCLUSION

The study empirically established a relationship between WHD adoption and care service engagement with theoretical support from emotional bonding and attachment theory as well as service-dominant logic. While attachment theory helps to explain the need of the patient to use WHD and service-dominant logic describes why it is essential for the provider to empower patient for collaborative decision making as well as enhancing patients' engagement in care service delivery process. The investigation enlightens the viewpoint of 'value – in - use' using the partial least square structural equation modelling (PLS-SEM) model with 1% significance level which provides methodological rigour and concludes that WHD adoption enhances patients engagement in care service delivery process and empowers the patient to make collaborative decision making by understanding the disease and treatment option in depth during the interaction with a physician. With a specific limitation of generalizability and adoption curve, the study provides useful information and implications in academic as well as in industry perspective to the provider, administrators and WHD developers to understand the post-adoption behaviour of the patient.

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