

## Exploring The Use of Smartwatches for Monitoring Elderly Health for Developing Country

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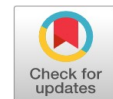
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**Abstract:** The healthcare of elderly is critically important for families, hospitals and government officials, as these all pay special attention to providing healthcare to older adults. As the technology is evolving, the use of IoT has revolutionized the healthcare industry turning it to be known as smart healthcare. Smartwatches are becoming important and common to use as an important tool for smart healthcare. Smartwatch-based smart healthcare can be efficiently used for elderly persons. There exist studies on smartwatch use by elderly persons investigating the factors influencing old age adults; however, there is limited research on studying the behavior of elderly persons for adopting smartwatches for the healthcare purpose especially for the developing countries like Pakistan. At the same social and technical perspective can provide a comprehensive way of how the elderly get healthcare using technical aspects of smartwatches. Using interviews and a qualitative research approach is being employed to extract insights from a diverse group of individuals. Semi-structured interviews were performed for this purpose. The data was subjected to thematic analysis using socio-technical theory, which revealed four main themes that are health monitoring at an older age, usability features of a smartwatch for healthcare, smartwatch adoption and acceptance and social support of using smartwatches by the elderly. These themes provide insights into the variables affecting the adoption, acceptance and social aspects of using smartwatch for healthcare in old age. It was revealed that smartwatches helped to encourage better healthcare for the elderly because they could be used as health monitoring devices to actively control and track health-related parameters. The results highlight the mutually beneficial acceptance of smartwatch to improve elderly healthcare. These observations offer vital advice for healthcare professionals, academics, and stakeholders looking to improve the healthcare of the elderly as smartwatches continue to reshape healthcare management.

**Keywords:** Smartwatch for Healthcare, Technical Features of Smartwatch for Elderly Healthcare, Smartwatch Capabilities for Elderly Healthcare, Perceiving the Use of Smartwatch by Elderly in Pakistan.

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### INTRODUCTION

Internet of Things (IoT) a well-known term now still getting more fame is a system where many smart and tiny processing devices including smartwatches have attracted significant attention from both academia and industry to build IoT-based smart solutions including smart homes, smart farming, smart grid, and smart healthcare. Smart healthcare is assisted using different body sensors to get the patient data to analyze the health level of a person or a patient. The use of smartwatches has a high adaptation rate for health-related use, health related data collection, and health management (Masoumian Hosseini et al., 2023). The global smartwatch adoption has reached 21.7% of the adult population and health and fitness tracking features are more demanding with 60% of users primarily using it for health and fitness (Pangarkar, 2024). The smartwatch which is personal computing device providing features like making phone calls, messaging, notifications, health-related activities, and fitness tracking. Device is smart enough to be worn on the wrist (Ogbanufe & Gerhart 2018).

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Along with rising trend of consumer devices such as smartphones, people are also purchasing smartwatches and who are demanding it recorded impressive growth. The various functions of smartwatch have attracted users due to their advantages in offering attractive technology along with healthcare and lifestyle. Smartwatch assists the healthcare using multiple functions like heart rate monitoring, tracking blood pressure, fitness options, patient tracking and communicating this data to edge and cloud (Cristescu et al., 2022). Countries around the globe are experiencing growth in number of elderly people versus general population (Talukder et al., 2020). With the growth of elderly people, providing healthcare facilities is becoming a challenge. Smartwatch along with inter-networking of other IoT devices enable to address this challenge.

A lot of research works exist addressing initial insights, approaches, concerns, intentions and behaviors of the older people regarding the use of IoT technologies for their health and its tracking (Talukder et al., 2020; Kekade et al., 2018). Mostly focus on the adoption and acceptance of technology, and potential benefits or barriers. However, fewer studies exist addressing the use of smartwatches for healthcare by elderly persons addressing social and technical behavior, and personal satisfaction aspects. Studies were performed to examine customer preferences for using smart applications and technologies rather than “how smartwatch influencing persons’ life regarding healthcare” (Usman, and Chukwueweniewe, 2023). The technology acceptance model (TAM) was extended to explore user adoption of smartwatches (Chuah et al., 2016) they also identified the roles of size used to display and usefulness in determining its adoption. The research (Hong et al. 2017) employed two intermediaries as the connections between users’ personal innovativeness and their persistence to use smartwatch. Pang et al. (2021) studied the factors influencing elderly persons when selecting new technologies. According to the results, users preferred self-paced learning, remote support, and flexible learning methods. This all showed that participants were less dependent on the provided instruction manuals when having some problems. Said et al. (2021) studied Malaysian consumers for behavioral intention towards the acceptance of smartwatches through a research model based on hedonic, health ology, serviceable, perceived innovativeness, perceived self-expressiveness, perceived compatibility, and the need for distinctiveness.

The structural model proposed by Talukder et al. (2021) includes four important factors for the continued use of smartwatch for elderly. These include device quality, emotional value, epistemic value, and social value. They have proposed a model for enablers and inhibitors perspective to cater factors mentioned already to study the continued use intention among the elderly. Their results showed that strongest is the social value will influence the continued use of smartwatch, followed by emotional and epistemic values and device quality. A smartwatch can provide continuous monitoring of elderly patients in what regard to unhealthy changes; additionally, it helps to detect and manage health conditions in an emergency. Good health has positive inferences on the quality of life (QoL) among the elderly. By using a smartwatch immediate feedback can be provided by accessing healthcare data at real-time and sharing it with medical centers via some available networks. This can greatly benefit the old age people. Smartwatch and related technologies offer reduced costs and avoid hospitalization resulting in improvement of elderly healthcare (Li et al., 2019). There exists a lot of research work (Said et al., 2021, Lu et al. 2016, Pang et al. 2021) on the technological aspects of smartwatches and consumer acceptance for general and healthcare use. Yet their adoption rate in real life is declined as of disruptive nature, requirement of additional smartphone to continue their operations and older people feel conservative towards any new technology. According to Shin et al. (2019) several studies seem to fail to consider whether the smartwatch has the required functions to complete specific healthcare activities with a special concern on elderly persons adopting or being reluctant to use a smartwatch.

There exist studies on smartwatch use by elderly persons investigating the factors influencing old age adults; however, there is limited research on studying the behavior of elderly persons for adopting smartwatches for the healthcare purpose. Especially the social and technical perspective can provide a comprehensive way of how the elderly get healthcare using technical aspects of smartwatches. Hence analyzing using a socio-technical lens will yield prominent insights into smartwatch technology use and its benefits concerning healthcare. Most of the previous research studies consider studying the behavior of general users for using the smartwatch and using the smartwatch for providing healthcare. However, since smartwatch offer many features that can be used by older adults for managing their health, so a study is required for developing countries to understand behavior and psychological factors in the adoption of smartwatches by elderly ones for healthcare, as the older ones at developing countries usually tend to avoid using the technology.

The application of a socio-technical system considers multiple factors, in addition to the technology itself for implementation design and use of technology in complex healthcare systems (Sittig and Singh, 2015; Irizarry and Barton, 2013). These research works implement social technical model to integrate specific technological and measurement dimensions of healthcare along with hardware and software, clinical content, the human-computer interface. The adoption of wearable activity trackers among elderly individuals in China from a socio-technical perspective (Shu, Li, & Hu, 2018). It examines the interplay between social factors (such as social influence and perceived usefulness) and technical factors (such as ease of use and perceived data accuracy) in shaping adoption behavior. The socio-technical theory can be applied to the context of studying smartwatch adoption for elderly healthcare. Socio-technical theory underlines the interaction between social and technical factors in shaping human behavior and organizational outcomes. For a research study on smartwatch adoption among the elderly for healthcare purposes, socio-technical theory could provide valuable insights into how both social and technical factors influence adoption and usage patterns.

## **LITERATURE REVIEW**

Internet of Things (IoT) technology is becoming popular day by day by providing automation of many aspects of daily life in the form of smart healthcare, smart house, smart driving and many more still under development. Smartwatches, gadgets and wristbands, smart dresses and related smart devices are embedded with different types of sensors, actuators tend to obtain data from their surrounding environment that is processed by using some IoT application, and latterly these devices actuate to show some response back to the environment. This all is helping to boost the use of IoT. These smart devices are becoming an important part of IoT and its application (Felea et al., 2021). A smartwatch, wristband and smart glasses are computing devices embedded in a variety of accessories providing multiple applications that can be worn on the body (Wright and Keith, 2014).

### **Smartwatch Featuring Healthcare**

The applications for smartwatches are increasing day by day boosting the Internet of Things, setting a new trend for smartwatch technology (Nagtegaal et al., 2015). The presence of fitness and healthcare applications in smartwatches is a bonus functionality that makes users feel it is worth buying a smartwatch (Adapta, 2016), hence more people are buying and using the smartwatches for healthcare.

Smartwatches are emerging and are engaging users in getting attention towards mobile-based smart technologies. A qualitative study (Iqbal and Jokela, 2022) focused on the issue of value creation and a better understanding of smartwatch adoption by the users, the study highlighted the factors motivating or demotivating users to use the smartwatch for different objectives. Smart wearables offer precise tracking of health data at real-time on any location, during any activities, and are rapidly increasing their market demand (Kang & Jung, 2020). Work by Blaine & Alexandria (2016) showed smartwatches can promote health by permitting self-monitoring of personal activity at daily to facilitate him in daily life, getting feedback on activity metrics, and helping communication with health care providers and family person. A smartwatch can be used for personal preferences like notifications, a health tracker, communication device, for entertainment or some combinations (Cecchinato, et al., 2015).

The use of smart-healthcare is increasing and related applications are available in most smart watches today making them attractive for sports man and persons anxious about their fitness level. Heart rate monitoring, exercise level, physical activity, heart rate, temperature monitoring and position detection applications are freely available and are in use to monitor their lifestyle. The smartwatch worn by patients on the wrist can record patient data and send this to a smartphone via available communication mean, helping the health-care sector. The smartphone generates an alert for healthcare staff. The application of health activities in smartwatches provides favorable views and behavioral intentions toward smartwatch (Kang & Jung, 2020). The study showed that smartwatches provide very specific health-related information by tracking multiple data permitting its users to vigorously check their health.

### **Smartwatch for Healthcare of Elderly Persons**

Recent developments in smartwatches have led to several applications like smart healthcare and remote health monitoring (Lu et al., 2016). The smartwatch combines features of smartphones with continuous monitoring of health-related data like step-counting, body temperature, heart rate monitoring, and physical activity levels

(Glowacki et al., 2018). They can provide feedback to persons by monitoring their health, help in real-time medication based on symptoms, and direct communication with caregivers and doctors (Reeder & David, 2016). People who use the smartwatch or around the arm can get some healthcare data but normally are used to interface with a smart mobile or a smart tablet via Bluetooth, WiFi, or a mobile network to facilitate a smartphone to manage and transmit the data from smartwatch.

Ali and Li (2016) showed how using smartwatches in a nursing home could improve communication and help to prevent fall accidents. A prototype was provided using smartwatch and found that the response time to alarms was reduced when the nursing home used their system instead of the regular one. The healthcare staff can wear the watch and immediately update about alarm and the information related to condition about why alarm was generated.

With the development of smartwatches-based healthcare, it became very easy for people to monitor their health level and their fitness at any location and anytime (Lunney, Cunningham, and Eastin, 2016). Normally it is difficult for people specifically for the older ones to check and monitor their health related parameters, and have some extra care for elderly ones. They have to visit some health centers to test for their blood pressure, temperature, blood sugar level and other factors that can be tedious for the elderly ones if they have to frequently visit the center. Smartwatches can help here to manage and monitor the health status of elderly ones. The smartwatch can collect continuous and real-time data to provide complementary information to some smart healthcare applications finally giving a complete tracking of the person's condition. The smartwatch can monitor one or more criteria regularly, store this data, and analyze it later on to assist healthcare providers in providing and managing their healthcare services (Bloss, 2015).

The physiological changes of body temperature and sweat constituents are desirable to understand physiological state of some people and can diagnose common pathological situations like temperature, glucose monitoring, hyponatremia, dehydration, hypokalemia and pressure ischemia (lactate in sweat) (Gao et al., 2016). The circadian rhythm for elderly adults is the hypothalamus, which also controls autonomic functions such as temperature (Nogueira et al., 2014). The smartwatch can actively measure the body temperature and report to the healthcare system in case of some uneven reading. Elderly persons can easily use the smartwatch to monitor their body temperature to avoid some health problems.

Some research work has proposed some random applications for elderly healthcare using sensors and IoT technology. Ransing & Rajput (2015) proposed an application named smarhome for elderly healthcare using wireless sensor network (WSN) to facilitate and help older people, by using many sensors to get the data of fire detection, gas leakage detection, checking either doors are opened or not. Magaña-Espinoza et al. (2014) propose an indoor system based on WSN for heart rate monitoring and motion rate to alert caretakers of the elderly through smartphones. Health monitoring of the elderly is proposed by measuring the health-related stats and forwarding these measurements to the medical server using Wi-Fi or GSM/GPRS data communication method (Rotariu et al. 2011). The IoT-based healthcare systems are present that are assisted by smart devices usually the smartwatch. These systems tend to monitor the health level of older adults and in case of some emergency, this system automatically notify the concerned medical center or the caretaker of the older ones.

### **Challenges of Acceptance of Smartwatch by Older People**

Smartwatches getting fame to track human activity in recent years. There are several smartwatch brands available that offers smartwatches with different capabilities enabling the watches to be used in different applications. The sustainability of smartwatch technology consists of different factors including ease of use, usefulness & pleasure (Park, 2020). Dehghani, et al. (2018), discussed how smartwatch is sustainable and that the intention to use the smartwatch was positively adapted due to appealing aesthetic and hedonic motivation. The buyer's buying intention is needed to be noted and studied when he is going for a smartwatch, such as perceived benefits and design aesthetics of the smartwatch are among high priorities (Kuo-Lun & ChiaChen, 2018).

Just as applications for smartphone are increasing, applications of smartwatch are also continuously increasing and are closely connected to emergence of the Internet of Things, setting a new trend for smartwatch technology (Nagtegaal et al., 2015). According to Adapta (2016), the presence of fitness and healthcare applications in smartwatches is a plus point making users feel it is worth when purchasing a smartwatch. However, factors affecting smartwatch can be classified into nuanced, contextual and multifaceted (Jeong, et al., 2017). Authors in (Blaine and Alexandria, 2016) stated that consumer data is also an issue tied to smartwatch, because smartwatches generate

continuous and large amounts of data hence storage will be a significant aspect to be considered in the future. Specifically in healthcare use, a smartwatch will collect different health related parameters data from the person and its environment.

Users persist in using some technology as they already used it or because it may be too stressful, this results in a reduction of adoption of new devices, but at the same hindering factor in use continuance, especially among the elderly (Tsai et al., 2019). Persons in their old age are normally not enthusiastic about using the latest technologies. A study found only 6.8% of individuals in Switzerland between the age of sixty five to eighty years used a smartwatch for physical activity tracking, and 2.3 % using the used an activity tracker having age of eighty years or older (Seifert et al., 2017). Elderly people may lack experience while using mobile devices or smartwatch (Pew Research Center, 2017), this prevent them to understand the technical details. In addition, the most prominent thing is that usually a smartwatch is not designed specifically for older adults. Older age also affects the perceptual, understanding, motor skills and cognitive use of smart devices (Charness & Boot, 2009).

### **Socio-Technical Theory and Using Smartwatch for Healthcare**

According to socio-technical theory, although technical and social systems are closely related, but by nature they are different from each other. The social systems consist of the human being with an unpredictable behavior but the technical systems aim to attain specified performance parameters (Walker et al., 2008). At its core, socio-technical theory advocates that successful systems design and implementation require consideration of both social and technical factors. Shin (2014) proposed a socio-technical framework by which the smart devices related to IoT environment development in Korea were analyzed. He studied the human-centered factors of smart devices and how humans can benefit from these devices.

The application of a socio-technical system considers multiple factors, in addition to the technology itself for implementation design and use of technology in complex healthcare systems (Sittig and Singh, 2015; Irizarry and Barton, 2013). These research works implement social technical model to integrate specific technological and measurement dimensions of healthcare along with hardware and software, clinical content, the human-computer interface. The adoption of wearable activity trackers among elderly individuals in China from a socio-technical perspective (Shu, Li, & Hu, 2018). It examines the interplay between social factors (such as social influence and perceived usefulness) and technical factors (such as ease of use and perceived data accuracy) in shaping adoption behavior. The acceptance of wrist-worn activity trackers is studied using a mixed method study among older adults living in the community (Puri et al., 2017). This research considers both social (such as social support and perceived usefulness) and technical (such as usability and data accuracy) factors in understanding adoption behavior.

The research exists implementing social technical theory to explore use of latest technologies for healthcare. Additionally, the use of a socio-technical theory lens to examine how smartwatches can be used for the healthcare of elderly persons in developing countries. The socio-technical theory can be applied to the context of studying smartwatch adoption for elderly healthcare.

### **METHODOLOGY**

The objective of this research is to examine behavior of elderly person towards smartwatch adoption for their healthcare. This research follows the qualitative research approach. This research will investigate and understand the experience and opinions of the participants, in the context of using smartwatches for the healthcare of elderly ones. Qualitative research is taken because this approach helps to understand the experience of the participants with respect to their context and gain an in-depth perspective of these implications (Klein and Myers, 1999). By applying the qualitative method, in-depth view of the participant's thoughts and actions can be offered.

This study will help to understand people, social, and cultural context, specifically examining the issues from the point of view of the participants. The data will be captured through the technique of narrative interviews with elderly ones, as described by Coffey & Atkinson (1996). Narrative interviews are a way of collecting reviews, comments and stories of persons with a patient centered approach to research and practice. The narrative approach follows person centered study process by placing them at the heart of the study, hence, honors the meanings that they assign to their own stories.

### Data Collection

For this study, a semi-structured approach was followed, with a relatively short list of predefined questions, grouped by type. The questions were open-ended and designed to gain an understanding of how the smartwatch is helping toward healthcare. There was an emphasis on how the elderly feel while using the smartwatch for the healthcare. In addition, what additional things or options need to be present in the smartwatch that can urge the elderly ones to easily use the smartwatch technology for healthcare and use it on a regular basis. The interview questions are provided in Appendix A. The goal was to reach the old people and get their reviews about the use of technology for healthcare process. Even the persons who are feeling comfortable with technology use and who are not comfortable with smartwatches. The inclusion criteria are set as the age considered is 60 years or above to be considered as elderly. Data was collected from 6 elderly ones belong from Pakistan who were in contact either directly from social media, or recommended by some friend leading toward quick cooperation and full participation phases. Moreover, the elderly ones were chosen who owned a smartwatch and using it for healthcare.

### Analysis of Data

Qualitative data analysis requires to identify, code, and categorize themes. Thematic analysis explores the meaning of a phenomenon, by coding qualitative information and subsequently identifying themes (Braun, and Clarke 2006). This process also identifies why specific categories were chosen. Thematic analysis will be observed in order to perform this research study. For qualitative data analysis and theme identification a six-step process is proposed, in following details are provided on how this research work is following these steps.

*Step 1: Data familiarization* : Transcribe the interview recordings and prepare the notes to become familiar with the data. Read and re-read the notes to engage in the data and identify key points.

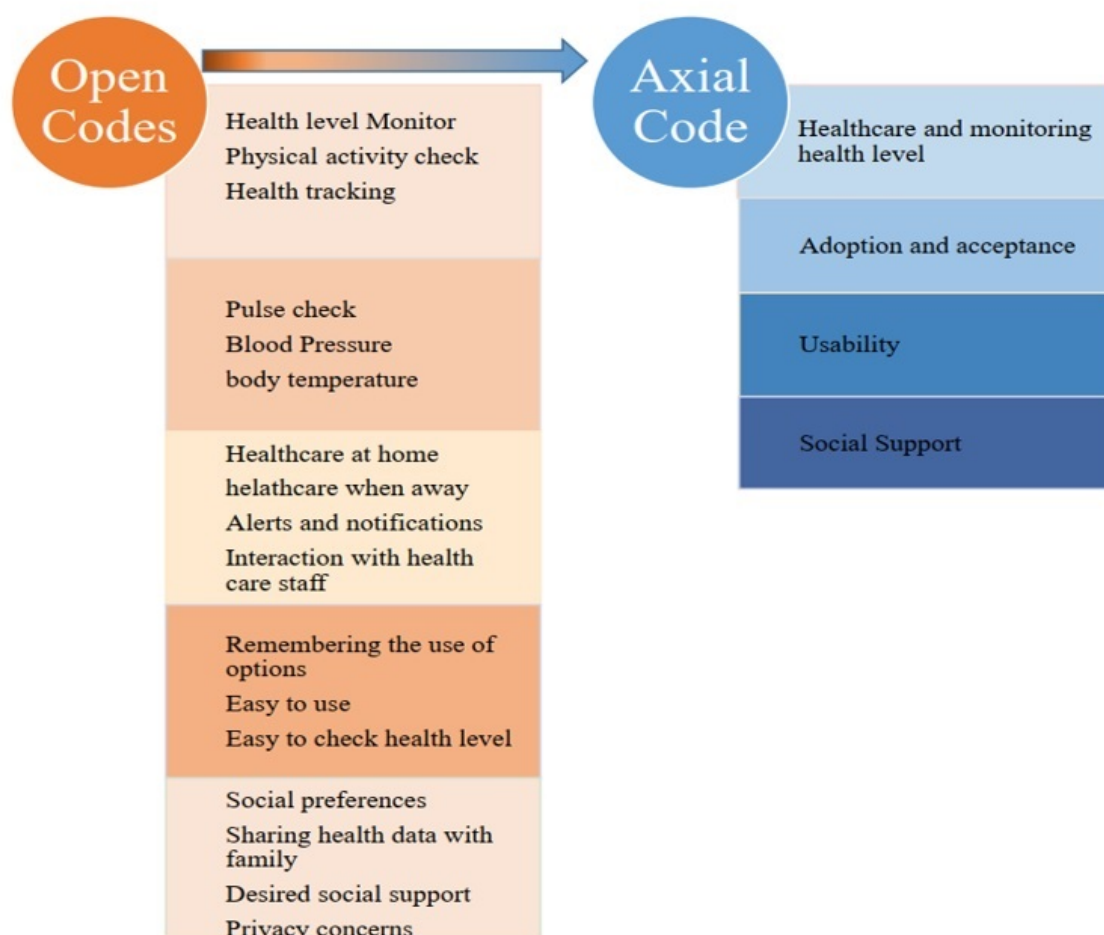


Figure 1: Coding Mechanism

*Step 2: Coding* : Start by coding and assign descriptive labels or codes to segments of text that were having meaningful concepts or ideas. Above mentioned highlighted features (healthcare benefits, easiness of lifestyle, and understanding of technical features) were coded with labels that accurately reflect the content of each snippet. For this process open coding is followed (Mills, et al., 2006). The explicitly stated themes as well as underlying or implicit themes that emerge from the data were performed. Axial coding helped to find the themes based on connections among the identified codes (Strauss & Corbin, 1999). It helped to identify major categories by sorting and organizing to identify resemblance of different codes identified in open coding phase (Creswell & Creswell, 2018). The open codes and axial codes are provided in Figure 1.

*Steps 3 to 5: Theme Development* : Theme development consists of finding themes, reviewing these and finalizing themes. At the start initial codes were organized into five different categories as shown using different colors in the figure 2 as open codes, after this a detailed review was performed and the identified themes were analyzed according to supporting data to ensure they accurately reflect dynamics of smartwatch adoption and use for elderly healthcare. Refining and revision processes were performed by considering alternative interpretations and perspectives from the data. For this research work major themes emerged related to health monitoring at an older age are as following.

- Health monitoring at older age.
- Usability features of smartwatch for healthcare.
- Smartwatch adoption and acceptance.
- Social support of using smartwatch by elderly.

#### **Step 6: Incorporation:**

The final step is incorporating the topics into a logical story that communicates the research findings. The research findings were expressed along with quotes obtained from the interviewees. These quotations helped research findings to perform in-depth analysis and served to emphasize the importance of using smartwatch for elderly healthcare.

### **EMPIRICAL FINDINGS**

This section presents the empirical findings of the research study performed.

#### **Theme 1: Health Monitoring at Older Age**

The main concern of study is using smartwatch for elderly healthcare. For this purpose, the participants were asked different questions with main concern on using the smartwatch for healthcare at the older age. Latest technologies are helping here and like the smartwatch that offers many features that can be used for health monitoring. Typically, the older adults in Pakistan are somewhat reluctant to use the latest technology but preferred if used for betterment, so regarding the question “Do you like use of latest technologies in your old age for any task of your life?” asked from the participants they were mixed response to use the latest technologies. Participants highlighted that they will prefer if these are easy.

Response from participant 2 “Yes, I would like using the latest technologies, especially if they help me stay healthy and independent. I find smartwatches quite easy to use.”

“I’m all for using the latest technologies, especially if they make managing my health easier.” (P3)

“I’m reluctant to use new technologies I faced some hard time to use smartwatch but sounds good for monitoring my health” (P6)

It exhibits comfort can be provided with technology and easiness of smartwatches can be used for healthcare purposes. These people are also willing to opt new technology. A prominent aspect of these technologies emerged as the use of smartwatch for healthcare. A further question put forwarded was regarding the extent of using smartwatch a normal use is observed in the interviews by most of the participants. And when asked the question to what extent they use it for healthcare, the reviews were encouraging as the participants are using the smart watch as it is facilitating them in the healthcare.

“at start it looks tough but the notification feature helped me to align with my health routing and I am using it regular now” (P1)

“I use my smartwatch extensively for healthcare as there exist many health related applications that help me to live a healthy life” (P2)

“once I came familiar with smartwatch now I use it regularly for monitoring my blood pressure, heart rate, and activity levels. It helps me stay on top of my health goals” (P5)

The active engagement with the technology highlights the potential benefits and opportunities associated with smartwatch adoption among elderly individuals. Regular utilization of the smartwatch for monitoring various health metrics reflects a proactive approach towards self-care and health management, indicating a strong alignment between their needs and the capabilities offered by the device. Participants were also asked to tell about the favorite healthcare features of the smartwatch they use and how these are helping in their healthcare. The response was measuring physical activity and heartbeat monitor and temperature recording. One participant said that he uses smartwatch for measuring his blood pressure and checking the oxygen levels and this helped to avoid some emergency as from the notifications he can control the blood pressure and maintain his oxygen level. A prevailing sentiment among the participants was the significant impact of health monitoring features on their daily routines and overall well-being. One participant P-1 expressed, "Thanks to the health monitoring features on my smartwatch, I feel more in control of my health as I can easily track my vital signs." This sentiment was echoed by others, who highlighted the convenience and empowerment that comes with continuous health monitoring.

### **Theme 2: Usability Features of Smartwatch for Healthcare**

The usability features of smartwatches play a pivotal role in shaping their effectiveness as healthcare tools for the elderly population. In a rapidly evolving technological landscape, ensuring that smartwatches are accessible, intuitive, and user-friendly is essential for promoting their adoption and enhancing their utility in healthcare contexts. When asked the participants about are how much you feel comfortable with features of smartwatch and their use for your healthcare:

“the large, easy-to-read display and simple navigation helps the usability. It makes it easy for me to access health-related information and features without feeling overwhelmed” (P1)

“I feel uncomfortable using my smartwatch at start, later on the voice command feature is especially helpful for me as it allows me to perform tasks hands-free, such as setting reminders or checking my health metrics” (P5)

“I appreciate the simplicity of the interface” (P3)

This shows elderly feel difficulties at start but the features of smartwatch help to increase usability for healthcare, attributing this to the device’s customizable settings and intuitive interface. Some smartwatch features and applications can be made favorite by setting priority or some related options. When the participants asked regarding the favorite features, the participants conveyed about their favorite settings and how they feel comfortable: “The sleep tracking feature on my smartwatch is one of my favorites. It helps me understand my sleep patterns” (P2)

“The step count application is my favorite it really helped in my fitness and overall health” (P4)

The older adults can easily use, navigate and understand the smartwatch features and memorize them or the notifications and vibrations are helpful regarding the healthcare use. Participant 3 stated “it easy to memorize its features” moreover, he said “I have learned its use within short span of time.” One participant said, “if there are only health related features and icons are there he will be more satisfied.” Health monitoring features such as heart rate monitoring, activity tracking, and sleep tracking are highly valued for providing valuable insights into overall health status and promoting proactive health management. Voice command functionality also stands out as a favorite feature, offering hands-free interaction for users with dexterity or mobility limitations. Overall, smartwatch features that prioritize ease of use, health monitoring capabilities, and personalized assistance are likely to resonate most with elderly participants for healthcare purposes.

### **Theme 3: Smartwatch Adoption and Acceptance**

Respondents argue that they normally tend to avoid new technologies but smartwatch has great potential and once they know it can be used to monitor healthcare much simpler way they showed positive to accept and adopt it. The most important factor is user acceptance, older people are more vulnerable than people of any other age group, their awareness with respect to digital literacy play and important role. One such response from participant 3 was “after some guidance about smartwatch I started to use the smartwatch for my healthcare, it helped to manage my health easier and more accessible” another similar response was “I’ve been reluctant to trying new technologies, when I heard about smartwatches for healthcare, I was intrigued. I learnt and now that I’ve been



using one, it helped me stay on top of my medications, track my fitness.” (P4). These responses reflect positive experiences and acceptance of smartwatches for healthcare among the elderly. The participant 6 updated, “I heard about smartwatches for healthcare at start I not paid any attention. My friend guided me and now I can’t imagine going back. It’s been a game-changer for me.” Overall, it appears that once elderly users overcome any initial reservations, they often find smartwatches to be valuable tools for managing their health and well-being.

#### **Theme 4: Social Support of Using Smartwatch by Elderly**

Smartwatches equipped with features such as GPS tracking, fall detection, and emergency alerts offer reassurance to family members by providing real-time updates on the elderly user’s location and well-being. this also facilitate effortless communication between elderly users and their family members, enhancing social connectedness and reducing feelings of isolation. When participants asked regarding how they feel along with your family while using smartwatch. Participant 2 expressed that he is comfortable and don’t feel shy when using it for his healthcare. “at start I don’t use it when I was with my family or going outside with friends and feel very comfortable using my smartwatch around my family. They’ve been supportive and encouraging so I incorporated it into my healthcare routine.” (P5)

This response shows that there is an increased interest and support from their family. Participant 3 stated “the family support was really helpful as regarding critical healthcare notifications are also forwarded to my family and this helped to handle any heath related problem in a good way.” The social and family support surrounding the use of smartwatches by the elderly is characterized by encouragement and assistance in integrating the device into their healthcare routine.

“My family and I use the shared activity tracking feature on the smartwatches to stay motivated and accountable for health goals. It’s like having a virtual support system that keeps us all on track and encourages healthy habits” (P5)

The exploration of health monitoring at older age reveals the profound impact of smartwatch technology in empowering elderly individuals to take charge of their health and well-being. Through regular monitoring of vital signs, physical activity levels, and sleep patterns, smartwatches offer invaluable insights and promote proactive health management among elderly users. Participant responses underscore the effectiveness of health monitoring features in fostering a sense of control and confidence in managing one’s health, ultimately contributing to improved health outcomes and quality of life in later years. Participants express appreciation for features such as large displays, intuitive interfaces, and customizable settings, which enhance accessibility and ease of use for elderly users.

#### **DISCUSSION USING SOCIO-TECHNICAL THEORY LENS**

The subject of smartwatches for healthcare has attracted substantial research. In addition, when talking about the healthcare of the elderly the latest technology is helping much more and new research and development are in progress. Examining smartwatch adoption by the elderly in developing countries through a socio-technical theory lens, mainly considering the themes mentioned previously as health monitoring, usability features, adoption and acceptance, and social support, offers a broad understanding of the dynamics at play in the adoption process.

Regarding the theme 1, how elderly perceive the role of smartwatches in health monitoring, including their attitudes towards continuous monitoring, the integration of health data into daily routines, and the perceived benefits in terms of proactive healthcare management. A smartwatch can provide desired healthcare outcomes for the old age adults when it is based on their daily life. Outcomes of this study demonstrate the selected elderly feel uncomfortable at start but tend to adopt smart watch for healthcare and add its use to their daily routine for their healthcare. Previous studies have similar findings suggesting that smartwatch regular use can facilitate healthcare (Nascimento, Oliveira and Tam, 2018), and, enhance the healthcare activities at older age (Lazaro et. al, 2020). It is observed that smartwatch use can facilitate healthcare at older age. The smartwatch provides advanced healthcare and physical monitoring metrics like heart rate, step count, body temperature, sleep statistics, these features empower one to take an active role in sustaining healthcare ranging from fitness and support to preventing and helping in tracking diseased and sickness (Chuah, 2019; Canhoto and Arp, 2017; Hong, Lin and Hsieh, 2017). Smartwatches are effective in promoting health, fitness oriented life among the users when they feel comfortable to wear it for prolonged duration (Adapa et. al, 2018). Reviews of the participants make it clear that tracking

heartbeat, blood pressure and body temperature are among common features used by the participants for managing their health by using smart watch.

The tastes of respondents showed that the need and behavior was clear that is for healthcare activity, while at the same time it also served as a tool for communications and social aspects as well. This makes it clear that the common perceived value according to the participants is for healthcare and this also accompanied with Iqbal and Jokela (2022). The elderly are using smartwatches to monitor their health & daily activities.

Exploring the usability theme (theme 2) studies have delved into the usability features of smartwatches for healthcare applications, shedding light on their effectiveness in enhancing user experience and promoting adoption among diverse populations, including the elderly. Smith et al. (2020) evaluated the usability of smartwatches among elderly individuals with chronic conditions, focusing on features such as navigation, readability, and ease of use. The findings revealed that participants perceived smartwatches as intuitive and user-friendly tools for managing their health, with clear displays and simple interfaces being particularly praised for their accessibility. These results align with the experiences reported by participants in this paper, the participants emphasized the importance of usability features such as large displays and customizable settings in facilitating their interaction with smartwatches for healthcare purposes. Users are willing to include fitness and health into their routines, and, as a result increasing emphasis on wellbeing. Smartwatches play a key role in healthcare offering a options and features that satisfy their needs (Dehghani, 2018). Users' intentions to continue engaging in health management when they see the results of their wellness. The participant's interaction in the study is skillfully proved, which shows how smartwatches provide a sense of empowerment that encourages elderly to maintain their participation regarding health.

The adoption and acceptance of smartwatches for healthcare (theme 3) purposes among elderly individuals are influenced by a myriad of factors, including usability, perceived usefulness, and social support. Peek et al. (2014) conducted a systematic review and identified different factors that influence the acceptance of technology for aging in place. Their study highlighted the importance of usability features, such as intuitive interfaces, large buttons, easier navigations and clear displays, in enhancing the usability of technology for elderly users. Smartwatches with simple and easy-to-navigate interfaces are more likely to be embraced by elderly users who may have limited experience with technology. This proves findings of this study, the participants have shown positive for using the smartwatch with a good interface. Lee et al. (2020) conducted a study to evaluate the usability of smartwatches for elderly users in healthcare settings. Their findings revealed that features such as medication reminders, activity tracking, and emergency alerts were highly valued by elderly users. Outcomes from this paper support this as the user comments are there claiming that their medication became regular after using the smartwatch for their healthcare and now they are enjoying the use of smartwatch for their healthcare. One response that he feels that the smartwatch is acting like a personal assistant that notifies him about his medication time to avoid a severe health related problem. This makes clear that usability features such as intuitive interfaces, customizable settings, and health management features are essential for enhancing the usability and acceptance of smartwatches for elderly healthcare users.

Social support (theme 4) and help play a vital role in facilitating the adoption and use of smartwatches among elderly individuals. Family members, caregivers, medical staff, and peers provide encouragement, assistance, and required technical support, which facilitate elderly users' acceptance and engagement with smartwatch technology. Demiris et al. (2013) investigated the role of social support in the acceptance of a community-based telehealth wellness system among older adults. Their study found that elderly individuals who received support from family members or caregivers were more likely to embrace telehealth technology. Results from this study show the viewpoints of the participants that they got better support and response from the family members when they shared their experience of using the smartwatch for the healthcare. Some elderly also suggested the use of smartwatches to their age mates when perceived the benefits of smartwatches for healthcare al old age. Mitzner et al. (2010) explored older adults' attitudes toward technology usage and found that peer support networks can enhance elderly users' confidence and motivation to adopt new technologies. Existing studies have highlighted the importance of social support to facilitate the adoption and acceptance of smartwatch technology among the elderly for healthcare purposes. These emphasize the importance of peer support and community help in promoting the adoption and continued use of smartwatch technology among elderly individuals.

Overall, the results from existing studies underscore smartwatch adoption among elderly individuals in healthcare settings and the importance of considering socio-technical factors in examining this phenomenon. By critically

analyzing these studies through a socio-technical theory lens, a deeper understanding was obtained related to interplay between social, technical, smartwatch technology factors that shape the adoption, acceptance, and utilization of smartwatch technology among elderly healthcare users.

## **CONCLUSION**

The adoption and use of smartwatch technology among elderly individuals in healthcare contexts are influenced by a myriad of factors, including usability features, acceptance dynamics and social support. Through performing analysis based on studies valuable insights were gained related to these factors and their implications for research and practice. The findings suggest that elderly individuals perceive smartwatches as valuable tools for enhancing their health and well-being in old age. Social support, particularly from family members, caregivers, and peers, plays a crucial role in shaping elderly users' perceptions of smartwatch technology. For example, one participant stated that for the emergency situation, the family members were well aware with the help of notifications and they handled the situation by shifting him to the hospital. Through encouragement, assistance, and technical support, social networks empower elderly users to embrace smartwatches as beneficial aids for managing their health and improving their quality of life. Elderly individuals' express optimism regarding the capabilities of smartwatch technology to improve healthcare in old age. Usability features such as intuitive interfaces, customizable settings, and health management features are perceived as valuable assets that enhance the effectiveness and acceptance of smartwatches among elderly users.

Moreover, understanding the factors influencing smartwatch adoption and acceptance is crucial for informing interventions and strategies aimed at promoting technology acceptance among elderly users. By addressing perceived usefulness, attitudes towards technology, and social influence, researchers, healthcare practitioners, and technology developers can design tailored interventions that effectively promote smartwatch adoption and use among elderly individuals, ultimately improving their health outcomes and quality of life.

This study confirms the significant roles of perceived usefulness, adaptability, facilitating applications, features, and self-reported healthcare status in directly predicting the intention to use of elderly toward smartwatch for their healthcare. On the one hand, the findings fill the research gap of older adults' acceptance of smartwatch while on the other hand the study helps community and other stakeholders to carry out feasible plans to facilitate the adoption of the smartwatch technology for the healthcare. In this study, majority of the participants expressed their willingness to accept smartwatch for the healthcare. The results showed that perceived usefulness and adaptability are the antecedents of intention to use smartwatch technology.

Collectively, the material and studies provided contribute to both research and practice by offering evidence-based insights into the factors influencing smartwatch adoption and use among elderly individuals. Healthcare professionals can get benefits from the insights and recommend the older adults to use the smartwatch technology for the healthcare. By understanding the social, technical, and organizational dynamics shaping elderly users' engagement with smartwatch technology, researchers, healthcare practitioners, and technology developers can design interventions and solutions that better meet the needs and preferences of elderly users, ultimately improving their health outcomes and quality of life. Overall, the material and studies provided serve as valuable resources for advancing our knowledge of smartwatch adoption among elderly individuals and informing efforts to promote the effective use of technology in healthcare settings.

## **REFERENCES**

- Adapa, A., Nah, F. F. H., Hall, R. H., Siau, K., & Smith, S. N. (2018). Factors influencing the adoption of smart wearable devices. *International Journal of Human-Computer Interaction*, 34(5), 399-409.
- Blaine, R. & Alexandria, D., 2016. Health at hand: A systematic review of smart watch uses for health. *Journal of Biomedical Informatics*, Volume 63, pp. 269-276.
- Bloss, R. (2015). Wearable sensors bring new benefits to continuous medical monitoring, real time physical activity assessment, baby monitoring and industrial applications. *Sensor Review*, 35(2), 141-145.
- Bölen, M. C. (2020). Exploring the determinants of users' continuance intention in smartwatches. *Technology in Society*, 60, 101209.
- Canhoto, A. I., & Arp, S. (2017). Exploring the factors that support adoption and sustained use of health and fitness

- wearables. *Journal of Marketing Management*, 33(1-2), 32-60.
- Cecchinato, M. E., Bird, J. & Cox, A. L., 2015. Smartwatches: the Good, the Bad and the Ugly?. In: *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems.*, 33(1), pp. 2133-2138
- Chuah, S.H.-W., Rauschnabel, P.A., Krey, N., Nguyen, B., Ramayah, T., Lade, S., 2016. Wearable technologies: the role of usefulness and visibility in smartwatch adoption. *Comput. Hum. Behav.* 65, 276–284.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and Mixed Methods Approaches* (3rd ed.). SAGE Publications
- Cristescu, I., Iordache, D. D., & Țirlea, C. (2022, June). Behavioral intention to use smartwatches: a case study. In *2022 14th International Conference on Electronics, Computers and Artificial Intelligence (ECAI)* (pp. 1-4). IEEE.
- Dehghani, M. (2018). Exploring the motivational factors on continuous usage intention of smartwatches among actual users. *Behaviour & Information Technology*, 37(2), 145-158.
- Demiris, G., Thompson, H. J., Lazar, A., Lin, S. Y., & Lee, J. (2013). Older adults' acceptance of a community-based telehealth wellness system. *Informatics for Health and Social Care*, 38(3), 233-252.
- Felea, M., Bucur, M., Negruțiu, C., Nitu, M. and Stoica, D.A., 2021. Wearable Technology Adoption Among Romanian Students: A Structural Model Based on TAM. *Amfiteatru Economic*, 23(57), pp.376-391.
- Gao, Y., Li, H., & Luo, Y. (2015). An empirical study of wearable technology acceptance in healthcare. *Industrial Management & Data Systems*, 115(9), 1704-1723.
- Glowacki, E. M., Zhu, Y., Hunt, E., Magsamen-Conrad, K., & Bernhardt, J. M. (2016). Facilitators and barriers to smartwatch use among individuals with chronic diseases: A qualitative study. *University of Texas, Austin*. Accessed November, 11, 2018.
- Hong, J. C., Lin, P. H., & Hsieh, P. C. (2017). The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch. *Computers in Human Behavior*, 67, 264-272.
- Irizarry, T., & Barton, A. J. (2013). A sociotechnical approach to successful electronic health record implementation: five best practices for clinical nurse specialists. *Clinical Nurse Specialist*, 27(6), 283-285.
- Kang, H. & Jung, E. H., 2020. The smart wearables-privacy paradox; A cluster analysis of smartwatch users. *Behaviour & information technology*, pp. 1-14.
- Kekade, S., Hseieh, C. H., Islam, M. M., Atique, S., Khalfan, A. M., Li, Y. C., & Abdul, S. S. (2018). The usefulness and actual use of wearable devices among the elderly population. *Computer methods and programs in biomedicine*, 153, 137-159.
- Lazaro, M. J. S., Lim, J., Kim, S. H., & Yun, M. H. (2020). Wearable technologies: acceptance model for smartwatch adoption among older adults. In *Human Aspects of IT for the Aged Population. Technologies, Design and User Experience: 6th International Conference, ITAP 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I 22* (pp. 303-315). Springer International Publishing.
- Lee, M., Wang, H., & Chen, S. (2020). Usability evaluation of smartwatches for elderly users in healthcare settings: A mixed-methods study. *International Journal of Medical Informatics*, 137, 104108.
- Li, J., Ma, Q., Chan, A. H., & Man, S. (2019). Health monitoring through wearable technologies for older adults: Smart wearables acceptance model. *Applied ergonomics*, 75, 162-169.
- Lu, T.-C., C.-M. Fu, M. Ma, C.-C. Fang, and A. Turner. 2016. "Healthcare Applications of Smart Watches." *Applied Clinical Informatics* 07 (03): 850–869.
- Lunney, A., Cunningham, N. R., & Eastin, M. S. (2016). Wearable fitness technology: A structural investigation into acceptance and perceived fitness outcomes. *Computers in Human Behavior*, 65, 114-120.

- Masoumian Hosseini, M., Masoumian Hosseini, S. T., Qayumi, K., Hosseinzadeh, S., & Sajadi Tabar, S. S. (2023). Smartwatches in healthcare medicine: assistance and monitoring; a scoping review. *BMC Medical Informatics and Decision Making*, 23(1), 248.
- Mitzner, T. L., Boron, J. B., Fausset, C. B., Adams, A. E., Charness, N., Czaja, S. J., & Sharit, J. (2010). Older adults talk technology: Technology usage and attitudes. *Computers in Human Behavior*, 26(6), 1710-1721.
- Nascimento, B., Oliveira, T., & Tam, C. (2018). Wearable technology: What explains continuance intention in smartwatches?. *Journal of Retailing and Consumer Services*, 43, 157-169.
- Nogueira, A. B., Sogayar, M. C., Colquhoun, A., Siqueira, S. A., Nogueira, A. B., Marchiori, P. E., & Teixeira, M. J. (2014). Existence of a potential neurogenic system in the adult human brain. *Journal of translational medicine*, 12, 1-33.
- Ogbanufe, O., & Gerhart, N. (2018). Watch it! Factors driving continued feature use of the smartwatch. *International Journal of Human-Computer Interaction*, 34(11), 999-1014.
- Pang, C., Collin Wang, Z., McGrenere, J., Leung, R., Dai, J., & Moffatt, K. (2021, May). Technology adoption and learning preferences for older adults: evolving perceptions, ongoing challenges, and emerging design opportunities. In *Proceedings of the 2021 CHI conference on human factors in computing systems* (pp. 1-13).
- Pangarkar, T. (2024, March 21). Smartwatch Statistics: New Wearable Technology. *Market Scoop*. Retrieved from <https://scoop.market.us>
- Peek, S. T., Wouters, E. J., Van Hoof, J., Luijkx, K. G., Boeije, H. R., & Vrijhoef, H. J. (2014). Factors influencing acceptance of technology for aging in place: A systematic review. *International Journal of Medical Informatics*, 83(4), 235-248.
- Puri, A., Kim, B., Nguyen, O., Stolee, P., Tung, J., & Lee, J. (2017). User acceptance of wrist-worn activity trackers among community-dwelling older adults: mixed method study. *JMIR mHealth and uHealth*, 5(11), e8211.
- Ransing, R. S., & Rajput, M. (2015, January). Smart home for elderly care, based on Wireless Sensor Network. In *2015 International Conference on Nascent Technologies in the Engineering Field (ICNTE)* (pp. 1-5). IEEE.
- Reeder, B., & David, A. (2016). Health at hand: A systematic review of smart watch uses for health and wellness. *Journal of biomedical informatics*, 63, 269-276.
- Rotariu, C., Costin, H., Andruseac, G., Ciobotariu, R., & Adochiei, F. (2011, October). An integrated system for wireless monitoring of chronic patients and elderly people. In *15th International Conference on System Theory, Control and Computing* (pp. 1-4). IEEE.
- Said, N. A., Seman, S. A. A., Ab Latiff, D. S., Ma'o, S. N., & Mozie, N. M. (2021). Consumers' Behavioral Intention Towards Smartwatch Adoption in Malaysia: A Concept Paper. *International Journal of Innovative Computing*, 11(1), 13-19.
- Shin, G., Jarrahi, M. H., Fei, Y., Karami, A., Gafinowitz, N., Byun, A., & Lu, X. (2019). Wearable activity trackers, accuracy, adoption, acceptance and health impact: A systematic literature review. *Journal of biomedical informatics*, 93, 103153.
- Sittig, D. F., & Singh, H. (2015). A new socio-technical model for studying health information technology in complex adaptive healthcare systems. *Cognitive Informatics for Biomedicine: Human Computer Interaction in Healthcare*, 59-80.
- Smith, A. (2014). Older adults and technology use.
- Talukder, M. S., Laato, S., Islam, A. N., & Bao, Y. (2021). Continued use intention of wearable health technologies among the elderly: an enablers and inhibitors perspective. *Internet Research*, 31(5), 1611-1640.
- Talukder, M. S., Sorwar, G., Bao, Y., Ahmed, J. U., & Palash, M. A. S. (2020). Predicting antecedents of wearable healthcare technology acceptance by elderly: A combined SEM-Neural Network approach. *Technological Forecasting and Social Change*, 150, 119793.

Walker, G. H., Stanton, N. A., Salmon, P. M., & Jenkins, D. P. (2008). A review of sociotechnical systems theory: a classic concept for new command and control paradigms. *Theoretical issues in ergonomics science*, 9(6), 479-499.

Wright, R. and Keith, L., 2014. Wearable technology: If the tech fits, wear it. *Journal of Electronic Resources in Medical Libraries*, 11(4), pp.204-216.