

USER AFFORDANCES AND PATTERNS OF BEHAVIOUR ASSOCIATED WITH WEARABLE FITNESS DEVICES
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Thesis submitted in fulfilment of the requirements for the degree Master of Technology

in the Faculty of Informatics and Design at the Cape Peninsula University of Technology

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Abstract

This narrative study responds to a paper and statement by Yang (2016:256) who states that “despite the positive prospects and functionality of wearable devices, little research has been done on user acceptance and behaviours concerning them”. This study made use of Engeström’s second generation Activity theory (1983) to examine how wearable fitness devices influence and support a number of users’ behaviour by attempting to uncover the underlying user affordances and patterns of behaviour that emerge when people interact with wearable fitness devices.

Data was collected in the form of the content analysis that identified the hot areas of discussion in documents in the field. The second part of the case study was conducted through qualitative interviews with eight participants.. In addition, through emergent research data was coded and modified to best describe participant responses. All participants in this study were users’ of wearable fitness devices which were identified via peers, referral and convenient target sampling. The snowballing sampling technique was also deployed to engage with willing participants.

In addressing my research objective I have identified four user personas in relation to wearable fitness device usage.

I also present some of the tensions and contradictions that users experience when engaging within their various individual wearable fitness device activity systems. My primary data analyses also identified seven themes which emerged from the obtained results, these include adoption, lifestyle management, affordances, self-reflection, community/normative influences, motivations/self-efficacy and goal setting and incentive.

Declaration

I, David Lucian van Staden, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.



Signed:

Date: 11 November 2019

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Dedication

"It is not my knowledge to have but my knowing to share"

For WGM van Staden

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Glossary

Terms/Acronyms/Abbreviations	Definition/Explanation
Internet of Things (GSMA, 2015)	Refers to any network enabled device that has internet connectivity
Wearable devices (Ericsson.com, 2016)	Devices that are worn on the body that collect, analyse, share and assimilate data and information with other networked devices
Activity tracker	Devices that are worn on the body that collect, analyse, share and assimilate data from user's physical activity
Persuasive technologies (Fritz et al., 2014)	Technologies that collect, track and record user data over time to motivate and influence behaviour
Affordance (Baber et al., 2017)	The distinct properties of a device can effectively provide indications regarding proper interaction and use of said device
Personal informatics/Quantified self (Rooksby et al., 2014)	Personal informatics can be thought of as the desire to know more about the self through data accumulation, using informatics systems as a reflective tool which informs the user about his/her individual habits, behavioural patterns and intentions, generating meaning in the process.
Human computer interaction (Clemmensen et al., 2016)	Research that investigates the relation between human and computer interaction
Informatics systems (Li et al., 2010)	Studies the behaviour, structure and interactions between human and computer
Smart watch	A wrist-worn devices commonly armed with an interactive haptic display and computer operating system

1 Introduction

1.1 Background to the study

Wearable devices are a component of the Internet of Things (IoT) that allow for communication to occur between various IoT devices, devoid of human interaction, by connecting all devices both actual and virtual in real-time.

This essentially poses the potential in transforming any electronic device as part of an embedded network linked to an array of other connected devices. These internet enabled devices, which are integrated within the physical world become part of a constant interchange and sharing of information, aiding in diverse applications such as predictive maintenance, reduced human effort, health and patient monitoring and better data analytics. This research dissertation and study responds to a growing academic concern in the area of design and technology user behaviour. The work responds to a paper and statement by Yang (2016:256) who states that “despite the positive prospects and functionality of wearable devices, little research has been done on user acceptance and behaviours concerning them”. The lack of research into human interaction design with regards to wearable devices is indeed clear. The research explores the reciprocal nature between humans and technology and how meaning is generated through interaction and interpretation. In particular, the research describes the affordances of smart watches, their relation to behaviour variables and how behaviour is influenced by factors that contribute to the adoption of wearable technology.

The aforementioned paper and remark by Yang (2016:256) is reinforced as a vital area of research as Yang mentions Chuah, Rauschnabel, Krey, Nguyen, Ramayah and Lade (2016:276) who says that “[a]lthough still in the early stages of diffusion, smart watches represent the most popular type of wearable devices. Yet, little is known about why some people are more likely to adopt smart watches than others.” Fritz, Huang, Murphy (and) Zimmermann (2014) emphasise that these persuasive technologies that collect, track and record user data over time, hold the potential to motivate and influence behaviour and change.

Fritz and his co-authors (2014) refer to their study involving 30 adoptees of wearable activity trackers, proving that user engagement and practice change over time. It argues that the success of these wearable activity trackers is dependent on an understanding of the value that these devices may offer in terms of adapting and evolving user engagement, in addition to the affordances that can be derived from self-monitoring over long term use in supporting human behavioural changes.

According to Baber and his co-authors an affordance relates to some objects properties that effectively provide indications regarding proper interaction and use of a device (Baber, Khattab, Russell, Hermsdörfer and Wing, 2017). Norman (1999) further conditions the occurrence of an affordance as existing independently from its perceived presence, stating that the perception of an affordance can still provide incentives despite the actual applicability of its real affordance.

These wearable devices which in effect are objects that allow for multiple mediated relationships to exist between users and their environment holds a number of potential affordances especially if we take into account Fritz and his co-authors who states that the “emergence of commercial wearable devices for tracking health and fitness related activities arguably represents the first widespread adoption of dedicated ubiquitous persuasive technology” (Fritz et al., 2014: 487).

1.2 Research area

1.2.1 Background of the study

As part of the 2030 United Nations Sustainable Development Agenda and the World Economic Forum’s Digital Economy and Society System Initiative, the Internet of Things has been identified as a key technology with value-generating applications in sustainability, environmental improvement, competitive markets and more sophisticated products as a consequence (Arias, Lueth (and) Rastogi, 2018). The Internet of Things (IoT) refers to any network-enabled device that has internet connectivity. These wearable devices have the ability to collect, analyse, share and assimilate data and information with other networked devices.

Wearable devices which are worn on the human body, are becoming increasingly popular within mainstream society (Ericsson.com, 2016). A study by Ericsson Consumerlab (2016) which involved a quantitative online survey of 2500 users of wearable devices between ages 15-65 across five countries, identified five key findings. One of these surveys identified wearable devices as the most personal device in that users would describe themselves as “naked” without their device. The same survey identified usage over several categories, results of which report that 67(%) of people made use of their wearable device during exercise, 49(%) while at work or college, 48(%) while shopping, 33(%) during dinner time and 26(%) whilst sleeping in bed. Other key findings include consumer predictions who allocated wearable device usage and uptake as mainstream within the next five years with applications beyond health and fitness. Other key insight posits wearable device manufacturers as data brokers linked to personalised healthcare. The report also found that 43(%) of surveyed participants believed wearables, such as smart watches, would replace smart phones whilst 74(%) assumed that wearable sensor technologies would allow for an array of mediated relationships to exist between users and how they interact with their physical environment (Ericsson.com, 2016:4).

1.2.2 Internet of things

The Internet of Things (IoT) refers to any network enabled device that has internet connectivity. In our current information age it forms part of many contexts. Included in its applications are smart cities, agriculture, wearable devices and healthcare (GSMA, 2015). As part of the 2030 United Nations Sustainable Development Agenda and the World Economic Forum's Digital Economy and Society System Initiative, the Internet of Things has been identified as a key technology with value generating applications in sustainability, environmental improvement, competitive markets and more sophisticated products as a consequence (Arias et al., 2018).

The Internet of Things embodies an array of billions of connected devices. These Internet enabled devices which hold the capability to share, collect and assimilate information in real-time, provide a variety of additional intelligent capabilities. Such connectivity allows for communication to occur between various IoT devices, devoid of human implication. Figure 2 shows findings from a report conducted by Ericsson.com on projected IoT growth in terms of the number of connected devices.

The Internet of Things

From connecting devices to human value

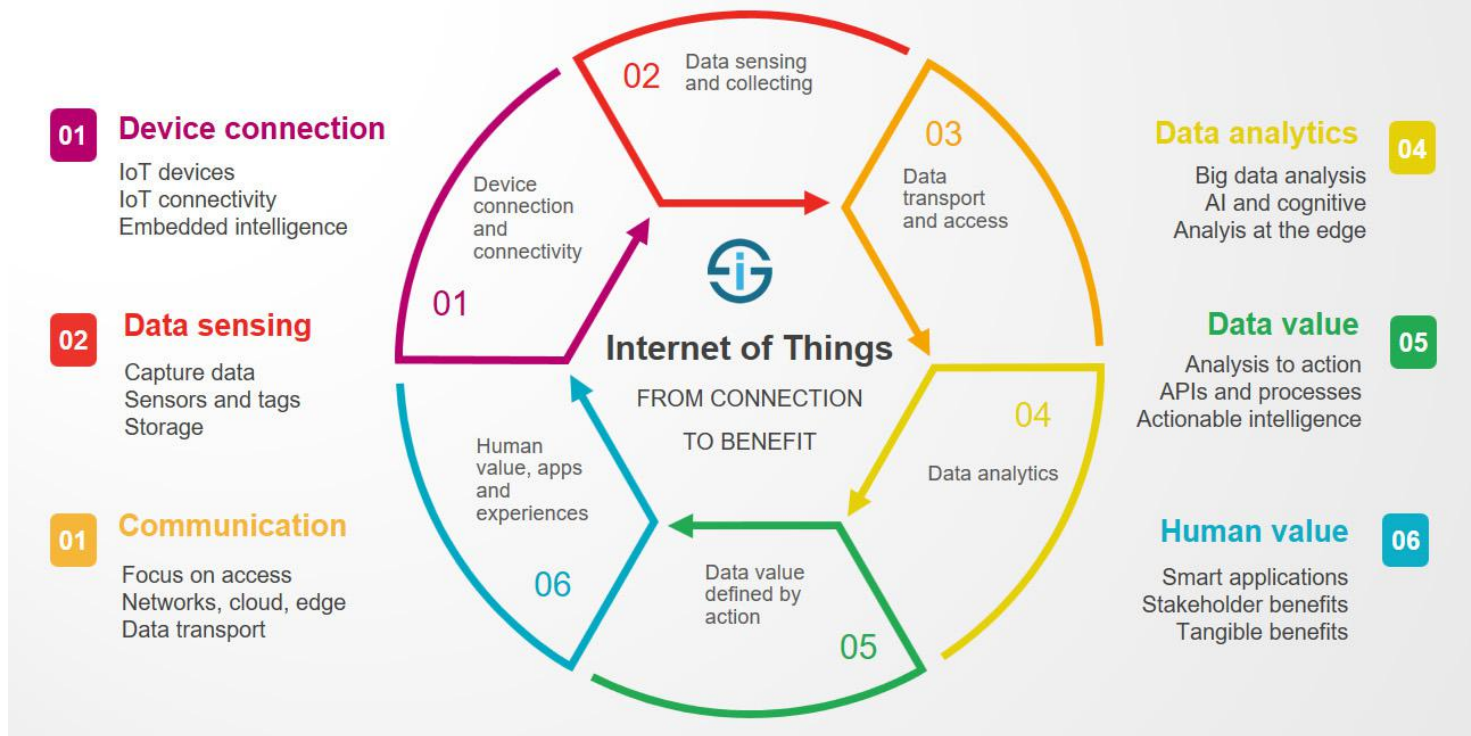


Figure 1: Internet of Things definitions(I-scopeu. 2019.)

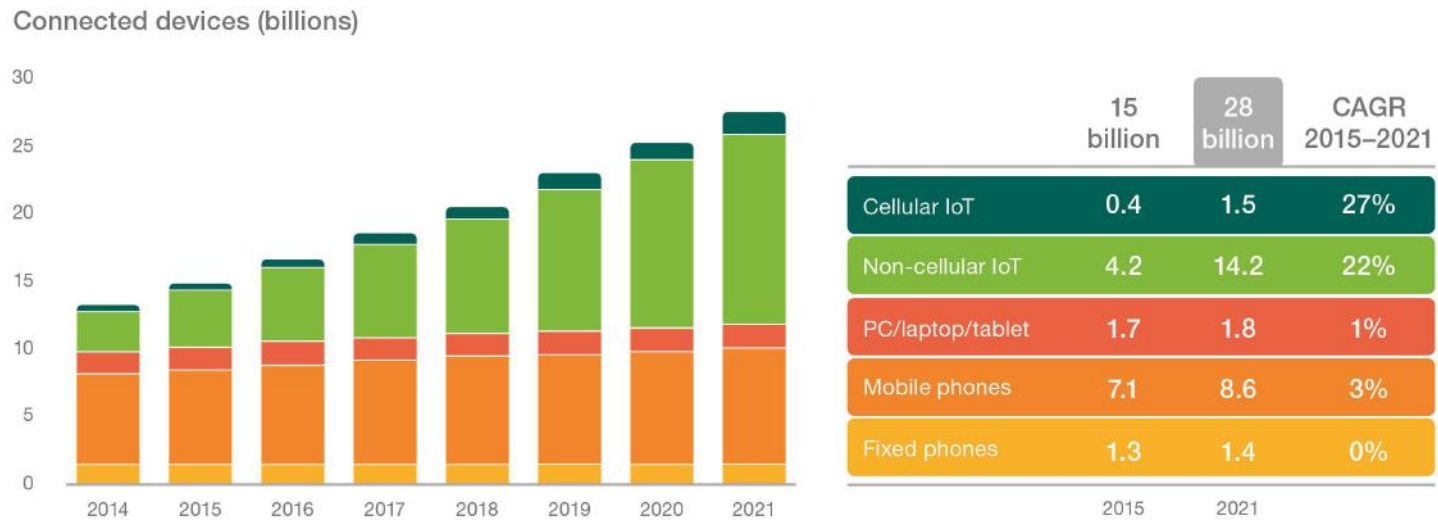


Figure 2: Internet of Things forecast (Ericsson.com, 2019).

1.2.3 Wearable devices

Wearable devices are a component of the Internet of Things, sharing the same efficiency to communicate intelligently by tracking and measuring an array of user biometrics, such as heart rate monitoring, activity tracking and blood oxygen levels. These wearable devices include smart watches and fitness trackers, and through active internet connectivity allow for a mediated relationship to exist between the physical and digital space. Wearable devices both collect and share information and form part in a constant interchange between users, with its users' being both consumers and producers of information at any given time.

Vendor	3Q17 Volumes	3Q17 Market	3Q 2016 Volumes	3Q16 Market	Year to Year
Xiaomi	3.6M	13.7	3.7M	15.2	-3.3
Fitbit	3.6M	13.7%	5.4M	21.9%	-33.0
Apple	2.7M	10.3%	1.8M	7.3%	52.4%
Huawei	1.6M	6.0%	0.6M	2.5%	156.4%
Garmin	1.3M	4.9%	1.3M	5.4%	-3.3%
Others	13.5M	51.4%	11.7M	47.7%	15.7%
Total	26.3M	100%	24.5M	100%	7.3%

Table 1: From International Data Corporation, Global Wearable's Market, November 2017 (IDC 2017)



Figure 3: Fitness trackers by Fitbit, Garmin, Xiaomi and more (Stables, J. 2019).

The literature suggests that wearable devices support several behavioural strategies that may influence behaviour. Sullivan and Lachman (2017) note that virtual coaching or device prompts via activity summaries can be effective in encouraging increased user activity, alluding to the motivational affordance of wearable activity trackers. One way in which this is achieved is through self monitoring. Wearable devices can track and monitor user's physical activity over long periods and provide users with feedback and progress reports to encourage healthy, positive behaviour.

In a study by Mercer, Li, Giangregorio, Burns, and Grindrod (2016) that explores potential drivers for behaviour change, several affordances were identified in relation to self-monitoring and self-regulation offered by current wearable devices. Their study states that "current wearable trackers offer significant potential with regard to behavioural change techniques relevant to uptake by all populations" (ibid). Wearable devices provide an array of affordances in part since they provide the user with easily accessible information that can be tailored to user objectives. It can facilitate monitoring of health and activity tracking in a guided and structured manner. Baber, Khattab, Russell, Hermsdörfer and Wing (2017) define an affordance as the ability to act and seize situational advantages in seeking individual intention. The suggestion by devices or objects providing cues or coaching user interaction can be linked to Hartson's (2003) affording types. He defines four types of affordances within interaction design: cognitive affordance, physical affordance, sensory affordance and functional affordance (Hartson, 2003). As a behavioural affordance, the way in which an object functions may influence its ability to both engage and prompt user activity. Through device prompts and user input, activities can be undertaken in a focused manner towards improving physical well-being (Mercer et al., 2016). Chuah et al. (2016: 276) further note that "little is known about why some people are more likely to adopt smart watches than others." Mercer et al. (2016) also list several behavioural change techniques that are not present in current wearable devices, bringing to our attention the potential and additional affordances current wearable devices may provide users in assisting user objectives within day to day use. In their findings are problem-solving, use of follow-up prompts, coping planning, motivational interviewing and environmental restructuring (Mercer et al., 2016).

1.2.4 Research problem

Wearable fitness devices can potentially change behaviour however further research is required to investigate the extent wearable fitness devices influence and support user practices and behaviour. This research is important as wearable fitness devices holds several affordances that can be linked to behaviour change and influence. The current literature suggests that wearable fitness devices hold key affordances such as motivation, reflection and self monitoring which can facilitate behavioural change strategies around personal needs and objectives. The research focuses on individuals who have already adopted these wearable fitness devices believing in the value that they afford. Understanding the variables related to specific use and context of wearable fitness devices and their related value to user practices will aid in the advancement of existing knowledge around the topic.

1.2.5 Aim

The aim of this study was to explore the patterns that emerge when people interact with wearable fitness devices.

1.2.6 Research questions

- What are the affordances of wearable fitness devices?
- How do people apply these affordances?

1.2.7 Research objectives

The objective of this study was to identify user personas in relation to wearable fitness device usage.

1.2.8 Significance of the study

This study contributes to understanding the patterns of engagement associated with wearable device usage. In addition, the development of personas in relation to device use and categories of behavior can assist, improve and increase our personal, professional and societal interaction, fostering a useful connection between the physical and digital space.

1.2.9 Research design and methods

I have used Activity Theory to underline and bind this study in answering my research questions. This study made use of second generation Activity theory (Engeström, 1983) to examine how wearable fitness devices influence and support a number of users' behaviour by attempting to uncover the underlying user affordances and patterns of behaviour that emerge when people interact with wearable fitness devices. As a narrative study it explored current users' relationships with wrist-worn wearable fitness devices to provide an understanding of how device use and interactions relate to personal and social practices (Johnson and Onwuegbuzie, 2004).

1.2.10 Data collection techniques

Data for this study was collected in the form of the content analysis that identified the hot areas of discussion in documents in this field. In addition, my main source of data for this study was collected by conducting individual interviews with willing participants in which I directed a line of inquiry around personal use of these wearable fitness device and how its functional features relate to everyday practices.

1.2.11 Case study

I have used a case study method to explore the contemporary relationship and the associated objectives and scenarios that users engage with when using wearable activity tracking devices. The chosen approach aimed to provide a fully descriptive interpretation of a phenomenon by interrogating mixed sources of data as described through individual accounts (Scapens, 2004:15).

1.2.12 Interviews

Yin notes that a challenging aspect of a case study methodology is the varied and diverse context of data collection and sources it inevitably provides, warning against a disconnect that could exist between uncovered variables and its relation to data points in addressing the research question (1981:104) In addressing this concern, my data was guided by a protocol which involved interviewing current users of wrist-worn wearable devices once circa 60 minutes. Audio recordings was transcribed and the text analysed and formatted using an inductive approach, moving from the general to the specific, to categorise and sub-categorise findings (Thomas, 2016: 237).

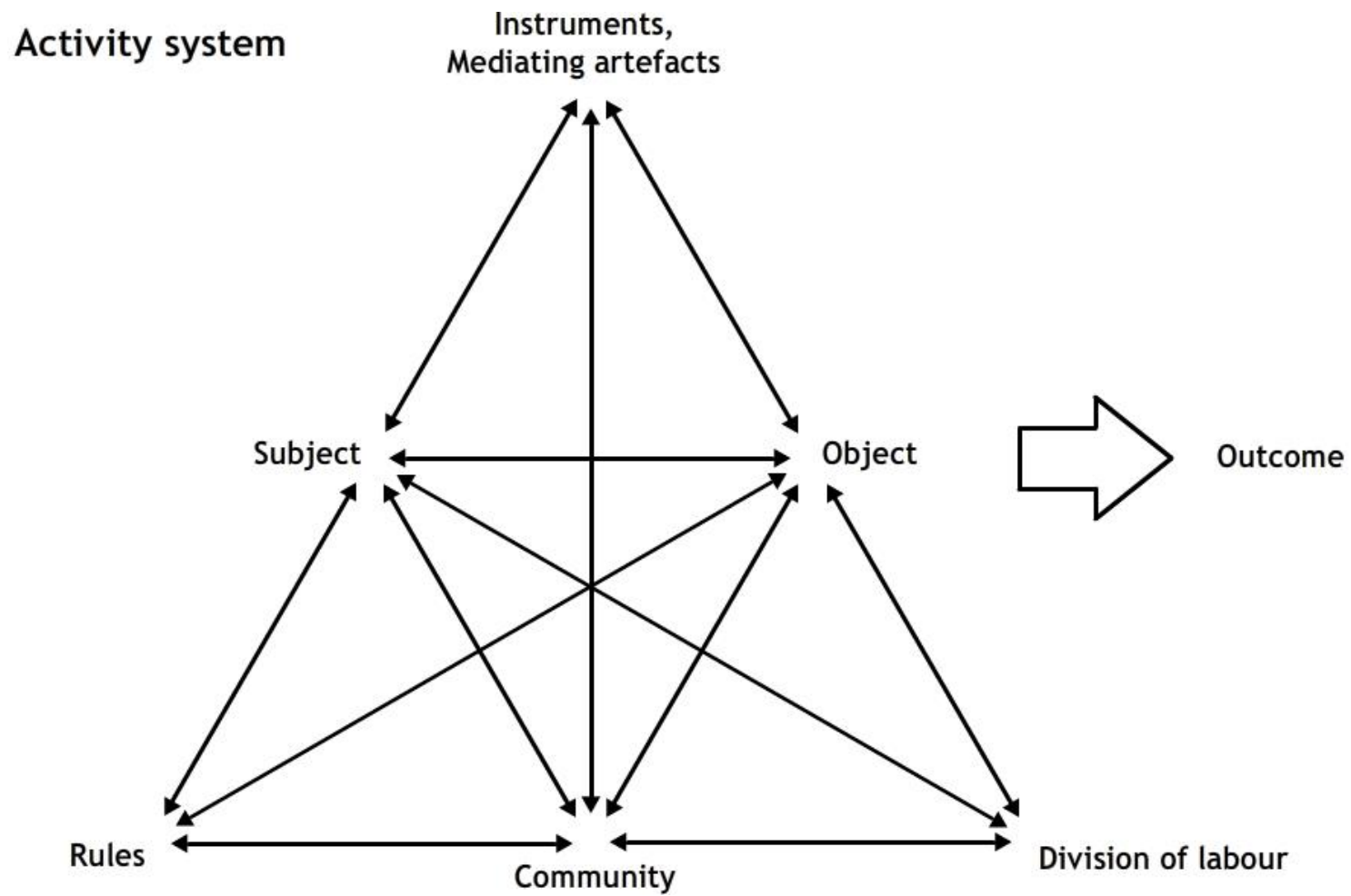


Figure 4: Engeström mediated structure of an Activity System (Engeström, 1983)

1.2.13 Delineations of the study

The scope of this study was limited to user interaction with wearable devices, with specific focus on wearable fitness and activity trackers. The study looked at current publicly accessible wearable technology, aiming to provide an understanding of how users interact with their wearable fitness device. This study did not investigate the inner technological workings of wearable fitness devices or for that matter the broader umbrella of the Internet of Things with regards to user security, user identity, health applications or information technology.

1.2.14 Outline of chapters

Chapter 1- Introduction to the study

- This chapter provides an introduction to the study as well as providing a background to wearable devices and the Internet of Things (IoT). Additionally, it briefly outlines the research objectives as it pertains to identifying user personas in relation to wearable fitness device usage. Furthermore, it outlines the research design and methods and significance of the study in relation to understanding the patterns of engagement associated with wearable device usage.

Chapter 2- Literature review

- In this chapter I report on my systematic review of current literature around wearable fitness devices and using Activity Theory as the model with which to examine an activity system i.e. user interaction with and usage of their wearable fitness trackers. Furthermore, it reports on results that relate to behaviour variables such as adoption, value, intention, enjoyment, image, observable differences, levels of interaction, behavioural encouragement and promoting positive attitudes around smart watches and fitness trackers.

Chapter 3- Research Design and Methods

- This chapter describes the research methodology and research design process undertaken within this narrative study. Using Activity theory as a lens and analysis tool it outlines the chosen approach indicating sample size, data sources, instrumentation which supplemented data collection and its analysis. As a narrative study it aimed to explore the patterns of behaviour that emerge when people interact with wearable fitness devices. For this reason Activity Theory was chosen as a theoretical framework in that it examines individual activity as interrelated and influenced by its environment of which such interaction is indirect and mediated by tools and signs (Vygotski, 1978) and (Hashim and Jones, 2007).

Chapter 4- Findings

- This chapter reports on my findings as obtained from individual interviews and thematic content analysis in response to my research question and sub questions. It also reports on results obtained from eight participants which were reduced to four personas using an Activity Theory framework. In this chapter I also highlight some of the contradictions and tensions that occurred between the various wearable fitness device activity systems in relation to personal use and its associated elements as represented within my four personas.

Chapter 5- Discussion and Conclusion

- In this chapter I provide a justification for this study by stating its contribution with regards to research into human interaction design and wearable devices, and cultural historical activity theory (CHAT).

1.2.15 Ethical considerations

This study and collected research remained ethical in its approach in that it put appropriate measures in place to mitigate possible physical, psychological, social, cultural, environmental or financial risk to participants directly involved in the study. Sources of data gathering involved conducting individual semi-structured interviews which required potential interviewees to provide written consent. In this letter of consent potential participants were made aware of the nature of the research and the kind of the data to be collected. Research for this study was done in Cape Town and made use of informants that are resident in Cape Town. Permission was asked from participants to allow for any reproduction, sharing of personal device data to preserve individual's privacy and personal information.. Where applicable personal data was anonymised by making use of pseudonyms to describe participants.

1.2.16 Summary

This chapter outlined the rationale for the study. It briefly discussed the theoretical underpinning as well as the associated research design and methods of enquiry deployed in addressing the research objectives and aims of this study.

2 Literature review

2.1 Introduction

In this chapter I report on my systematic review of current literature around wearable fitness devices and using Activity Theory as the model with which to examine an activity system i.e. user interaction with and usage of their wearable fitness trackers. As mentioned in the introduction, there is a growing academic concern about the lack of research into human interaction design and especially its potential to influence behaviour. The prevailing objective starts with a critical exploration of a paper and statement by Yang (2016:256) who refers to the positive aspects and functionality of wearable devices as well as the lack of research into the influences on user behaviour. This review reports on results that relate to behaviour variables such as adoption, value, intention, enjoyment, image, observable differences, levels of interaction, behavioural encouragement and promoting positive attitudes.

The content analysis application to the literature regarding the affordances of smart devices, of which I discuss in more detail later, contributed immensely to the study. It became possible to evaluate at a glance, the constructs and categories directing the scientific discussion in peer-reviewed publications.

2.2 Methodology and Data Collection

This review was based on the assumption that smart watches have behaviour influencing affordances but little is known about specifics associated and the extent to which user interactions can be modified. This review explored how smart watches and fitness trackers potentially influence user behaviour, as well as future affordances. The latter informs a large part of my own user based research. Additionally, it uncovers some of the research methods used within this field, as it pertains to human computer interaction.

Data was obtained through database searches, reference searches and article abstracts via EBSCOhost, AMC digital library, Academic Research Premier and IEEE Xplore Digital Library. These were chosen since they are leaders in the field of computer and technological system research. Additionally, these databases offer full text availability of articles. Initial sampling was done based on the number of citations, journal type and subject relevance. As an integral part of the research design and methodology, I applied specific constructs and categories to my search for applicable literature over various databases. This served as an independent first phase of the research process, as I was able to identify the most relevant and critical areas of research with respect to the potential affordances that users gain from smart device use. Studies were included if they were written in English between 2014 and 2018 and reported on research findings that clearly related to my own research.

This was done to provide the most up to date literature on the topic. Initial searches across the specific databases yielded a total result of 10 308 articles based on keyword entries. Of the 10 308 I excluded 10 098 based on exclusion criteria which included studies related to and reported on perception and behaviour in virtual reality, haptic visual interaction and motor imagery, design structure matrices, input devices and wearable technology, activity based working in the office, activity recognition systems, embedded RFID's, source code instrumentation, mobile app design, cloud objects, wireless technology, power management, cloud computing servers, Big Data etc. Database and article searches yielded 210 studies. These articles were then screened for eligibility from their article abstracts, illustrated in Table 2.

A content analysis second phase was employed, (Figure 6 and 7) to more specifically demarcate the “hot” points to pursue in this much-contested area. My inclusion criteria for this phase of the content analysis reported on results that relate to behaviour variables such as adoption, value, intention and enjoyment.

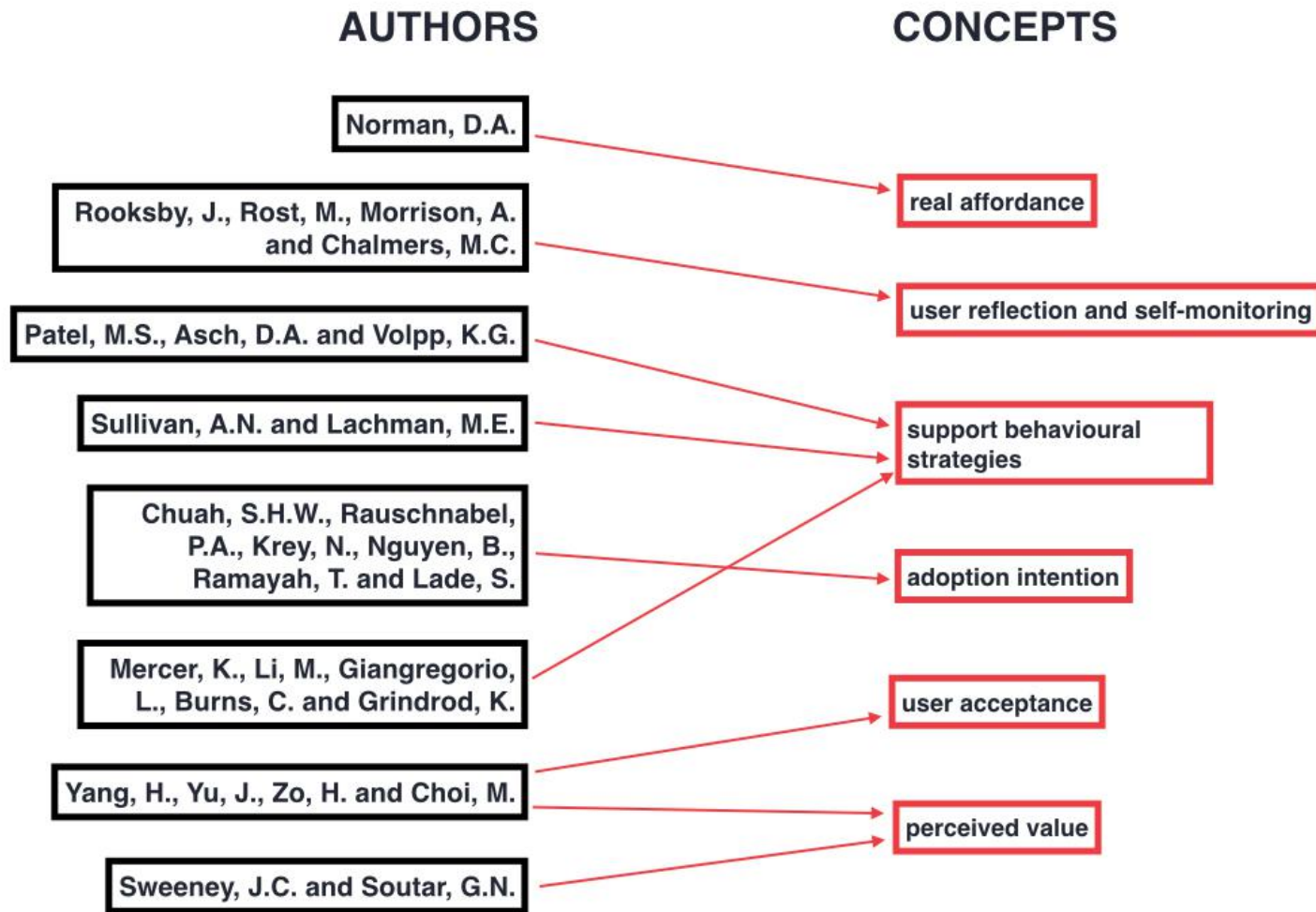


Figure 5: Content analyses: first phase (Author, 2018)

Key Authors	Adoption factors		Behaviour and Influence		Real world context		Strategies for behavior change		Barriers to adoption		Forming beliefs		Goal-setting			
	Affordances and Barriers	Challenges	Coaching	Real world context	Strategies for behavior change	Barriers to adoption	Forming beliefs	Goal-setting	Affordances and Barriers	Challenges	Coaching	Real world context	Strategies for behavior change	Barriers to adoption	Forming beliefs	Goal-setting
Adapa, A., Nah, F.F.H., Hall, R.H., Siau, K. and Smith, S.N.																
Ajzen, I.																
Atzori, L., Iera, A. and Morabito, G.																
Baber, C., Khattab, A., Russell, M., Hermsdörfer, J., Wing, A.																
Bagozzi, R.P.																
Becker, M., Kolbeck, A., Matt, C. and Hess, T.																
Brian Kiessling, I.I. and Kennedy-Armbruster, C.																
Canhoto, A.I. and Arp, S.																
Cecchinato, M.E., Cox, A.L. and Bird, J.																
Chang, H.S., Lee, S.C. and Ji, Y.G.																
Chuah, S.H.W., Rauschnabel, P.A., Krey, N., Nguyen, B., Ramayah, T. and Lade, S.																
Consolvo, S., McDonald, D.W. and Landay, J.A.																
Dehghani, M.																
Dehghani, M., Kim, K.J. and Dangelico, R.M.																
Duro, L.																
Fogg B.J.																
Fritz, T., Huang, E.M., Murphy, G.C. and Zimmermann, T.																
Gagné, M. and Deci, E.L.																
Harrison, D., Marshall, P., Bianchi-Berthouze, N. and Bird, J.																
Hartson, R.																
Hitchings, H.																
Jarrah, M.H., Gafinowitz, N. and Shin, G.																
Jeong, H., Kim, H., Kim, R., Lee, U. and Jeong, Y.																

Figure 6: Content analyses second phase (Author, 2018)

Individual documents were classified according to subject relevance. These were then analysed in order to identify constructs that would form part of the code list. Outcomes from my examination included the original 210 studies which were screened for eligibility. Of the 106 subsequently identified, 52 met inclusion criteria for investigating the behavioural strategies and motivations that wearable technology and activity trackers afford their users. These studies were included as they reported on results that relate to behaviour variables such as adoption, value, intention, enjoyment, image or brand, observable differences, levels of interaction, behavioural encouragement and promoting positive attitudes. These 52 studies became the rationale of my content analysis. Table 2 numerically summarises my inclusion and exclusion criteria.

number of records through online academic databases and search engines (includ. EBSCOhost, AMC digital library, Academic Research Premier and IEEE Xplore Digital Library and Google Scholar)	
Keywords: behaviour, wearable devices, smartwatches, activity trackers, benefits, affordances and fitness trackers.	
Period 2014-2018	10 308
Additional records through other sources eg. references	26
Exclusion criteria	10 098
Screened records	184
Records assessed for eligibility	106
Studies included in Literature Review	54
Full text articles excluded	52

Table 2: Summary of inclusion and exclusion criteria (Author, 2018)

2.3 Data Analysis

Data analysis and coding was done using Atlas Ti, a qualitative data analysis and research software package. My investigative procedure entailed making use of predetermined codes as generated through literature as well as the development of new codes. Through a process of reading and re-reading text, initial codes were further developed into sub-codes to achieve data saturation. As an example, the code affordances was further developed into sub-codes to include types of affordances such as physical and sensory affordances.

2.4 Analysis of the literature

The current literature suggests that wearable fitness devices hold key affordances such as motivation, reflection and self monitoring which can facilitate behavioural change strategies around personal needs and objectives. Understanding these variables related to specific use and context of wearable fitness devices and their related value to user practices, aids in the advancement of existing knowledge around the topic. In what follows I put forward the critical areas that were illuminated as a result of the content analysis, which serves as an integral part of my main design strategy and methodology. These critical areas are interpreted under the following; affordance types, personal informatics, motivation, intention, goal setting, and perceived value.

2.4.1 Affordances

According to Baber and his co-authors an affordance relates to some objects properties that effectively provide indications regarding proper interaction and use of a device (Baber, Khattab, Russell, Hermsdörfer (and) Wing, 2017). On affordances, Norman (1999) makes two very clear distinctions; that of perceived affordance and real affordance. He conditions the occurrence of an affordance as existing independently from its perceived presence, stating that the perception of an affordance can still provide incentives despite the actual applicability of its real affordance. A distinction is made between real affordance and perceived affordance, where the former is the amplitude of potential action and the visible perception of such possibility (Norman, 1999).

In *Affordance, Convention and Design*, Norman (1999) further argues that the distinct properties of a device can effectively provide indications regarding proper interaction and use of said device. He argues that knowing the operational properties of a device is related to three important aspects - conceptual models, constraints, and affordances. Hartson (2003), in a concept paper on human interaction design, reaffirms the conceptual importance of affordances as an evaluative measure, arguing that understanding the conceptual underpinning as it drives theoretical formulation, aids in explaining the practical predictability of users with reference to computers or systems interaction. He describes four affordance types as supportive of user interaction: cognitive affordance, physical affordance, sensory affordance, and functional affordance and necessitates that their division, although conceptually integrated, is justified by a need to understand the different methods and procedures associated with them.

2.4.2 Cognitive affordance

Cognitive affordance provides clarity on the device's functionality and imparts an understanding of the potential outcomes or consequences through physical user interaction. Hartson (2003) further states that cognitive affordance is partially shaped or impacted by social convention as its meaning or interpretation depends on recognisable and relatable indications

2.4.3 Physical affordance

Physical affordance is physical interaction with an object and, more importantly, it supports the users' physical intention in relation to the desired activity or functionality. Physical affordances are the enabling factors that support or aid the accomplishment of physical activities whereas cognitive affordances serve as a measure of awareness attributed to understanding interplay and outcomes (Hartson, 2003).

2.4.4 Sensory affordance

Sensory affordance can be thought of as a supportive component related to the previous two affordances. In addition, it is connected to human senses such as touch or haptic feedback, and auditory or visual incentives (Hartson, 2003).

2.4.5 Functional affordance

Functional affordances refer to the functional characteristics of a system or device that adds purpose through interaction in order to facilitate user intentions and goals. Functional affordance is the operationalised variables that enable use and utility (Hartson, 2003). Hartson's affordance types suggest that wearable devices and in particular wrist worn activity trackers, hold a number of activating interactions or affordances to assist user motivations and objectives. For example, these devices usually employ a touch-sensitive, interactive visual display. Additionally, users are alerted via device prompts which includes audio, haptic and visual cues which promote user feedback and structured engagement.

2.4.6 Personal informatics

A key usability factor of these wearable fitness trackers is their ubiquitous ability to permit online connectivity using smart sensor technologies, to assimilate and present contextual information for accumulation and observation of personal quantified data (Personal Informatics) (Li et al., 2010). This exchange of information usually occurs as part of a larger digital ecosystem, making participating users part of a collective digital fabric. It generalises connectivity as part of a distributed knowledge base where value is generated through a collective exchange of information. Based on Hartson's (2003) observations, and provided that we analyse an experience exhibiting the necessary criteria affirming the characteristics of his affording types, I suggest that Personal Informatics, also termed Lived informatics (Rooksby et al., 2014) are most influential and perhaps fundamental in developing effective systems that support user reflection and self monitoring (Li et al., 2010). In broad terms, Personal informatics is the desire to know more about oneself through data accumulation, using informatics systems as reflective tools informing the user about individual habits, behavioural patterns and intentions, thus generating meaning. A study by Li et al. (2010), in response to addressing and quantifying problems related to effective use of informatics systems, surveyed and interviewed a number of people that actively collect and reflect on their personal activity tracking information. Their findings advanced the development of a stage based model in an effort to outline personal informatics systems. The study also concluded that there are several barriers that individuals confront related to their model categories (Li et al., 2010). Below I briefly comment on their five stage model demonstrated under the following headings Preparation, Collection, Integration, Reflection and Action.

2.4.7 Preparation

According to Li et al. the preparation stage deals with the associated motivations that drive users to collect and capture personal data. This process also encourages users to make specific decisions regarding the necessary tools needed in gaining user quantified information. What Li et al. points out, however, is that barriers often occur as a consequence when device tools become inadequate in capturing relevant data leading to device abandonment and the adoption of new tools.

2.4.8 Collection

The collection phase refers to the period where users actively accumulate quantified data. This usually incorporates different stages of introspection and self reflection, involving interaction with people and the user's environment. The collection phase is a combination of the frequency of data collection and the reasons for tracking various activities, such as sleep patterns, exercise etc. According to Li et al. barriers encountered during this phase relate to tool paucity, lack of motivation and lack of integration which their study posits is due to a lack of time investment from users (Li et al., 2010).

2.4.9 Integration

The integration stage is the middle ground between the preparation and collection phase where users' quantified data is transformed and reflected upon. Barriers experienced during this phase, according to Li et al, are dependant on the ease of integration and amount of effort users experience as they transition from capturing the data to reflecting on the captured data. Li et al also point out that these integration barriers may also prevent users from considering or acting on the captured data which, in their study, they ascribe to a disconnect between collected format and outputs (Li et al., 2010).

2.4.10 Reflection

According to Li et al. in the reflection stage users contemplate on captured data. Li et al make two observations that may occur during this process, that of short term reflection and long term reflection. These processes occur when users analyse and interact with captured and tracked information that is visually and graphically represented. This is seen as valuable by Li et al. in that users become able to think about and compare data to expose developments or patterns. Difficulties encountered during this phase are attributed to users being unable to understand, retrieve or explore the information (Li et al., 2010).

2.4.11 Action

In the action phase, users decide to take action based on the information they have accumulated about their new physical or environmental endeavour. This new knowledge allows for the individual to set targeted goals or provide recommendations that incentivise and motivate a change in certain behaviours (Li et al., 2010). A significant point posited by Li et al. in their stage based model is that an effective personal informatics system needs to consider all parts of the involved system. This requires the resolve of barriers and tensions in order to provide a holistic approach in the design of personal informatics systems, and to ensure prolonged, committed user engagement.

2.4.12 Motivations and Intention

The literature suggests that the forming of new behaviours are formed through motivation and intention. In The Theory of Planned Behaviour, Ajzen (1991:206) it is contended that intention and individual response can be oriented by understanding the attitudes linked to personal situations or control beliefs and perceived behavioural controls. Control beliefs are the conceived affordances that provide the users with a perceived ability (perceived behavioural control) that incentivises intention and motivation. Ajzen (1991:196) comments that “the more resources and opportunities individuals believe they possess, the greater should be their perceived control over the behaviour”. What can be confirmed from this in relation to these persuasive technologies, is that they hold a number of affordances that can improve and increase our personal, professional and societal interaction, fostering a measurable connection between the physical and digital. In a study by Ericsson Consumerlab (2016) involving 2500 users of wearable devices, 74(%) of users held the belief that wearable devices and sensors ,which include wearable fitness trackers, will assist in how they interact with their physical environment. According to Karahanna et al. (1999:188), individual attitudes are influenced by perceived usefulness, image, compatibility, visibility, and result demonstrability. Below I briefly comment on these influential factors.

2.4.13 Perceived usefulness

Perceived usefulness is the subjective belief that using a particular system or device will improve performance. “Image” is defined as the relevant perceived enrichment one obtains within a social context as a result of device or system adoption (Karahanna et al., 1999).

2.4.14 Compatibility

Compatibility is the level of integration that a particular device or system offers within typical user activity (Karahanna et al., 1999).

2.4.15 Visibility

Visibility is the degree to which a system or device's permutations are evident to users or organisations, bearing relevance to users' perceived behavioural beliefs in a particular system or device (Karahanna et al., 1999:188).

2.4.16 Result demonstrability

Result demonstrability explains the perceptible results that can be communicated as consequence of adopting a system or device (Karahanna et al., 1999:188). A cross-sectional study that explored organisational acceptance of information technology involving 30 organisations in China, found that intention is a forecaster of real behaviour (Mao and Palvia, 2006). The study involved adapting a research model from its United States origin. Its significance alluded to the cultural and social consideration in technology acceptance and use.

2.4.17 Intrinsic and extrinsic

The literature also distinguishes between intrinsic motivation, extrinsic motivation and hedonic motivation as influential and motivational causes that affect intention. Venkatesh et al. (2012) defines hedonic motivation as "the fun or pleasure derived from using a technology" (2012:161). Conceptually speaking, hedonic motivation is a predictor of behavioural intention. (2012:161). Intrinsic motivation implies individual preferences or selective incentivised motivation that can be purely situational or experience based. Extrinsic motivation in turn are motivations that are purposeful and goal orientated (Venkatesh et al.2012), (Rogers, 1995).

2.4.18 Goal setting

In 2015, Mansi, Milosavljevic, Tumilty, Hendrick, Higgs, (and) Baxter conducted a feasibility study focussing on increasing physical activity amongst workers (Mansi et al., 2015). The study, involving 53 participants, found that goal setting and self monitoring supported through motivational feedback or prompts, in this case email communication, could be effective in increasing physical activity. The study reports that of the 53 participants that concluded the intervention, all increased their daily step count from 5993 to 9792 steps per day. Mansi et al. (2015:6) and Fogg (2009:2) also suggest that smaller incremental goals that seem achievable and manageable by an individual or receiver are more likely to yield actual behavioural change. Locke and Latham (2002:706) identified and established in their goal setting theory that challenging goals had a direct and positive correlation with high achievement outcomes, provided individual ability is capable of achieving set goals. They point out that challenging goals do not naturally equate higher achievement outcomes, instead goal setting as a behavioural and motivational strategy of action, provides individualised focus and direction, lessening personal bias in attaining tasked objectives (Locke (and) Latham, 2002:707). Fogg's Behaviour Model (2009) also suggests that smaller incremental goals that seem achievable and manageable by an individual are more likely to yield actual behavioural change, equating behavioural adoption to three categories, namely motivation, ability and trigger (Fogg, 2009:2).

2.4.19 Perceived value

Yang, Yu, Zo (and) Choi, in a study investigating user acceptance of smartwatches in relation to their perceived value, describe the phenomenon as an individual's or customer's overall perceived trades and gains as pertaining to a device and interaction (Yang et al., 2016). Sweeney (and) Soutar, view perceived value as a generative construct that could exist both conceptually or independently of the device (Sweeney et al., 2001). Zethaml's study exploring consumer perception related to price, value and quality and which involved the collection of data from focus groups, company interviews and 30 consumer interviews, found that perceived value is largely a perceived phenomenon based on individual interpretation and meaning (Zeithaml, 1988). Outcomes of the study based perceived value within four categories of interpretation: price, desired need, received quality and cost to consumer, and value received in relation to consumer cost. Each of these yield a separate set of variables, summarised as "perceived value is the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" (Zeithaml, 1988:13) In their theoretical model, the same study lays out several strategies that would boost value and consumers' perception thereof, among them intrinsic and extrinsic motivation. (Zeithaml, 1988:18).

2.4.20 Behavioural theories

This literature survey included several studies from which I identified numerous theoretical grounds that aim to uncover some of the theories addressing how smart watches, activity trackers and wearable devices influence behavioural strategies and motivate behaviour. The Technology Acceptance Model (TAM) examines how actual behaviour of technological adopters is influenced by perceived usefulness and ease of use. The model cautions, however, that “technology acceptance research has not considered group, cultural, or social aspects of decision making and usage” (Bagozzi, 2007:247).

Gagné and Deci (2005) address Self Determination Theory as examining “self-motivation and personality integration, as well as for the conditions that foster those positive processes” (2005:68). On adoption of wearable devices, Adapa et al. (2018) draw conceptual similarities between Unified Theory of Technology Acceptance and Use of Technology (UTAUT) and the Technology Acceptance Model, as both relate to usability, accessibility and utility (2018:39). In a study aimed at trying to understand people’s motivations for using wearable trackers, Leão et al. (2017) note Uses and Gratifications Theory as a well suited approach in understanding the drivers behind wearable device use and the associated enjoyment in an everyday context (2017:28). The Transtheoretical Model of Behaviour Change is another method of describing intentional change and its progression to ultimate behaviour change (Consolvo et al. 2009:406).

2.5 Theoretical Framework

To understand Activity Theory, I briefly outline below its genesis, drawing specific attention to the development of Activity Theory or Cultural Historical Activity Theory (CHAT), as a means to describe, analyse and interpret human interaction in relation to their socio-cultural environment as it pertains to customs, attitudes, behaviour and practices.

2.5.1 CHAT and Leontiev Vygotski

Cultural Historical Activity Theory (CHAT) as developed by Leont’ev (1978; 1981) and Vygotski (1978), was originally conceived as an alternative approach aimed at describing human psychological practices as an evolutionary process. Vygotski (1978), posited that in order to describe human activity, one must consider human activity as a relationship between individuals and their social environment (Yamagata-Lynch, 2010). In his theory Vygotski developed a framework in which he underlined the essential interrelated relationship that exists between individual cognitive processes and their associated historical, cultural and systematised locations (Rogoff, 2008).

Drawing from Marxist political theory, Vygotski advocated for a more unified framework that considered human actions as complex systems that are formed through participation and the mediated act of co-created meaning. In essence, his method of investigation sought to examine individual action and its locale as the unit of analysis, examined along with its collective transactions and methods of production (Yamagata-Lynch, 2010).

2.5.2 Mediated action

Vygotski used the concept of mediated action to describe the relationship between shared signs and symbols and its role in allowing the advancement of human consciousness as a result of interactions that occur between operations, actions and activities (Leont'ev. 1978;1981) In his theory, all human action can be thought of as a non-static, mediated process that is linked to a specific cultural, organisational or historical context. As a socio-cultural phenomenon, Vygotski defined this relationship between signs, and tools and procedures as one that allows for transformative engagement to occur where new meaning is formed as individuals modify and develop new activities and new tools as consequence of mediated action between people and their environment. Furthermore, the human mind is portrayed as a genesis emerging and occurring as consequence of interaction with its environment, which can be understood and analysed only through the occurrence of an activity (Kaptelinin, 1996).

This mediated action that occurs between people and artefacts or tools can also lead to the development of new signs. In a sense, signs or indicators assist in the generation of new meaning in that they serve as tools that help individuals make sense of their changing environment. Signs may also be appropriated by a subject in order to transform initial signs into tools or cultural artefacts, as made available within their social environment This then assists in generating new meaning or in achieving an objective. It is generally agreed upon that it is the object of an activity system that drives individual participation in an activity system. This permits for the interplay and mediated processes to occur between the various elements (Yamagata-Lynch, 2010).According to Kaptelinin the general viewpoint of Activity Theory can be characterised as a means to assimilate the objective, in that the objective is viewed not as a disembodied action but a transformative and contextualised act (Futerman, 2015:83). Secondly, it seeks to identify as an activity system the relation of living organisms to one another and to their physical surroundings and the socio-cultural factors that depict the cultural aspects and cognitive developmental elements of humans (Kaptelinin, 1996).

2.5.3 Principles of Activity Theory

Kaptelinin and Nardi (1997:158), in defining Activity Theory as a conceptual structure as apposed to a predictive approach, ascribe five principles of Activity Theory that facilitate identifying the various components present in an activity system (Futerman, 2015:84). These include:

- hierarchical structure of activity,
- object-orientedness,
- internalisation/externalisation
- tool mediation
- development

2.5.4 Hierarchical Structure of an Activity

Kaptelinin and Nardi (1997:158), in outlining the hierarchy of an Activity System, describe the unit of analysis as the activity. These activities are applied to an object in order to achieve a specific outcome or direction. Actions in turn are conscious efforts undertaken to achieve a goal that are applied through operations which play a supportive role in allowing actions to adapt to situations as they unfold.

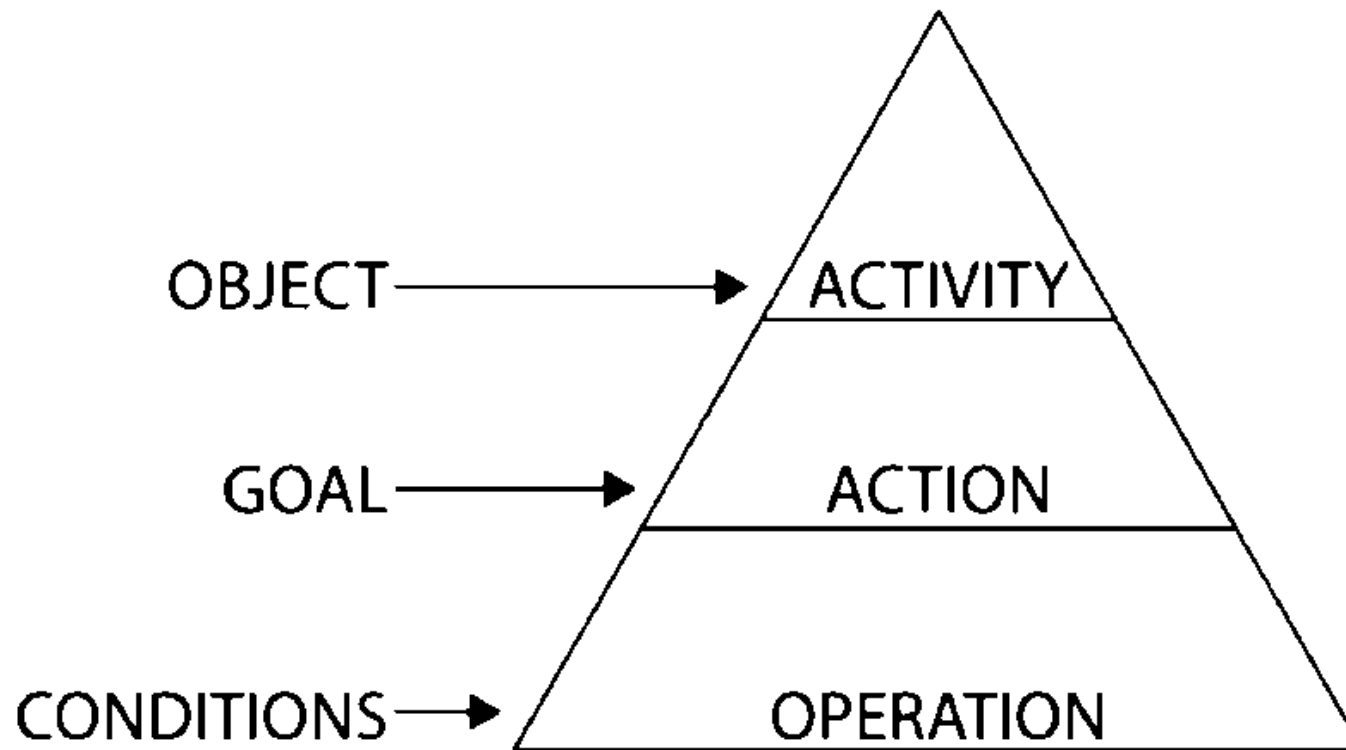


Figure 8: Hierarchical Structure of an Activity (Leont'ev, 1981)

2.5.5 Object-orientedness

The basis of object-orientedness states that our reality is objective in terms of its constituent parts that make up reality as well as its associated cultural and social properties (Kaptelinin and Nardi (1997:158). It also serves as a means to differentiate human activity according to its object (Futerman, 2015:84).

2.5.6 Internalisation/Externalisation

Activity Theory distinguishes between internal and external activities. It highlights that internal activities need to be analysed in relation to their constituent external counterparts if they are to be understood within a meaningful context. The relationships between internal and external activities are seen as transformative forces interrelating the two. Furthermore, the act of internalisation is the transformative agency that can turn an external activity into an internal activity. In a sense this can be seen as a reflective tool in that it allows people to adjust their interactions with current reality without the manipulation of their external environment. The act of externalisation however, may serve as a means to remedy internalised action (Kaptelinin and Nardi (1997:159). In wearable device usage (WDU) understanding device interactions and applications are key if it is to serve a collaborative role in supporting user objectives. As such internalisation may involve the acquisition of additional knowledge that allow users to customise device feedback while externalisation would involve applying such end user customisation to a fitness routine or training program.

2.5.7 Tool mediation

In Activity Theory terms, human action is negotiated through a mediated method by tools and signs. In the context of wearable device usage (WDU), a tool may be a step counter in that it mediates an activity toward an object, whereas a sign such as achieving 10 000 steps in order to receive a reward, direct such interaction. These tools and signs are developed as part of an activity and carry with them fragments native to its contextual background, such as cultural, historical and social knowledge. The use of tools and signs may also influence an individual's external behaviour and his or her way of thinking (Kaptelinin and Nardi (1997:159) and (Futerman, 2015:86).

2.5.8 Development

Development in Activity Theory states that human practice and its development not only changes over time as consequence of its socio-cultural context, but that such change over time is informed by the context of progression. In understanding activities, it is important to track how an activity changes over time, taking into account its history and development (Kaptelinin and Nardi (1997:159) and (Futerman, 2015:86).

2.6 Activity systems as framework for analysis

Activity Theory, as a framework for qualitative analysis, assumes three theoretical constructs; namely activity systems, contradictions and the zone of proximal development.

The zone of proximal development will not be applied as an analysis tool in this study. I have taken this decision based on Yamagata-Lynch, interpretation stating “Vygotsky used the concept of zone of proximal development (ZPD) as a metaphorical tool to explain the potential learning of children while collaborating in problem solving activities with an adult or peer” (2010:18). Contradictions in Activity Theory serve as generative construct in that it puts forward the notion of acquiring new knowledge when an activity system implements new external elements. Such contradictions in addition may lead to innovative ways in an attempt to support mediated and mutable activities (Engeström, 2010:137). Mwanza-Simwami, in explaining an Activity Systems, states that “At the individual level, the activity system can be used to study a single person’s interactions with his or her tools and the environment; whilst an analysis of collaborative practices can be focussed on examining shared objectives” (Mwanza-Simwami, 2013:180). The significance of the Vygotski model in terms of Activity Theory stems from analysing individual action as the unit of analysis. As a concept, Activity Theory examines individual activity as interrelated and influenced by its environment of which such interaction is indirect and mediated by tools and signs Vygotski (1978) and (Hashim and Jones, 2007). Figure 9 illustrates Vygotski’s mediational model.

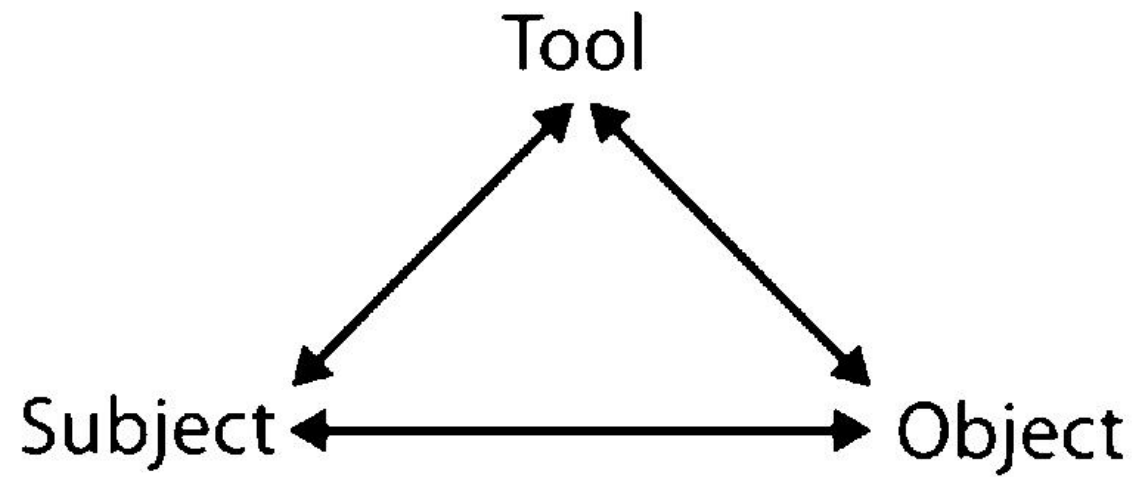


Figure 9: Hierarchical Structure of an Activity (Leont'ev, 1981)

Engestrom expanded on Vygotsky's mediational model to include community, which is mediated by cultural practices and social norms or the structured context between a subject and a community. The division of labour indicates how action should occur or how the flow of activities should be executed or distributed amongst other elements within the activity system in order to achieve an activity. These include ecosystems, virtual communities and smart sensors or smart notifications. These are negotiated in a mediated fashion between community and object. Rules are the associated customs both implicit and explicit as understood by the subjects involved within an Activity system which rule, or regulate the functioning of an activity system. This also includes frameworks, conventions, customs, laws and the mediated relationship between the subject and the community. The gathering of data as part of this study was analysed using Engestrom's second generation Activity Theory. (Engestrom, 1987). Activity Theory was chosen as it represents human activity as a dynamic, socially constructed phenomenon whose mediations can be understood through the operationalising between various elements within an activity system. Engestrom identified these elements as subject, object, tools, rules, division of labour and community.

In Activity Theory, human activity is understood through the study of artefacts and how human action is influenced and inseparable from a mediated relationship between artefacts or tools and the related components within an activity system. Human activity is viewed as a dynamic process containing elements that are under constant transition. (Kutti et al., 1996: 23). Roschelle, on activity theory, further describes it as an explanatory tool of which its fundamental and critical objective involves an analysis of an activity in an attempt to understand the infusion of individual activity in relation to society and artefact (Roschelle, 1998:242). The interrelatedness of an activity system can thus permit influence to occur or affect individual action in relation to tool, subject, object, rules, division of labour, community or tensions and contradictions which may exist as consequence of an interplay between participating activities within an activity system.

The section below describes my understanding of the various elements of a wearable device usage (WDU) Activity system.

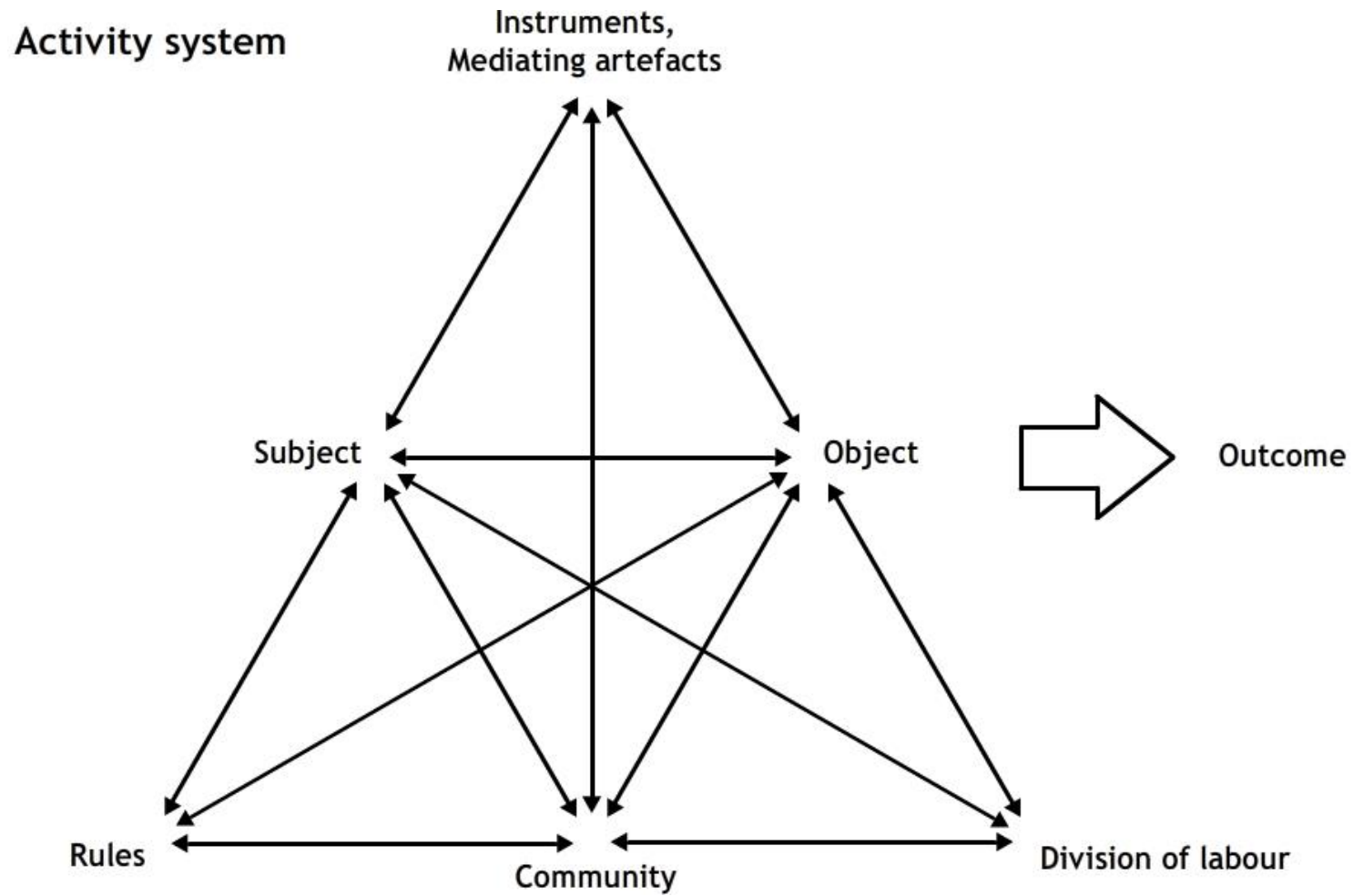


Figure 10: Engeström mediated structure of an Activity System (Engeström, 1983)

2.6.1 Tools

Within a WDU Activity system, tools refer to the characteristic behavioural affordances and device features that exist within an activity system to facilitate desired goals and outcomes. In this study, these may encompass functional affordances and physical affordances such as battery performance, smart notifications, a heart rate monitor and wireless connectivity.

2.6.2 Subject

The subject in my study refers to personalised action or the community involved or taking part within the WDU Activity System. These operators, depending on the mediated role they play within the Activity System, may include active adoptees or member groups and how they transition or adapt behaviour through wearable fitness device usage.

2.6.3 Object

The object within a WDU Activity system refers to the associated reasons pertaining to actionable intent or desired outcome or goals.

2.6.4 Rules

Rules within a WDU Activity system are the associated customs both implicit and explicit as understood by the subject involved within an Activity system which rule, or regulate the functioning of an activity system. These include group dynamics, social and cultural norms and device utility.

2.6.5 Community

The community within a WDU Activity system refers to the setting in which the activity system is taking place and can be understood as a shared object which is mediated by cultural practices and social norms or structured social context.

2.6.6 Division of Labour

This refers to the associated power dynamics and assigned roles of responsibility necessary in order to achieve an activity. This element, as part of my WDU Activity system, also indicates how action should occur or how the flow of activities should be executed or distributed amongst other elements within the activity system in order to achieve an activity. These include ecosystems, virtual communities and smart sensors or smart notifications.

The unit of observation in this study is the interviewed participants owning a wrist-worn wearable fitness device, with an existing belief in the value and potential affordances of these devices. An additional point of interest for the research was to explore how concepts that relate to probable behavioural changes and influences in users, developed to various levels of interaction, structure and to uncover the underlying drivers behind these constructs (Anselm and Corbin, 1994: 276). The study, as examined using Activity theory as the main source of analysis, is bound by time and context in that it explored an existing experience represented by a group of participants currently using wrist-worn wearable devices in their day to day lived context. This approach was chosen in order to provide a fully descriptive account of an experience by analysing and interpreting a range of context and user engagements (Scapens, 2004:15).

2.7 Conclusion

In this literature review, 106 studies were identified, of which 53 met inclusion criteria for investigating the current literature around smart watches and fitness trackers. Additionally, this review investigated some of the theories used to examine smart watches and activity trackers usage. My review reported on results that relate to behaviour variables such as adoption, value, intention, enjoyment, image, observable differences, levels of interaction, behavioural encouragement and promoting positive attitudes. The literature is clear that wearable devices hold the ability and capability to influence and change behaviour over long term and sustained use. The literature also suggests that wearable devices hold key affordances such as motivation, reflection and self monitoring which can facilitate behavioural change strategies around personal needs and objectives.

3 Methods

3.1 Introduction

This chapter describes the research methodology and design process undertaken within this narrative study, as well as sample size, sources; instrumentation which supplemented data collection and its analysis. This study uncovered some of the user affordances and patterns of behaviour associated with wearable fitness devices. The study focussed on individuals who have already adopted these wearable fitness devices, believing in the value that they afford. The current literature suggests that wearable fitness devices hold key affordances such as motivation, reflection and self monitoring which can facilitate behavioural change strategies around personal needs and objectives, which I addressed in chapter two. Understanding these variables related to specific use and context of wearable fitness devices and their related value to user practices will aid in the advancement of existing knowledge around the topic. I have used Activity Theory to underline and bind this study in answering my primary and secondary research questions, namely What are the user affordances and patterns of behaviour associated with wearable fitness devices? Additionally, what are the affordances of wearable fitness devices that are most frequently used? and How do people apply these affordances?

3.2 Research Design

The aim of this study was to explore the patterns that emerge when people interact with wearable fitness devices.

3.3 Research strategy

I have used a case study method to explore the contemporary relationship and the associated objectives and scenarios that users engage with when using wearable activity tracking devices. The study is located within users' everyday context, as Yin notes, in order to enquire into a phenomenon as it occurs within specific contexts especially when the relationship between a phenomenon and context cannot be clearly defined. (1994:13). This study was bound by time and setting in that it explored the accounts of an experience as represented by a group of participants using wrist-worn wearable fitness devices recurrently. The chosen approach aims to provide a fully descriptive interpretation of a phenomenon by interrogating mixed sources of data as described through individual accounts. (Scapens, 2004:15) Additionally, my approach aimed to explore rather than confirm themes or classifications of behaviour, potentially unearthing additional questions around wearable device usability and its effects on behaviour within the field of human -computer interaction (Yang, 2016:256).

3.4 Qualitative research

As a narrative this study explored current users' relationships with wrist-worn wearable fitness devices to provide an understanding of how device use and interactions relate to personal and social practices (Johnson and Onwuegbuzie, 2004). I have used a case study method to explore the contemporary relationship and the associated objectives and scenarios that users engage with when using wearable activity tracking devices. This involved interviewing a number of current users of wrist-worn wearable devices once circa 60 minutes of which audio recording were transcribed and text analysed and formatted using an inductive approach. Data was collected in the form of the content analysis that identified the hot areas of discussion in documents in the field. The second part of the case study was conducted through qualitative interviews with eight participants, reaching data saturation after analysing four participants. In addition, through emergent research data was coded and modified to best describe participant responses.

All participants in this study were users' of wearable fitness devices which were identified via peers, referral and convenient target sampling. The snowballing sampling technique was also deployed to engage with willing participants. Figure 5 illustrates themes derived from my content analysis. Potential interviewees were issued a letter inviting them to take part in the study (See Appendix M). All participants for this study, were at the time of interviewing, living in Cape Town, both men and women, who already owned, wore or used wrist-worn wearable device or fitness/activity tracker. My target demographic included both old and young individuals ranging between ages 23-54, from various economic backgrounds, who engage in a variety of activities. This was a deliberate attempt on my part to ensure that I gain a variety of user insights and contextual overlap. Yin notes that a challenging aspect of adopting a case study methodology is the varied and diverse context of data collection and sources it inevitably provides, warning against a disconnect that could exist between uncovered variables and their relation to data points in addressing the research question (1981:104). In addressing this concern my data collection process was guided by a protocol which involved interviewing current users of wrist-worn wearable devices once for approximately 60 minutes. Audio recordings were transcribed and the text analysed and formatted using an inductive approach, moving from the general to the more specific, to categorise and sub-categorise findings (Thomas, 2016: 237).

Thomas (2016: 237) notes that a general inductive approach aims to:

- condense raw textual data into a brief, summary format
- establish clear links between the evaluation or research objectives and the summary findings derived from the raw data
- develop a framework of the underlying structure of experiences or processes that are evident in the raw data

Building on Thomas (ibid), my research approach relates to the above framework (a, b and c) in the following way.

- interviews were formatted in order to determine analytical categories by reading of transcripts in order to establish constructs or themes
- Data was sorted, further categorised and coded in order to provide descriptive accounts' potential patterns. It was validated against an existing theoretical framework (Engestrom, 1987) in order to describe the conceptual variances underpinning user interactions with wearable fitness devices
- Patterns were considered and analysed in relation to existing literature, conducted research and an analysis through the lens of Activity Theory. (Engestrom, 1987) in order to describe user patterns of behavior and affordances associated with wearable fitness devices. Furthermore, a point of interest was to explore how constructs that relate to behavioural changes and influences in human behaviour, develop various levels of interaction, structure and what the drivers behind them are (Anselm and Corbin, 1994: 276)

A content analysis of the research was employed to more specifically demarcate the “hot” points to pursue in this much-contested area. Figure 11 is an adapted framework illustrating the inductive approach applied to my content analysis.

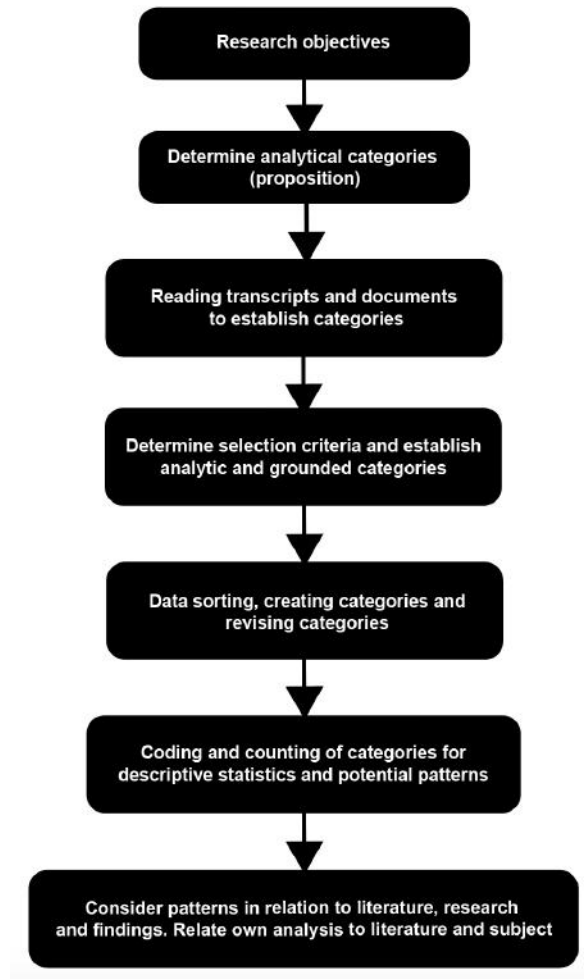


Figure 11: Stage model of content analysis: Adapted (Hancock et al., 2016:59)

3.5 Research phases

3.5.1 First phase: Pilot study

A pilot study was done amongst a Facebook group named, The Apple Watch User, consisting of 16,323 members. Members were invited to take part in an online survey and answered a number of questions related to personal use of their wearable activity and fitness tracker. The collected data informed my interview protocol. Initial findings from the online survey showed that a majority of users ascribe their level of engagement with their fitness and activity tracker as related to physical activity, often motivating them towards action, affirming my belief that users adopt these devices believing in the value that they may afford in relation to positive and actionable thought with the process of thinking translating into action in order to achieve specific results. Fig 13 shows participants' responses when asked to answer, does your Apple Watch Motivate you and How would you describe such motivation?

Length of use amongst participants' ranged from 3 months to 3 years, attributing adoption and sustained usage to factors such as ecosystem integration, usability factors such as texting, health monitoring and tracking of blood sugar levels. The majority of participants stated that their device made them feel very positive. (Survey Monkey, 2018). Fig 13 and Table 3 illustrate participant responses both graphically for ease of reading as well as individual responses in Table 3 to provide additional context.

Certain questions in the online survey related specifically to the usability factors of Apple Watches. This was due to my line of inquiry as directed towards an existing online Apple Watch user group. The pilot study also provided key insight into factors that influence and support continued use which assisted in delimiting my interview questions. Table 4 illustrates user responses related to factors that influence adoption and use of these wearable fitness devices. Key discoveries inter alia include device features such as smart sensors, health monitoring as well as potential tensions associated with usage.

These explorative findings, combined with the results of the content analysis study applied to the literature, have contributed enormously to simplify and streamline the focus and direction of the qualitative interviews with participants. Furthermore, these findings informed my empirical assumption around actual usage of wearable fitness devices and its potential user affordances. From these, I was able to formulate a set of propositions in an attempt to explain the associated variables and concepts related to usage. Table 5 illustrates a set of propositions or statements guided by the literature review and empirical data.

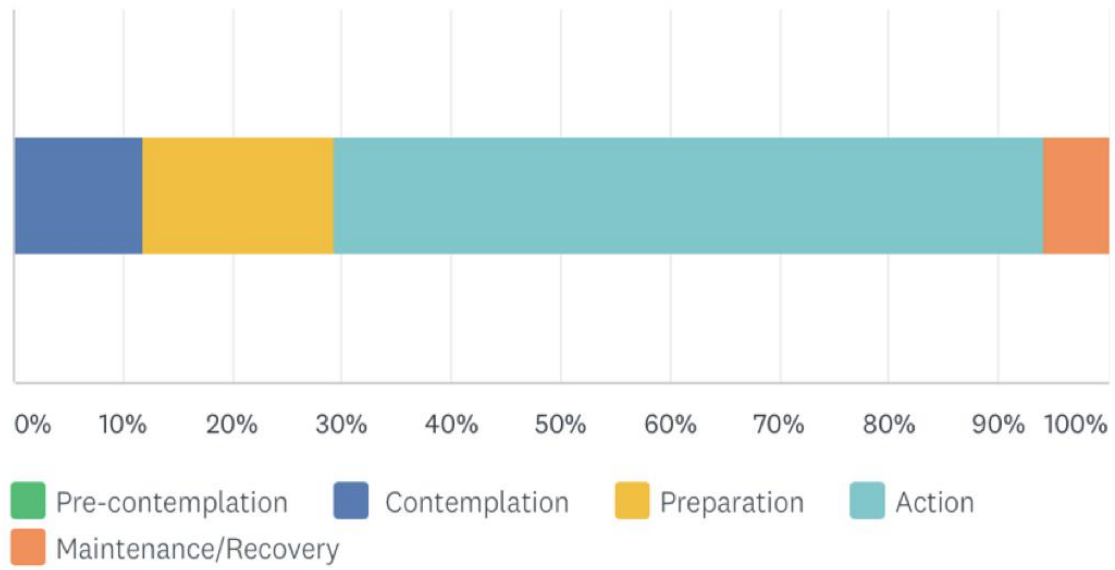


Figure 12: Participant responses (Survey Monkey, 2018)

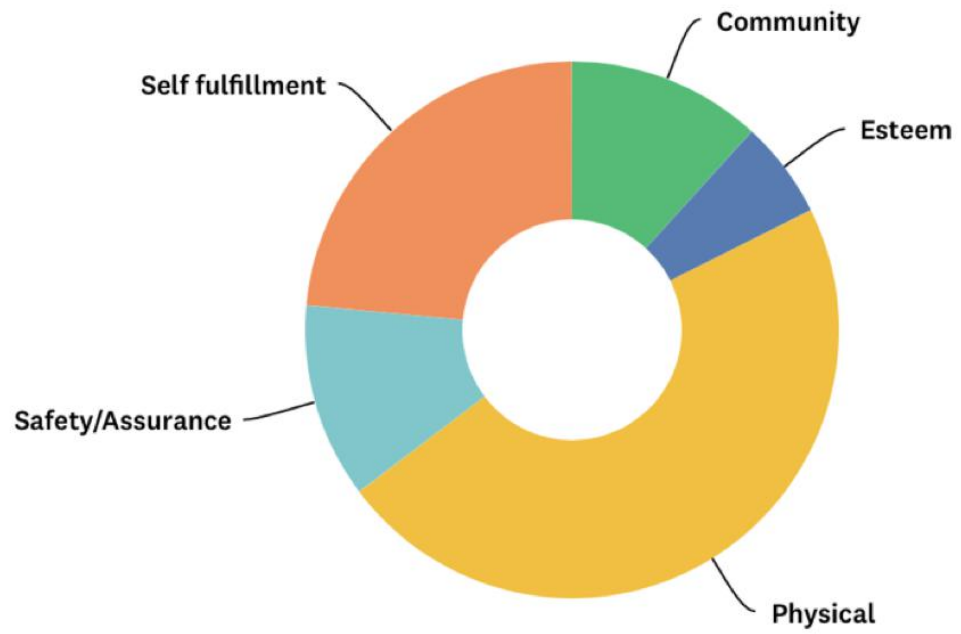


Figure 13: Participant responses (Survey Monkey, 2018)

How would you describe your experience with your Apple Watch?	Participant
It's great	P1
Overall, very good	P2
Amazing device. Works in association with the iPhone. Apple Pay easy even when I don't have my phone. Many more like maps with hepatic feed back. Heart monitor apps	P3
Only complaint is that it's such a pain to move the icons around	P10
I love it! Wear it 24/24. Using it for workouts, sleep, calendar	P11
Mostly enjoyable with the occasional frustration	P13
Good, never had an issue	P14
It's great. I love it. I love the reminders for work	P15

Table 3: Participant responses (Survey Monkey, 2018)

How would you describe your experience with your Apple Watch?	Participant
Call and text from watch	P2
I am legally deaf.	
The hearing surfs are made for Apple and use both the iPhone and Apple Watch to control them.	P3
Seamless integration with the Apple ecosystem	P5
Fitness and health, sleep monitoring, that it syncs to my phone	P6
Heart rate monitor and syncing with phone for calendar and phone alerts	P8
I need it to monitor my daughter's diabetes. Her values are displayed on my watch.	P10
I own Apple iPhone and was looking for a watch for running.	
The price was similar to the running type watches.	
I was looking at but with extra features that I liked.	P13
Able to track my blood sugar long with my terrible sleep habits	P14

Table 4: Participant responses (Survey Monkey, 2018)

Potential proposition	Literature examples
Wearable devices potentially hold a number of affordances which promote user feedback and systematised engagement	Literature-Hartson, 2003 Cognitive physical sensory and functional affordances in interaction design Behaviour and Information Technology
Perceived value as it pertains to wearable devices is a precursor to adoption	Literature-Yang, Yu, Zo and Choi, M., (2016) - User acceptance of wearable devices
The intention to use information technology is a forecaster for real behaviour, however social and cultural context play a role	Mao and Palvia, P., 2006. Testing an extended model of IT acceptance in the Chinese cultural context
The affordance of wearable devices in motivating smaller incremental goals that seem achievable and manageable by an individual or receiver are more likely to yield actual behavioural change	Literature- Mansi, Milosavljevic, Tumilty, Hendrick, Higgs and Baxter, (2015). Investigating the effect of a 3-month workplace-based pedometer-driven walking programme on health-related quality of life in meat processing workers: a feasibility study within a randomized controlled trial. Literature-Fogg BJ., (2009) The new rules of persuasion
User reflection and self-monitoring in its application varies, largely as consequence of dynamic and changing user motivations, environment and personal preferences	Literature-Li, Dey and Forlizzi (2010) - A stage-based model of personal informatics systems
Users adopt wearable devices for a number of reasons that are related to behaviour change and influence. Wearable devices offer a number of affordances. People use these affordances to shape behaviour	Author, 2018

Table 5: Propositions derived from literature and empirical data Adapted from (Baxter and Jack, 2008:551)

As an integral part of my research design and methodology, I have applied specific constructs and categories to identify the most relevant and critical areas of research in respect to the affordances that users gain from smart devices. The pilot study served as an initial phase to find constructs and categories that would direct my literature review. Combined with my explorative content analysis, I derived propositions from literature and empirical data in order to more specifically develop themes which I applied towards my qualitative interview schedule. Figure 14 illustrates relationship between themes, interview questions and research objectives.

3.5.2 Second phase: Interviews

As stated earlier and shown in Table 5 and Figure 14, data for this study was collected in the form of the content analysis that identified the hot areas of discussion in documents in this field. In addition, my main source of data for this study was collected by conducting individual interviews with willing participants. These semi-structured interviews lasted approximately one hour during which I directed a line of inquiry around personal use of these wearable fitness device and how its functional features relate to everyday practice. Semi-structured interviews also permitted me to adapt my line of questioning to allow for naturally occurring data and generated data aimed at providing a rich descriptive picture of participants' experiences of a phenomenon.

This allowed for an understanding of personal context and a comprehensive study of the subject to elicit meaning (Ritchie, 2013:57). Interview questions were directed towards exploring current users' relationship with their wearable fitness device and to examine the potential affordances that smart devices hold for users. It also sought to understand the levels of engagement that users have with wearable fitness devices and how we may interpret or understand a connection between the physical and digital space. Willing participants were asked to voluntarily complete a consent form indicating that I had their permission to audio record our conversation. Participants were also provided the option, if at any point they want, for me to turn off the recorder or keep something they said off the record. No notes were taken during these individual semi-structured interviews to minimise distraction and disruption. Interviews were recorded, transcribed and thematically analysed.

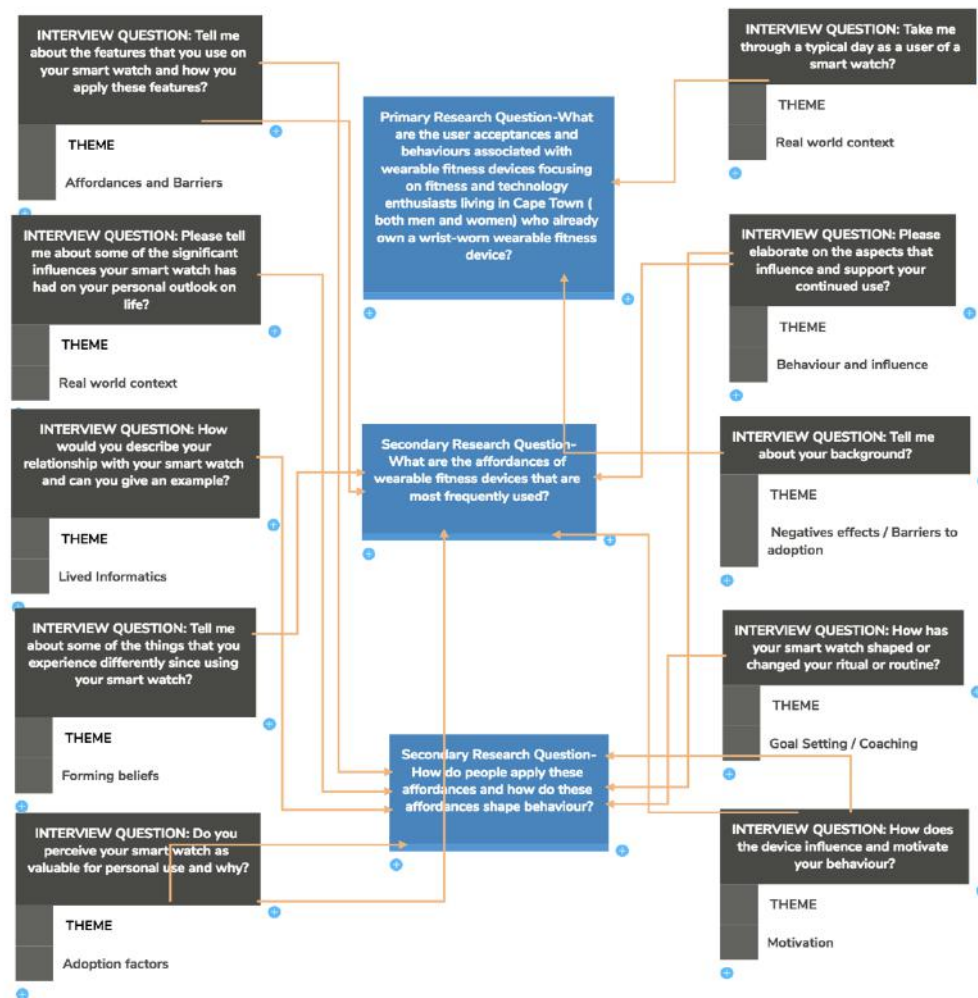


Figure 14: Illustrating relationship between themes, interview questions and research objectives (Authors, 2019)

3.5.3 Third phase: Interview data

The collected data from my semi-structured interviews and its explanation through coding and thematic analysis served as the primary source for referencing emergent data and analysis. In chapter 4 I unpack the associated themes as advanced through an inductive approach.

3.5.4 Analysis of Interviews

I have identified several themes or constructs as a result from analysing and coding participant interviews. Data was thematically coded and analysed using Atlas Ti using the lens of Activity Theory of which I will discuss in more detail in chapter 4. The thematic analysis used predetermined codes as generated through literature, and through the development of new codes. By reading and re-reading text, initial codes were advanced into sub-codes to achieve data saturation. As an example the code affordance was further developed into sub-codes to include types of affordances such as physical and sensory affordances. Thematically coded interview data was allocated to what was deemed appropriate in relation to its Activity Theory elements of which I unpacked in chapter 2. The focus of this study attempted to gain an understanding through the study of artefacts and tools, how human action is influenced and inseparable from a mediated relationship between artefacts or tools and the related components within an activity system.

The interrelatedness of an activity system can thus permit influence to occur or affect individual action in relation to tool, subject, object, rules, division of labour, community or tensions and contradictions which may exist as consequence of an interplay between participating activities within an activity system. Data as gathered from interviews were firstly analysed in relation to their Activity Theory elements using the individual activity as a unit of analysis, as illustrated in figure 15. This data was subsequently further cleaned and developed where participant responses were mapped according to various Activity Theory criteria as illustrated in figure 16. This enabled me to identify redundancies by filtering concepts through Activity Theory which also enabled the identification of tensions and contradictions within the various activity systems. In essence data was analysed, tabulated and classified according the activity of which the outcomes were then developed into personas as illustrated by figure 17.

Unit of Analysis: Summary(Participants)				Activity Theory Elements (Participants)											
P1	P2	P3	P4	Tools	Subject	Object	Outcome	Rules	Community	D.O.L					
Adoption of device	Everyday use	GPS tracking	Rehabilitation	Feedback Elements	T1 User	S1 Altruism	OB1 Reward	OU1 Cultural Factors	R1 Event	C1 Social groups				DOL1	
Sync device with phone	Earning/collecting loyalty points	Step tracking	Monitoring physiology	Resources	T2 Player	S2 Self-interest	OB2 Challenge	OU2 Values	R2 Story	C2 Context				DOL2	
Getting fit	Gamification of activity	Using navigational features	Cycling	Messages	T3 People	S3 Ego	OB3 Progress	OU3 Laws	R3 Emotion	C3 Functional Arrangements				DOL3	
Track exercise	Incentivised exercise	Tracking short runs	Self-reflection	Progress	T4 Places	S4 Intrinsic Reward	OB4 Goals	OU4 Tradition	R4 Culture	C4 Production				DOL4	
Planning	Device adoption	Device adoption	Technological integration	Points	T5 Ideas	S5 Extrinsic Reward	OB5 Objective	OU5 Beliefs	R5 Time	C5 Distribution				DOL5	
Monitoring heart rate	Consistent use	Becoming active	Ease of use	Dashboard	T6 Professional	S6 Scoreboard	OB6 Ego	OU6 Language	R6 Space	C6 Exchange				DOL6	
Syncing of device	Prolonged use	Sedentary behaviour	Device interaction	Levels	T7 Student	S7 Points	OB7 Intrinsic Reward	OU7 Convention	R7 Community	C7 Obligations				DOL7	
Physiological measurement (fatigue)	Inactivity and use	Adopting new behavior	Monitor hear rate	Badges	T8 Instructor	S8 Badges	OB8 Extrinsic Reward	OU8 Information	R8 Group	C8 Online Community				DOL8	
Take up exercise	Recreational use	Unhealthy behaviour	Glancing at device	Rewards	T9 Administrator	S9 Reputation	OB9 Scoreboard	OU9 Actions	R9 Social Media	C9 Friends				DOL9	
Situational awareness	Repetitive use	Setting challenges	Personal development	Incentives	T10 Advisor	S10 Challenge	OB10 Points	OU10 Conditions	R10 Exclusive	Family				DOL10	
Adopt new behaviour	Syncing of device	Maintaining active lifestyle	Early adoption	Location	T11 Lecturer	S11 Emotions	OB11 Badges	OU11 Competencies	R11 Elitist	Colleagues				DOL11	
Informed decision making	Logging of data	Community engagement	Over-training	Time	T12 Academic	S12 Feedback	OB12 Reputation	OU12 Peer Pressure	R12 Power Dynamics	Acquaintances				DOL12	
Continued use	Instructional activity	Competing with virtual community	Intermittent checking of device	Status	T13 Athlete	S13 Power	OB13 Challenge	OU13 Time Pressure	R13 Friends	Feedback Elements				DOL13	
Device adoption	Maintaining physical fitness	Improving health through exercise	Exercise	Experience	T14 Participant	S14 Resources	OB14 Emotions	OU14 Outside factors	R14 Family	Resources				DOL14	
Tracking physical activity	Hiking	Remote participation	Device interaction	Skill	T15 Members	S15 Levels	OB15 Feedback	OU15 Perceived Difficulty	R15 Teachers	Space				DOL15	
Knowledge management	Organisation and planning	Competition races	Device adoption	Knowledge Ability	T16	Achievement	OB16 Power	OU16 Experience	R16 Colleagues	Networks				DOL16	
Self-management	Sedentary behaviour	Group running	Using advanced features	Communication	T17	Status	OB17 Resources	OU17 Skill	R17 Device Prompts and feedback	Structure				DOL17	
Self-reflection	Device utilisation	Time management	Continued use	Socialization	T18	Goals	OB18 Levels	OU18 Knowledge Ability	R18 Digital ecosystem	Organisation				DOL18	
Community engagement	Device interaction	Coaching	Adopt new behaviour	Application	T19	Group Association	OB19 Achievement	OU19 Support	R19	Institution				DOL19	
Relocation	Device abandonment	Digital assistance	Sedentary use	Collaboration	T20	Feedback	OB20 Status	OU20 Relatedness	R20	Monitoring				DOL20	
Normative influence	Power dynamics	Ease of use	Self-regulation	Emotions	T21	Enjoyment	OB21 Group Association	OU21 Altruism	R21	Interface				DOL21	
Sharing activity	Operating device	End-user customisation	Cooking	Story	T22	Balance	OB22 Feedback	OU22 Functionality	R22	Non centralised communities				DOL22	
Logging activity	Decision making and influence	Interval training	Listening to music	Fear	T23	Performance	OB23 Balance	OU23 Social Media	R23	Virtual Communities				DOL23	
Ease of use	Customization	Using advanced features	Create intimate space	Agony	T24	Fun	OB24 Competencies	OU24 Normative Influence	R24	Multimedia Instructions				DOL24	
Device abandonment	Personalisation	Self-reflection	Location sharing	Greed	T25	Heterogeneity	OB25 Performance	OU25 Social Needs	R25	Loyalty Program Partners				DOL25	

Figure 15: Illustrates analyses of interview data using the activity as the unit of analysis (Author, 2019)

Participants response	Activity Theory elements						
Quote	Tools	Subject	Object	Outcome	Rules	Community	D.O.L
It's just my continued reliance on this for my health information	Instant access to information	Over-training	Device interaction	support health goals	Engage in physical exercise	Community	Digital ecosystem
I'm an IT man by training, ya! And I'm kind of a bleeding edge adopter. I'm the guy that bought the first plasma screen tv the ones you needed a crane to move it.	Compatibility	user rehabilitation	Tracking RR data of heart rate	Accomplishing tasks	device utility	Fitbit Online community	smart sensors
Ya, no it uploads to my phone and then I can view it on my watch. Its all in the Apple health app so everything is there.	heart rate monitor	User of lifestyle wearable technology	Self-reflection	Adopt new behaviour	Device interaction	Friends	Technological integration
Its like when you wear a wedding ring and your wedding ring is off your finger. There's a point where you feel there is something missing here	music app	Active health tracking	social sharing	Analyses and data comparison motivate to increase exercise	Battery life	Social groups	Smart notifications
later on now I've got a heart rate monitor that speaks with ANT and Bluetooth so I can talk to my Garmin watch and I can talk speak to this watch [Apple watch] at the same time.	Logging activity	Long term active user of fitness tracker	Create intimate space	Mindfulness	Normative Influence	Family	Compatibility
I am very attached to my smart watch. I feel naked when I don't wear my smart watch. I don't sleep with my smart watch because I have a sleep app on my phone that doesn't need the watch, that actually listens through my snoring and body movements	Vibration alerts	Adoptee and user of Apple Watch 3	Tracking personal progress	Monitor hear rate	Understand device interface	Loyalty program partners	Vibration alerts
I did once when I didn't have my heart rate monitor on the bicycle I turned around and said ok cool that's it. and somebody said I can't believe that you self managed like this but I said I have to you know, are you going to pick me up on the side of the road if I just completely overturned. Because this thing in cycling is if you ride in a peloton or a pack of people you get carried away in the group conversation and the guys are talking and the next thing you look down and ooo I'm in the red line already.	Smart notifications	survivor of heart attack	Location tracking	Monitoring physiology	accessibility of data	Group members	Third party integration
I think that's definitely it's more real-time it's immediate, where I would have had to check things afterwards or you get back home and then you start wondering how did that go how did this go	smart sensors	Early adopter	monitoring physiology	Peace of mind	Syncing		inactivity alerts
I'm not really into the activity rings and things to me that is not that important it's interesting but it's not important I'd rather go and have a look at my heart rate and other things not particularly related to this is blood sugar and weight for instance.	feedback loops	Cyclist	Self-regulation	Personal development	Pairing		immediate feedback
I'm almost 56 years old. I'm a boyfrie from the Western Cape, went to school here traveled all over the country various jobs but mostly IT. Settled back in the Cape worked for Avia for 10 years and while I was there in 2011 on my 48th birthday I had 3 heart attacks on the same day, survived those learned some big lessons.	GPS function	exerciser	Leisure time	Potential self-diagnosis	Ensuring device functionality		High-quality displays and touchscreens
I had 3 heart attacks in 2011 so my concern has always just been my health specifically my heart so my initial SmartWatch was not very smart watch its a specific Garmin device that could not only give me my heart rate and everything else but could also track your RR data of your heart rate	Ease of use	Continued user	Immersive integration	Realtime Self-Assessment	battery life		Training schedule
yes absolutely can't do it without the watch. I would be flying blind.	Bluetooth capability	User with community engagement	Glanceability	Self-awareness	Physiological Needs		activity summaries
I've had this watch for probably about 2 years so I would say 2011 - 2016 I use the Garmin, the Garmin is not a practical device it is a watch as well but it's not designed to be worn as a watch it's got a very limited lifespan so 8 hours and your battery is dead and it's a chunky thing it's wasn't a practical device, this thing [Apple watch] is nice in practical.	Practical application		Self-Assessment	Self-management	Usability factors		Device prompts
The heart rate monitor in the watch has a function where if it detects your heart rate goes over a 120 beats per minute and you haven't been active, its called tracardia so if that happens the watch actually taps you on the arm and says hey dude something is not lekker here.	Garmin fatigue metre		Rehabilitation	Self-motivation through comparison of activity	Support systems		
7 years at least	End-user customisation		Practical application	Self-reflection			
So what the watch did for me initially as well was other than just monitor my heart was that it became a great motivating tool, so I could upload all my workouts to the Garmin website share on Facebook and people would go hey man you making a nice recovery but in the end it's like a self motivation tool.	wireless connectivity		Technological integration	Self-regulation			
so if we've had a disaster in the centre something and I feel stressed and literally I can feel my heart and I'll go let me just check what's going on here and I think that mindfulness also helps you just to say ok just calm down, there we go now we good.	Find my friend app		Personal development	Sense of security			
say well I rode 40 km this morning and if I look back at 3 weeks ago I could only do it in this time and that becomes you driver then ya. So to me that was a motivational tool	Apple Watch 3		Refer back to logged data	Situational awareness			

Figure 16: Illustrates the mapping of participant responses according to various Activity Theory criteria (Author, 2019)



Figure 17: Illustrates one of the personas as developed according to user activities (Author, 2019)

3.6 Limitations

The scope of this study was limited to user interaction with wearable devices, with specific focus on wearable fitness and activity trackers. The study looked at current publicly accessible wearable technology, aiming to provide an understanding of how users interact with their wearable fitness devices. The chosen data collection methods, which encourage freely provided user feedback, may have included participant biases, a limitation that was not measured, filtered or determined within the scope of this study. All participants took part voluntarily and did not receive any compensation. The research did not investigate the inner technological workings of wearable fitness devices or for that matter the broader umbrella of the Internet of Things with regards to user security, user identity, health applications or information technology. Eight participants were chosen for the study, consisting of 4 men and 4 women ranging between the ages of 24 and 56 years. All participants resided in South Africa and held positions within the finance sector, education, academia, corporate and design sectors. Participants usage levels in relation to wearable device usage ranged from being power users, incentivised users, health and fitness users and recreational users. All participants were reasonably healthy exhibiting no mental, emotional or physical challenges.

3.7 Ethical Considerations

This study and collected research remained ethical in its approach in that it put appropriate measures in place to mitigate possible physical, psychological, social, cultural, environmental or financial risks to participants directly involved in the study. As part of my proposal submission, an ethics document was submitted outlining associated research activities related to individual participation, sampling and data collection. Sources of data gathering involved conducting individual semi-structured interviews which required potential interviewees to provide written consent. In this letter of consent potential participants were made aware of the nature of the research and the kind of the data to be collected. Participants were not offered any incentive to take part in the study to alleviate biases participants might feel obligated to provide what they deem as the “correct” answers when incentivised for giving their time. Being aware that participants may have had inherent biases or felt pressured in providing contextually acceptable responses which may even lead to false declarations, the study relied on the collection of data from both participant testimony and coding of text based on content analysis. Research for this study was done in Cape Town and made use of informants that are resident in Cape Town. Permission was asked from participants to allow for any reproduction, sharing of personal device data to preserve individual’s privacy and personal information. Where applicable, personal data was anonymised by making use of pseudonyms to describe participants. Audio recordings and transcripts were stored in a secure location unlabelled to ensure anonymity of participants. Prior to the actual interviews participants were made aware of the amount of time necessary to conduct interviews. Interviews were conducted face to face at a location set by the interviewee, in order to make participants feel at ease and encourage a sense of ownership over their environment. Data protection and sharing of personal data were kept private and stored at a secure location. Participants were put under no obligation to participate and were made aware that they could withdraw from the study at any time or decline to answer any questions, without negative

repercussions.

3.8 Summary

This chapter describes the research methodology and research design process undertaken within this narrative study. Using Activity theory as a lens and analysis tool it outlines the chosen approach indicating sample size, data sources, instrumentation which supplemented data collection and its analysis. As a narrative study it aimed to explore the patterns of behaviour that emerge when people interact with wearable fitness devices. For this reason, Activity Theory was chosen as a theoretical framework in that it examines individual activity as interrelated and influenced by its environment of which such interaction is indirect and mediated by tools and signs (Vygotski, 1978) and (Hashim and Jones, 2007).

4 Findings

4.1 Introduction

This chapter reports on my findings as obtained from individual interviews and thematic content analysis in response to the following research questions:

- What are the affordances of wearable fitness devices that are most frequently used and how do people apply these affordances?

My main source of data for this study was collected by conducting individual semi-structured interviews with users of wearable fitness devices. In addition, data for this study was collected in the form of a thematic content analysis that identified the “hot” areas of discussion in documents in this field. My literature review and content analysis have shown that wearable devices could assist in behavioural interventions and influence user behaviour. The personal and pervasive nature of these wearable technologies presents us with the existence of a mediated relationship between the digital and physical space, alluding to the possibility that people may adopt and become users of these wearable fitness devices for a number of reasons. I now turn to a descriptive interpretation of emerging data as it unfolded from my semi-structured interviews and thematic content analysis. These have been categorised under specific themes from collected data.

4.2 Emerging themes

4.2.1 Theme 1: Adoption

Adoption of wearable fitness devices have been found to coincide with users experiencing some form of life changing event or self-realisation. In some instances, its ascribed an ability or provision in monitoring a participant’s physiological state such as heart-rate monitoring post suffering cardiac arrest. As one participants points out this “new technology” holds several potential utilitarian functionalities and features that may be gained from device useage, aiding in user adoption. The below quote also speaks of how emergent technology might not only drive adoption but how it may play a key role in supporting and driving user goals in the process.

“I’m a computer programmer so I sit at a desk most of the day and I think like four years ago I also reached a point where I just needed to do something. I was just like you know a downward spiral, getting unhealthy, wasn’t eating right and all of that stuff, so I kind of made a change, started running a bit and then with running comes the device, it’s the new technology” (Participant 6, 2018, p.2).

The technological characteristics associated with adopting these wearable fitness devices relates to concepts of perceived compatibility and usefulness.

Adoption and abandonment of these devices over time also have been found to relate to how users perceive these devices within a socio cultural sense, attributed to aspects such as branding, community or peer pressure, perceived value, customer support and perceived risks. In some situations, users have adopted completely new devices of which they perceived as better suited to their human experience or personal values. The lack of integration within a users existing technological ecosystems and personal needs have also been found as reasons for abandonment. This is confirmed in the below quotes,

“I used to be an Apple person but it’s sort of limiting. I moved over to Android recently and I feel like I’m not going back to Apple because it’s sort of elitist. so I’ve changed from being an Apple person to an Android person” (Participant 1, 2018, p.6).

The above quote illustrates how perceived value in relation to brand identity may instil negative connotations within the user as consequence of a disconnect between a user’s personal values and brand identity.

“I’m almost 56 years old. . . I had three heart attacks in 2011 so my concern has always just been my health specifically my heart. So my initial smart watch was. . . a specific Garmin device that could not only give me my heart rate and everything else but could also track your RR data of your heart rate. . .” (Participant 8, 2018, p.8).

In the above quote user adoption is ascribed to perceived benefit and the added functionality that support user objectives, which in this instance relates to monitoring physiology and general health.

“The issue that I have with the Fitbit is that other people have access to my data” (Participant 1, 2018, p.5).

The above quote illustrates how data security and data privacy are key components that may drive both device adoption and/or abandonment.

“When I went to buy the watch they said it was like the Toyota of watches so it’s kind of like the long lasting one. It’s still affordable in terms of R2500. it’s more like an entry-level smart watch. I bought the watch maybe a year and a half ago most for the GPS because I used to track my runs through Strava which is an app. . .” (Participant 7, 2018, p.1).

Additionally, other factors that drive adoption and usage are related to perceived value and perceived benefit as measured in relation to monetary value and device functionality.

The aforementioned issues all play a part in user adoption of these wearable fitness devices. They influence adoption in a number of ways and are largely idiosyncratic by nature in as much that they bear relevance to a user's age, health and wellness state, social status and associated privacy and social or financial risk.

4.2.2 Theme 2: Lifestyle management

During active engagement the pervasive and personal nature of these wearable fitness devices provides users with companionship by considering the emotional and physical state of its users often through device prompts and feedback. These are particularly evident where users engage in strategic and focused behavioural interventions that are aimed at using technology in a supportive and strategic manner for personal health and fitness management. In focussed and goal orientated scenarios these wearable fitness devices promote and encourage increased activity and sustained usage. These are afforded through usability factors such as increased battery life or built in GPS functionality.

“I got this one because it had eight hours but there was another one which had twelve hours. I figured at the time that I wouldn't run for more than eight hours but now I am actually which becomes a bit problematic... I remember I used to run with mates without tracking... now I'm a little bit more on it now but I also have much more awareness of like how far I run and how long a route takes. I used to do all that measurements in my own mind so this is more using a tool to make it more defined” (Participant 7, 2018, p.1).

The exchange of information between users and their wearable fitness devices may also increase mindfulness and self-reflection through life logging. This entails using these sensor technologies as a means of tracking and quantifying daily activity in order to provide the user with insights, using large amounts of data, about their patterns of behaviour. As such these devices may support a user's lifestyle management plans through its proliferation of use and ability to aggregate data across various platforms and applications that motivate positive behaviour.

Another point of interest are the social affordances these devices hold in motivating user behaviour. In principle these wearable fitness devices are able to provide users with a sense of achievement and reward by engaging with activities that are tracked and compared on a social platform which is illustrated in the below quotes,

“Once you start seeing that progress then you just want it more and more you know...and the Fitbit app is like amazing in terms of motivation and that type of stuff. You’ve got like your community and you know you get interactive with other people and its probably like out of all the fitness apps I think its superior by far. Just because of that whole community vibe. Its got like these challenges that you do that’s very cool. So with Fitbit the community is huge. Once you get into the challenges then you just get invited like the whole time and then you competing against people from like America” (Participant 6, 2018, p.2).

The above quote illustrates how the notion of community may drive user adoption. Additionally, it shows how device features that support social interaction may lead users to adopt new behaviours or engage in new activities.

“I think it was a big thing as I said it’s the tracking ability. When we running people are on Strava and because you know its going to be on a network it becomes a competitive thing. For me that is the biggest motivation” (Participant 7, 2018, p.9).

Some users experienced frustration due to a disconnect that occurred between captured device data and users having access to such data for self analyses. This may be viewed as tensions that came about when users who wish to track meaningful and holistic, accurate measurement are not supported by the necessary end user customisation to facilitate such efforts.

4.2.3 Theme 3:Affordances

The affordances that users encounter are contextually grounded, which may be understood as variables related to aspects of user intentions such as their social image, social participation or an intent for self-reflection. Moreover, these persuasive technologies reckon on assisting users in a way that allow them to become self-aware by being designed in a manner to change users’ attitudes and behaviours. This suggests the concept of material determinism where users’ choices and actions are determined by the material factors of their tools. Users’ who collect and track activities may use such means to organise their activities and roles for behaviour change in that it can be thought of as tools allowing users’ to achieve set goals or outcomes similarly influencing the means of such interaction with their environment. The aforementioned is echoed in the quotes below,

“Now that I’ve got the watch it also motivates me to actually run because I see it lying there and I’m like Oh you should go for a run” (Participant 2, 2018, p.2).

“So what the watch did for me initially as well was other than just monitor my heart was that it became a great motivating tool. So I could upload all my workouts to the Garmin website share on Facebook and people would go hey man you making a nice recovery but in the end it’s like a self motivation tool” (Participant 8, 2018, p.2).

The above quote illustrates the potential social affordances users experience through device usage and applications.

In some sense these device affordances can be thought of as the ability to create practical and social applications that provide meaning for the user when applied to specific contexts. In other words, it can assist users with selecting and establishing roles or personas as well as interpreting such roles or personas to drive intention and behaviour.

“So the community ya. . . The Fitbit has got a lot of it. I would say having this online presence made me take photos with the things, the activities I was doing. Going out at sunrise and you like “I wish everyone could see this sunrise” so now you can take a photo and attach it to your activity and other people can experience it and it encourages them cause now they think “oh wow that’s what I’m missing I’m not waking up early. So I enjoyed that aspect of encouraging other people which has led me to onto like I said doing coaching to try and help other people get there as well because its not that hard its justhard to find the motivation” (Participant 6, 2018, p.6).

A disconnect may occur when these wearable fitness devices fail to support a users quantified persona. This can be characterised by the degree these wearable fitness devices integrate into peoples’ everyday life’s and its ability to adapt to different in situ user modalities and social practices. This also relates to these devices ability or inability to generate possibilities for action by conveying contextual information that are perceived as valuable and meaningful within the user’s own context. This is echoed in the following quotes,

“I think that I am more conscious of the structure of my working out and how much time I spend in the gym. Previously I would know by just what’s on my schedule. I’ll go there at six in the morning or whatever because at seven I need to go to work so it was in my head. Now I am conscious of the amount of detail that I have i.e. you’ve been in the gym for an hour but you only been actively working out for 40 minutes the other 20 minutes you were just goofing around” (Participant 5, 2018, p.2).

This is further echoed in the below quotes where the act of data capture and activity tracking become reflective tools that serve as a means to influence and direct user intentions.

“If I really wanted to track I probably could have but now I’m mindful of it because it’s in front of me. So now that its in front of me I can go you know I actually don’t really feel bad about the burger that I had because I walked seven kilometres today. So you just being mindful or being conscious of the information or the data that you now have. Whether I consequently use it or not that’s now my choice” (Participant 5, 2018, p.2).

“So if my whole life is built around getting more for my buck and getting points for how I purchase things then my Fitbit should be an extension of me” (Participant 1, 2018, p.4).

4.2.4 Theme 4: Self-reflection

Wearable fitness devices are generally worn on the wrist worn allowing users quick access to an array of sensor and application data throughout the day. This constant collection and easy exchange of information result in additional affordances that trigger behavioural interventions or guide user activity. This happens as a result of analysing and reflecting on user data captured by these devices, influencing personal awareness toward action. In some cases, these wearable devices are used to track user physiology using smart sensors such as heart rate monitors.

“The heart rate monitor in the watch has a function where if it detects your heart rate goes over a 120 beats per minute and you haven’t been active, its called tachycardia so if that happens the watch actually taps you on the arm and says hey dude something is not “lekker” (not well) here. I’ve had it a couple of times. . . I sometimes just get my heart rate going up and then it comes down again. But just the fact that it says to you there is something wrong means ok so now I have to go and check what’s caused this now” (Participant 8, 2018, p.4).

These smart sensors that capture digital quantified data provide users with interactive feedback through the medium of smart notifications. Such interaction with these computational devices become a resource assisting users in making more informed decisions. This suggest that active and prolonged engagement with these devices may creates additional affordances. The notion of self-reflection for example can serve as a means to structure change due to how these devices support different user context in conjunction of a user’s own desire to be more active. The below quotes serves as an illustration,

“I would argue that the benefit of having that information is the choice that you now make. . . now I can decide whether to do something with that information or not, but at least it’s there so now its my choice” (Participant 5, 2018, p.3).

“I think my watch has helped me to take stock of things that usually would seem quite pervasive during the day” (Participant 3, 2018, p.2).

In a mediated approach quantified data, captured through smart sensors and notifications can motivate user behaviour to actionable thought when such activity is incentivised within a social context. The act of self reflection in a real sense becomes a tool afforded through an incentivised activity.

“I found it really awesome because it made me more excited to do exercise and when I reached my 10 000 points I was happy about it. I felt fit. It made me want to take the stairs instead of the elevator. It made me want to go for a walk instead of a drive, so it was very positive, it changed my behaviour” (Participant 1, 2018, p.1).

Similarly, the subjective elements that influence human action are quantified through this means of self reflection in relation to quantified data. This is echoed in the below quote,

“I’m a slightly competitive person so I like to compete against myself and see ok my stats was this last week and following week how its changed. So that’s pretty much how I apply it. If I moved less this week, I’ll try and I try to move more the following week. So I think it creates a constant awareness of that you need to move and get up” Participant 4, 2018, p.1).

The tracking and publishing of quantified data on digital social platforms as a method to monitor personal progress indicates the affective potential of these fitness devices hold to motivate user behaviour. This can be ascribed due to device affordances that facilitate a users ability to extend their context of experience. This influence occurs as interaction points between perceived meaningful data geared towards self-management and reflection that allow for user comparison within a larger social group. This is echoed in a quote below,

“In terms of running outside I’ve made a lot more friends. My flat mate is in some running group and we go run at least once a month, do a park run and stuff. . . I did my second one like a month ago and it made me so happy to see there is this whole community of people. You running in there and people are cheering you on. That’s obviously also motivates you to run more and be part of this clan” (Participant 2, 2018, p.8).

4.2.5 Theme 5: Community and normative influences

The wireless connectivity of wearable fitness devices allows for data capture and data transmission to occur between multiple user groups across different digital platforms. This socio-technical affordance or these devices ability in permitting social actions and exchanges to occur without the constraint of physical locality have been found to be drivers that influence device adoption. The below quotes serves as an illustration,

“I’m going to be honest with you when I first got it the first few months I loved it, it was like the best thing to have. I was seen as this fit girl. I would share it on the Polar app, so Polar has an app and a little blog thing so you can say I just ran a 3 kilometre and its quite fun. I like to go back and check last year I ran 5km in like half an hour and now I’m only doing it in 20 minutes so it’s nice to see your progress as well and it’s nice to share with friends and stuff” (Participant 2, 2018, p.4).

Moreover, this socio-technical affordance may cause users to adopt new behavioural traits that can be interpreted as aspirationalism or a perceived need to conform in the interest of gaining social acceptance. Similarly, this notion of social conformity behind device adoption can also be understood as a means of self expression, providing users’ with a means to communicate their values and beliefs in comparison to a social group or social convention. The relational phenomenon of persuasion by society or a social group occurs through normative and informational influences. This is shown in the below quote,

“So it was a bit of a thing where I wanted one because everyone had an exercise watch and it looked really cool” (Participant 2, 2018, p.1).

The above participant response relates to a series of questioning that attempted to uncover how adoption and usage relate to influencing continued use and its extend in supporting physical activity and exercise. The participant's response is significant in that it positions human activity as being partial to persuasion by means of society or group dynamics and the associated power relations that ensue through normative and informational influences. This action of social conformity where individuals feel they have to adhere to and maintain social guidelines in order to fit in leads to social or group compliance causing in some cases device adoption and a potential associated behaviour change.

This social affordance or instilling a sense of belonging to a community has also been experienced as a social pressure, ascribing adoption as influenced by current or fashionable trend. Pre-adoption this social pressure is perceived as a positive in that it encourages a healthy lifestyle through a supportive community led environment or social group. The below quote expresses this notion,

“What is also nice about the Fitbit apps you can sought of create a fitness community on your app. I suppose Apple has got it as well or something similar. So you can essentially challenge friends or be in an exercise group without being physically close to those people. So its also creating that accountability of I have to perform for a team” (Participant 4, 2018, p.10).

This sense of community can also introduce tensions where users feel that they have to perform. When these tensions cannot be resolved in that users are unable to implement workarounds, it can lead to some cognitive dissonances in users' and a decline in use or temporary abandonment. This is confirmed in the below quote,

“I was very much in the Strava world... I would log my activity on Strava and it was cool in the beginning because you're accountable, you know someone's watching you the whole time. It's almost like you feel you have to log your activity everyday and if you don't you feel uneasy inside. I needed a break and I've kind of taken a step back because it's daunting when someone is watching you the whole time” (Participant 6, 2018, p.4).

In the above quote the user reached a saturation point in relation to capturing quantified data and its context of participation, necessitating temporary abandonment of their device. This can be seen as an affordance, allowing users to self-reflect and self-evaluate yet where support and engagement still occurs via online communities or social comparison.

The community aspect and socio-technical functionality of these devices can however contribute to overcoming engagement barriers as it allows users to participate in alternative ways and engage with new experiences. This is shown in the quote below,

“So I've got a lot of friends in other countries that are linked to my Apple Watch so you can actually monitor how they are doing in terms of fitness and so that's been fun as well so it does create a sense of community other than Facebook so not necessarily needing to log into Facebook but then still being able to communicate with someone. That part I like which I did not anticipate” (Participant 3, 2018, p.4).

Acceptance or a sense of belonging within a social group engenders trust creating affective affordance that influence users' cognitive processes, behavioural outcomes and motivations. This may foster new interactions or the adoption of new behaviours as a result of being part of a community.

“You know Fitbit would be like this virtual community and then when that started becoming real community then things changed. . . Like I said the Fitbit was the gateway and you get more involved you need more advanced features so yes it's like a natural progression” (Participant 6, 2018, p.3).

Additionally, by making use of these wearable fitness devices usability factors that support comparative analysis between group members the act of personal analysis within a group context becomes an incentivised activity that motivates user behaviour. This also drives the adoption of new behaviour as shown in the quotes below,

“In terms of running outside I've made a lot more friends. . . I did my second one like a month ago and it made me so happy to see there is this whole community of people. You running in there and people are cheering you on. That's obviously also motivates you to run more and be part of this clan” (Participant 2, 2018, p.8).

Adopting new interactions or behaviours are influenced by the ability to share an activity within the context of a community. This occurs either within a virtual community or real community. This influence is supported by device usability factors and the functional affordances these devices hold to track and transfer quantified data that are logged and shared online. The feeling of being watched socially, as mentioned above by one of the participants also means that users perceive logged activity as a measurable experience that may occur as enabling or transitional activities.

Users are enabled in that they are encouraged to do more challenges and events that are often incentivised. As a transitional activity users move from engaging with one set of norms to the next set of norms by taking part in online and offline challenges. This may form part of a users' health management strategy, instilling accountability and self-efficacy. This is retold in the below quote,

“So if you get this device that's got all of these features that you not really using you almost want to make the most of it, so you do tend to try new things like going for a swim so I can use the swim feature on the watch. Going for a ride just to use that feature so it is encouraging in that sense. I do feel that push but in a good way as well you know” (Participant 6, 2018, p.6).

4.2.6 Theme 6: Motivation and self-efficacy

The means of using narration on a digital social platform to contextualise quantified data plays a significant role in aiding the natural progression of user objectives around health and fitness management intentions. This may play out in the form of Gamification where users adopt a player role, seeking game points or rewards, and actions are applied within specific context in order to motivate behaviour. This is echoed below,

”The Fitbit all forms part of me trying to Gamify my life to get points so I can get a return on my purchases. . . The interface is amazing its really great but with me its about getting those points by Gamifying my experience because I’m incentivised by external motivation” (Participant 1, 2018, p.2).

The social sharing of a curated narrative suggest that users adopt personas as part of an exchange that influence or shape user behaviour, affecting thoughts and ideas as an outcome of an interaction or comparison with others. This occurs as an effect brought about by social networks interaction and these persuasive technologies ability to enrich user experiences and its progress of monitoring and capturing quantified data.

By simply being part of a social network or community users become more aware and self-reflective. This creates motive and drive that aid in operationalising user goals or prompt users to engage in new challenges or objectives, leading to potential behavioural change through the control of these motivational affordances. This occurs in a form of journaling where users record their achievements or as reflective thought, where users would go back to logged activity data and measure progress against a target population. The is shown in the below quote,

“It was a very big motivating factor to go and get out there everyday, go try and get the best sunrise photo. I think that kind of started an Instagram account, because of that. I was never interested in Instagram before” (Participant 6, 2018, p.7).

Additionally, regular device interaction in conjunction with user objectives triggers intrinsic motivational drivers that encourages users to engage in physical activity and increased device use. This is experienced as a sense of achievement when progress is measured against set goals and quantified data. The following quote echoes this,

“When I started running it was short distances like 3km, 5km was a push but soon after I got the device I wanted to run 10km then 15km, then 20km and that happened very quickly. Probably getting from 0-3km took about the same amount of time to like 3km to half marathon. So that’s a big motivating factor. So from 0-3km was about 5 months very slow progression. . . there was no sought of drive to try and get better it just naturally happened and then with the device that was the motivation. There was a big drive to get better as quickly as possible and just try and run further and harder” (Participant 6, 2018, p.7).

Users are extrinsically and intrinsically motivated either by reward or incentives which in certain cases influences behaviour or

support positive changes in attitude or activities, as shown in the quote below,

“I found it really awesome because it made me more excited to do exercise and when I reached my 10 000 points I was happy about it. I felt fit” (Participant 1, 2018, p.1).

The usability factors of these wearable fitness devices play an important role in supporting individual activities which may include the efficiency and accuracy of tracking of correlations between quantified data, or providing users through device engagement with focus and targeted goals. These adaptive systems that continuously monitor and provide the user with easily accessible personal information in turn create potential affordances stemming from how effective and efficient these devices are in allowing users to achieve objectives. This is shown in the below quote,

“When I was using it I was fit. I used to go to gym. I used to run. I used to run a lot more. I used to be aware of my fitness” (Participant 1, 2018, p.11)

Additionally, the type of engagement these devices support in terms of its interface and ecosystem, and how easy is it to apply device features and functionality also play a role in terms of affecting user acceptance, as commented in the below quotes,

“Of the data I don’t use I see it as peace of mind. Even if I don’t use it if for whatever reason I need to go back and retrace my steps I can go in and say, for example am I healthy enough, is it sufficient that I track how many times I go to the gym. Am I comfortable with the fact that I’m not tracking my calories. If tomorrow I find out you know you making an incomplete decision, then I’ll go and see because the data is there. Then you can say ok let’s work out in the past week how many did I burn. Am I on the right track am I not. Do I need to change my behaviour to account for that but at least the information to make the decision is there” (Participant 5, 2018, p.4).

These motivational affordances may also increase a user’s level of self awareness or instil mindfulness by providing users with effective and accurate access to information that may form part of a behavioural intervention or an existing health management or fitness routine. This is illustrated in the below quote,

“What I do is I’ll sit here tap the heart rate monitor just to see what my heart rate is and I know if its sitting at the 80s or 90s, I’ve got a naturally high heart rate but if it’s sitting there I need to get myself a little bit more active because that’s a sign of my heart not being happy so that’s kind of my thing that I do” (Participant 8, 2018, p.8).

4.2.7 Theme 7: Goal setting and incentive

The usability factors of these devices in providing effective and accurate support to users whilst engaging in activities have been found to trigger new behavioural changes. Through motivational feedback and device prompts these devices mediate a positive correlation between achieving outcomes and setting incremental goals, as illustrated in the below quote,

“Because it got these little messages that says “you nailed it” “only so many steps to go”, so little motivational things that it does that makes me want to do it. So usually ten minutes to the hour the watch will vibrate and it will tell me for the hour you haven’t done 250 steps yet you need to do 139 more or whatever amount ‘I still have to do and then it will vibrate and then obviously I can get up and I’ll walk around and then, I don’t know its very silly but when you hit it it will either say like “good stroll” or “solid stepping” I don’t know I find it kind of very encouraging, like ok lets see what gets me moving in the next hour but sometimes obviously you have to ignore it like if you in a meeting but it creates that awareness of get up, move, stretch” (Participant 4, 2018, p.2).

Other functional features of these wearable fitness devices such as water-resistance have led to the adoption of new behavioural norms. These when combined with achievable goals and challenges become part of a user’s motivational strategy towards action and direction as commented on in the following quote,

“There was a lot of encouragement to try things. So if you get this device that’s got all of these features that you not really using you almost want to make the most of it, so you do tend to try new things like going for a swim so I can use the swim feature on the watch. Going for a ride just to use that feature so it is encouraging in that sense. I do feel that push but in a good way as well you know” (Participant 6, 2018, p.6).

User intentions are influenced by incentives that are linked to information captured by these wearable fitness devices as well as a users perceived pleasure derived from such technological engagement.

These wearable technologies with its human centric approach, coupled with incentivised activity can have a positively change on users attitudes or personal outlook on life based on how users interpret the perceived usefulness of their device.

The users level of engagement correlates to their level of use that may have negative and positive associations. Such associations depend on the devices perceived usefulness in helping users to focus goals, as shown in the below quote,

“I used to always have this vision of exercise but its made me actually get into it on a more serious note” (Participant 2, 2018, p.9).

The absence of incentive based activity or motivational affordances post adoption can be attributed to a number of things that may lead to device abandonment. Reasons found were a lack of third-party software integration and ineffective device syncing. This included the inability to utilise device affordances which hindered the capability of these devices to provide immediate and connected access to quantified data through high quality interactive haptic displays and smart sensors.

What can be perceived as a potential negative are users propensity in developing an overhaul reliance or trust in these devices, leading to a potential dependency. This trust or habit forming occurs over time and is linked to the pervasive nature of these wearable devices that proliferates almost every aspect of the users' experience especially when used in conjunction with an existing self management plan or objective. The aforementioned are echoed in the following quotes,

“The health thing is the one thing where I can see whether I’m over exercising and that I did initially, I over trained because I wasn’t following my cardiologist advice that said keep your heart rate below a 140 don’t go above 140 not yet and I thought no bugger this I can go to 180 and then I got fatigued terribly fatigued so to me that was a big lesson just like flying a plane trust your instruments and I’ve been trusting this instrument” (Participant 8, 2018, p.3).

This overhaul reliance or trust in these devices is further shown in the below quote,

“Its almost like a dependency. Its like you become very dependent on it and you almost need it. it’s like an addiction I think it is hey, it becomes an addiction” (Participant 6, 2018, p.5).

This user dependency that serves to drive intention, monitor health or motivate behaviour may present itself as Nomophobia which is an irrational fear of being offline or an obsession termed The Fear of Missing Out (FOMO) or The Fear of Being Offline (FOBO). This causes psychological tensions where users reported on experiencing anxiety. Moreover, too much device feedback may lessen use or lead to temporary abandonment due to tensions that arise as illustrated in the following,

“Its like when you wear a wedding ring and your wedding ring is off your finger. There’s a point where you feel there is something missing here. You used to it it gives you a sense of comfort. I think that is my sense of comfort” (Participant 8, 2018, p.4).

Additionally, tensions occur as a result of not being able to utilise device affordances. This may be attributed to a user’s inability to monetise loyalty points collected through device usage. Other tension include psychological pressures imposed as emotional guilt. Between activities users have reported on experiencing guilt purely by the device’s presence. This shows that the motivational and perceived affordances these devices hold in maintaining healthy behaviour and self-reflection can also have negative implications. The following quotes are examples of this,

“So there was no incentive for me to use the Fitbit if I wasn’t going to get the points... So now there’s a disconnect between getting those points and using them” (Participant 1, 2018, p.2).

“It makes you exercise more and you feel guilty if you wearing this watch everyday but you doing nothing with it it’s just there because it’s a watch” (Participant 2, 2018, p.3).

4.3 Primary data analysis summary

In the above findings I’ve reported on the seven themes which emerged from the results I obtained from of my interviews and thematic content analysis. I also presented some of the tensions and contradictions that users experience when engaging within their various individual wearable fitness device activity systems. In the following section I analyse the data using an Activity Theory framework.

4.4 Emerging personas

The purpose of this section is to provide an analysis of my explanatory interview findings. I used Activity Theory in asking questions of eight participants. Results obtained from my eight participants were reduced to four personas. I now turn to a secondary data analyses of my four personas using an Activity Theory framework.

I also highlight some of the contradictions and tensions that occurred between the various wearable fitness device use activity systems in relation to personal use and its associated elements as represented within my four personas.

The manifestation of contradictions within activity systems can serve as generative paradigms in that it puts forward the notion of acquiring new knowledge when an activity system implements new external elements in order to acquire specific outcomes and aims. Contradictions or tensions in addition may lead users to seek and acquire innovative ways in an attempt to support the mediated activities that drive a user’s particular activity system. (Engeström, 2010:137).

For my analyses I have used Engeström second generation Activity Theory framework, studying users’ individual interactions in relation to their tools and environment, where such an analysis focusses on the collaborative practices between individual use and the mediated action that occur between shared objectives in order to generate meaning (Mwanza-Simwami, 2013:180).

This chapter also explores wearable fitness device usage as a dynamic, personal and socially constructed phenomenon whose mediations can be understood by operationalising the various elements within a user's activity system. These activity elements are shown and its user context explained under the following headings: subject, object, tools, rules, division of labour and community of which was outlined in chapter three.

4.5 Persona 1: Middle aged early adoptee of new technology that is health conscious post suffering cardiac arrest or similar health related event

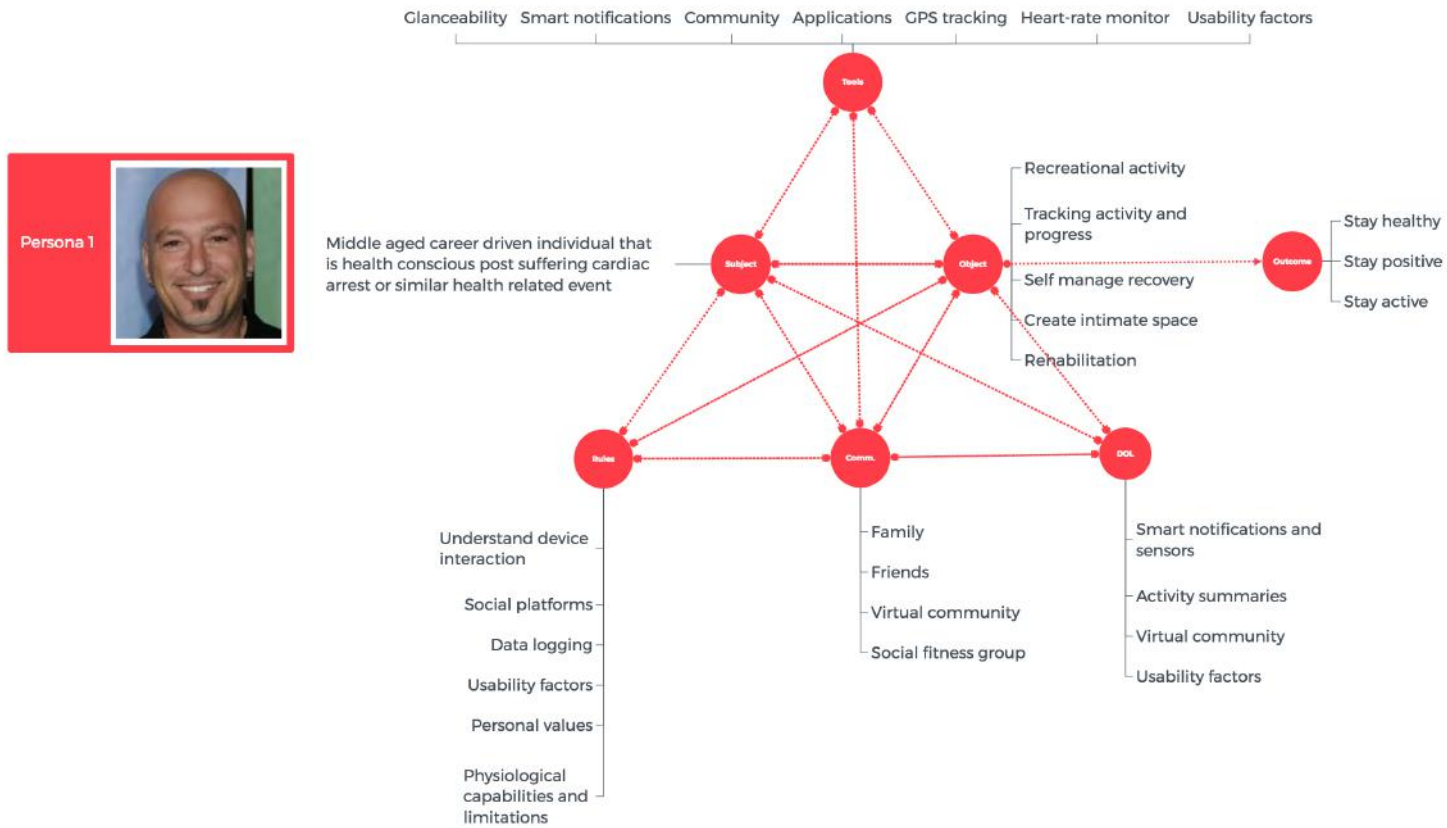


Figure 18: Persona 1 Activity System (Author, 2019)

4.5.1 Tools

Tools refers to device features and the characteristic behavioural affordances that are present within an activity system in order to facilitate user goals and outcomes.

The subject made use of several behavioural and device affordances, termed tools. One such tool was glanceability which relate to the display of digital information that allowed users quick access to pertinent health information. The real time immediacy of information through high quality interactive displays and haptic feedback provided the subject with self awareness and in some instances peace of mind by allowing reflection to occur on captured data. This concept is supported by the following statement,

“... so if we’ve had a disaster in the centre and I feel stressed and literally I can feel my heart and I’ll go let me just check what’s going on here and I think that mindfulness also helps you just to say ok just calm down, there we go, now we good” (Participant 8, 2018, p.8).

Tensions and contradictions may however occur as a result of a subject’s over reliance on real-time captured data, that have been shown to cause psychological stress. This occurs as an effect of the interrelatedness between participating activities within an activity system that permit influence to occur which may have negative consequences. This is illustrated by the below quote in relation to the subject’s active use of the tool, heart rate monitor,

“... what’s happening is your kind of keep focusing on this thing and that makes you then agitated and excited, so my heart rate just kept on going up and I took it off” (Participant 8, 2018, p.6).

The subject made use of additional tools where the division of labour was shared in a mediated method through the use of activity summaries, smart notifications and usability factors in achieving an objective.

4.5.2 Subject

The subject (Figure 18) refers to an early adoptee of new technology that is health conscious post suffering cardiac arrest or similar health related event. Their objective, mediated by tools related to the use of these wearable technologies in a supportive manner, aiding in physical rehabilitation.

As a user of these wearable fitness device the subject self diagnose entailed using tools to provide detailed information associated with specific physical activities and desired goals. The subject also experienced internal transitions or adapted behaviour as a result of device feedback and usage. Such internal transitions occurred by the subject’s ability to integrate and understand device feedback and establish such technological integration as components of the subject’s activity system.

As a result, both the subject and the object converged in a mediated approach to keep the subject active, healthy and positive (Figure 18). This is echoed in the below quote,

“I think it’s the whole activities thing but not from their activity applications it’s from my own desire to want to be active and to see my heart is actually responding properly and to extend my life, I think that’s the big thing” (Participant 8, 2018, p.9).

4.5.3 Object

The object refers to the associated reasons pertaining to actionable intent or desired outcomes. Is it regarded as both a contested space and negotiated space that is acted upon. It exists within a mediated relationship that have developmental outcomes.

In achieving an object, the subject used adaptive technologies in relation to tracking physiology to achieve a situation of change by introducing rules which the subject perceived as being able to manage recovery or physical rehabilitation.

The device as a tool also allowed the subject to curate his domestic environment where the object was to enhance a feeling of well-being and emotional connection with an individual or social group. This is reinforced by the following quote,

“So one of the nice things is at home we do a lot of stuff in the kitchen because I love cooking and that’s our place where we “kuier” (socialise) in the evening. We’ll have some wine and a cook-up and the nice thing is I can play my iTunes playlist from my phone onto our Bluetooth speaker in the kitchen. So we’ve got our music going but if something happens and you want to change the track or put the music down you can do it from your watch and that’s the coolest thing” (Participant 8, 2018, p.9).

4.5.4 Division of Labour

The division of labor refers to the associated power dynamics and assigned roles of responsibility necessary in order to achieve the subject’s activity. In the above activity system (Figure 18), the division of labor is shifted in favour of smart notifications and device sensors and assigned a predominant role of supervision on behalf of the subject. It functioned to inform decision making and the management of potential conflicts as experiences by the user in relation to a specific context or environments.

The division of labor was shared between participating parties that required the subject to engage with a virtual community, forming part of a digital social platform. In it the role of the virtual community served in providing encouragement that informed the subject’s decision making process based on what the subject chose to share publicly. This permitted self reflection to occur and instilled a sense of achievement in relation to motivation gained from social interaction. In the below quote the subject illustrates the role of the virtual community in the subject’s decision making process, relative to activity summaries,

“So what the watch did for me initially as well as other than just monitor my heart was that it became a great motivating tool. So I could upload all my workouts to the Garmin website share on Facebook and people would go hey man you making a nice recovery but in the end it’s like a self motivation tool” (Participant 8, 2018, p.2).

The subject held the predominant power relation in that interactions occurred as consequence of the subject’s intervention. However, in the subject’s activity system this power dynamic shifted in favour of device usability factors that allowed for intermittent checking of device data to ensure the subject’s heart rate and pace was at a normal level. This developed a sense of reliance and dependency, which can be deemed a tension associated with the subject’s outcome. This is confirmed by the following quote,

“I am very attached to my smart watch. I feel naked when I don’t wear my smart watch...Its my source of everything” (Participant 8, 2018, p.4).

4.5.5 Rules

The rules are the associated customs both implicit and explicit as understood by the subject to regulate the functioning of an activity system. These include group dynamics, social and cultural norms and device utility. The subject highlighted the need and desire to maintain an active lifestyle. This had the effect of ensuring self monitoring took place and the management of lifestyle choices to ensure well-being. Precise rules were set by external factors such as requiring the subject to understand device interaction in order to mediate between activities. This included being able to actively engage with digital or social platforms although only in as much the subject felt assured that such engagement did not compromise their personal values or physiological capabilities and limitations. This is reflected in the below quote,

“I didn’t have my heart rate monitor on the bicycle [so] I turned around and said ok cool that’s it and somebody said I can’t believe that you self managed like this but I said I have to you know” (Participant 8, 2018, p.9).

4.5.6 Community

Community relates to the subject’s internal and external activities and can be understood as a shared object, mediated by cultural practices and social norms or its structured social context. The subject interacted with several communities which included family, friends, virtual communities and social groups. These groups were made up of object-oriented states where they served as a means to differentiate between the constituent parts of the subject’s activity system and its associated cultural and social properties.

The community furthermore became the transformative agency in that it allowed the subject a means of reflection in order to adjust interactions in relation to their environment or objectives.

The following quote illustrates the development of the subject's practice as informed by the context of progression and socio-cultural context.

“...if you are in this virtual world, you can kind of do it on your own time whenever you want but then when it comes to like real people you want to run in a group with other people so things kind of shift, so I think I'm moved probably not so much by the device but more by the app” (Participant 6, 2018, p.3).

4.6 Persona 2: Typical user who requires ad hoc information in a corporate and social environment

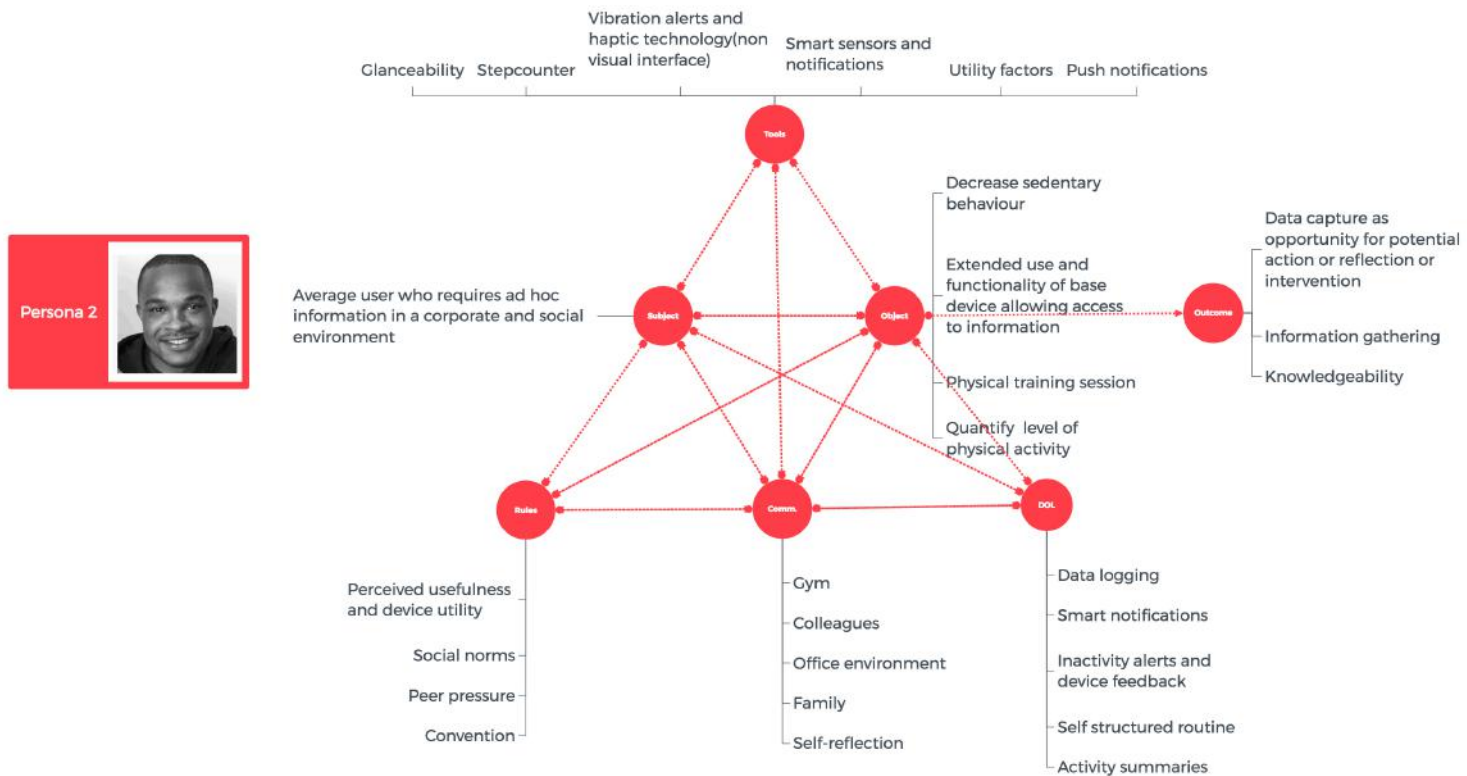


Figure 19: Persona 2 Activity System (Author, 2019)

4.6.1 Tools

The subject made use of several tools, the basis of which was their object-orientedness directed at mediating the subject's interactions. The subject used tools in a flexible manner that allowed for the modification of behaviour and the potential development of new activities or techniques by adapting to specific socio-cultural contexts.

Tool use included a step counter, smart sensors and notifications in addition to vibrational alerts and push notifications which was applied in an objective manner as an extension of the subject's primary or base device. These tools allowed quick access to ad hoc information that provided peace of mind knowing that the device is constantly capturing useful information for later reflection.

This mediated action was shared amongst other elements of the subject's activity system where responsibilities and duties were purposed and distributed to further improve internalised action. Such internalised action formed part of the subject's decision making process and made use of rules.

The subject made use of tools in a mediated method as part of an existing activity, native to the subject's contextual background. This mediated relationship was distributed in parallel to include community and division of labor.

Tools were used as part of the subject's internalised action or objectives which included a desire to decrease sedentary behaviour, quantifying the levels of activity and assist in structured exercise. This power dynamic which is situated within the subject's perceived relevance of information in influencing compliance or non compliance is echoed in the below quote,

“Well certainly, its free information I guess. My doctor will come one day and say listen you need to know how many calories you burnt this past month and I can go, you know what I can give you the answer. The value is in knowing that it is there and having the choice whether I use it or not” (Participant 5, 2018, p.4).

4.6.2 Subject

The subject refers to a typical user of a wearable fitness device who requires ad hoc information in either a corporate, social or personal environment. The subject made use of their device to mainly track day to day activities. Furthermore, the subject tracked captured quantified data as a source of relevant information that could inform decision making or influence behaviour. The subject's developmental decisions where based on the contextual relevance of captured device data, influenced by the subject's perceived value of such data relative to the associated ease of device use, convenience and usability that extended the capability of the subject's primary device. This is confirmed in the below quote,

“The nice thing I like is I get the timeline as well so for me from five to six or six to seven there’s most activity and then during the day its just dead you know stuff like that but I would typically look during the day or towards the end of the day. I also noticed that with that you can’t change your behaviour during the day because you only seeing this information after the fact. Now you can go and say I can correct that for tomorrow but if I come half way through the today and I check it again I can go I need to walk more” (Participant 5, 2018, p.5).

4.6.3 Object

The subject was motivated by activities through the mediation of tools that allowed for data capture and the accumulation of information to occur as elements of participation. The object refers to that which enabled individual choice to occur in relation to the subject’s needs and environment. This allowed for potential action, reflection or interventions on part of the subject and correlated to supporting the subject’s internalised activities. The object also related to the subject’s perceived value and relevance of quantified data and its ability to influence or direct actionable thought.

Tensions arose when the subject experienced an inability to make informed decisions based on captured quantified data, or when such information was deemed irrelevant in that it did not provide opportunity for action or reflection, relative to set outcomes.

For example, where the objective was to decrease sedentary behaviour, development was only acted upon based on the subject’s knowledgeability of a situation or context of progression. Moreover, in the subject’s activity system, the object was negotiated by inactivity alerts, device feedback, smart notifications, data logging and activity summaries all of which served as a potential opportunity action or reflection . This is illustrated in the below quote,

“I comfortably with the fact that I’m not tracking my calories. If tomorrow I find out you know you making an incomplete decision, then I’ll go and see because the data is there. Then you can say ok let’s work out in the past week how many did I burn, am I on the right track am I not? Do I need to change my behaviour to account for that, but at least the information to make the decision is there” (Participant 5, 2018, p.4).

4.6.4 Division of labour

During regular device use the division of labor was assigned to smart notifications, data logging and device feedback through inactivity alerts. This outlined the hierarchy of the subject’s activity system which described the activity as attached to the subject’s need for opportunities of potential action, reflection or intervention.

The subject, being conscious about structured exercise and its perceived value used device activity summaries as a co-defined element with a mutual interest that permitted engagement in fitness challenges or social events. In this context device activity summaries formed part of the subject's training plan or as part of a self-structured routine. This is outlined in the quote below,

“The only time I was checking that throughout the day was when I had the IMPI challenge because I had to track my activity but now without that thing driving me, that you have to do 5 km today without that I'm quite comfortable only doing this at the end of the day” (Participant 5, 2018, p.5).

4.6.5 Rules

Rules related to a shared system of participation that was centred around the users perceived value or usefulness in relation to device data and active engagement. This shared system of development occurred in a mediated approach between the community and division of labour, intended in supporting the subject's required knowledge criteria to make decisions. This dynamic between the various activity elements shifted the subject's outcomes as a predominant power dynamic and in some instances caused tensions and contradictions in relation to other activity elements. This was a result of the subject becoming aware of certain limitations and guidelines involved within specific domains which differed from the subject work activities or social-cultural context. This is shown in the following quote,

“I think this thing is a valuable thing to have. It does have a strong consequent impact on peoples lives and I think it has potential to change people's behaviour. Perhaps I haven't reached that stage and also I would admit I'm not fully using it for everything because I know all the apps that I have on my phone are here. So a lot of the apps I can still use here but I still go back to the phone because its got a bigger screen. I'm probably not using it to full capacity” (Participant 5, 2018, p.7).

Other tensions occurred when the subject was unable to either apply knowledge to achieve an outcome or when such activities were not deemed mutually exclusive, possessing overlap between codes of practice or personal habits. This however provided the subject with an opportunity to explore activities in a collective and developmental manner which brought about reflection and peace of mind by knowing that specific data was being captured which the subject may judge useful at a later stage.

In a social setting the rule of convention or office etiquette became both a method of executing activities without becoming overt or it provided flexibility in response to social interactions. The below quote illustrates this,

“For example if I'm travelling in Johannesburg and the meeting before is running late I have to get to the airport you know [if] in the middle of a presentation it looks absolutely rude if I whip out my phone and look at it but now I can just quickly without seeming obvious. So professionally I think it has I don't know if this is the right term but it has brought back some form of decorum in this thing of people pulling out phones in front of your face in a meeting” (Participant 5, 2018, p.6).

Peer pressure was perceived as a tacit means of influence that determined the subject's external activities in relation to the mediated activities of their activity system. The rule, as a problem setting, was initially based on the subject's perceived risk which determined a shift in power dynamic where the active involvement of others helped the subject in making difficult decisions., This indicated the implicit influence that occurred through social interactions and how it provided structure to the subject's internal activities. The subsequent quote conveys this notion,

“The other thing I would add was my wife also told me I am buying one so you must also get one so I don't feel bad about buying it. So there is also that peer pressure. So that also made the choice rather because these things are quite expensive” (Participant 5, 2018, p.7).

4.6.6 Community

The foremost communities of engagement that the subject interacted with were office colleagues, family and the gymnasium. In addition, the subject generated a community of action through continuous device interaction and data gathering as a means to support self reflection. The various community groups involved the associated social norms and context that were mediated in order to achieve specific outcomes. In the case of the gymnasium the community was a structured external environment that allowed the subject to engage with their internal activities which was to track fitness and performance.

The office setting served as collective community of practice, where the system of activities was already defined. The action of using the device to discreetly glance at incoming messages and notifications in such a context were understood as a shared object within a parallel activity. This is illustrated in the following quote,

“At work the thing that we always talk about is in meetings if someone, the phone vibrates and they pull it out its actually quite distracting and it's something we've talked about because of the daily meetings. I think previously they actually banned it in meetings in the boardroom but this allows you to sneak a peek without being obvious around it” (Participant 5, 2018, p.6).

4.7 Persona 3: Fitness power user that actively and consistently tracks activity

Immersive tasks Utility factors Heart rate monitor Smart sensors Wireless connectivity GPS tracking Glanceability End user customization Applications Third party compatibility

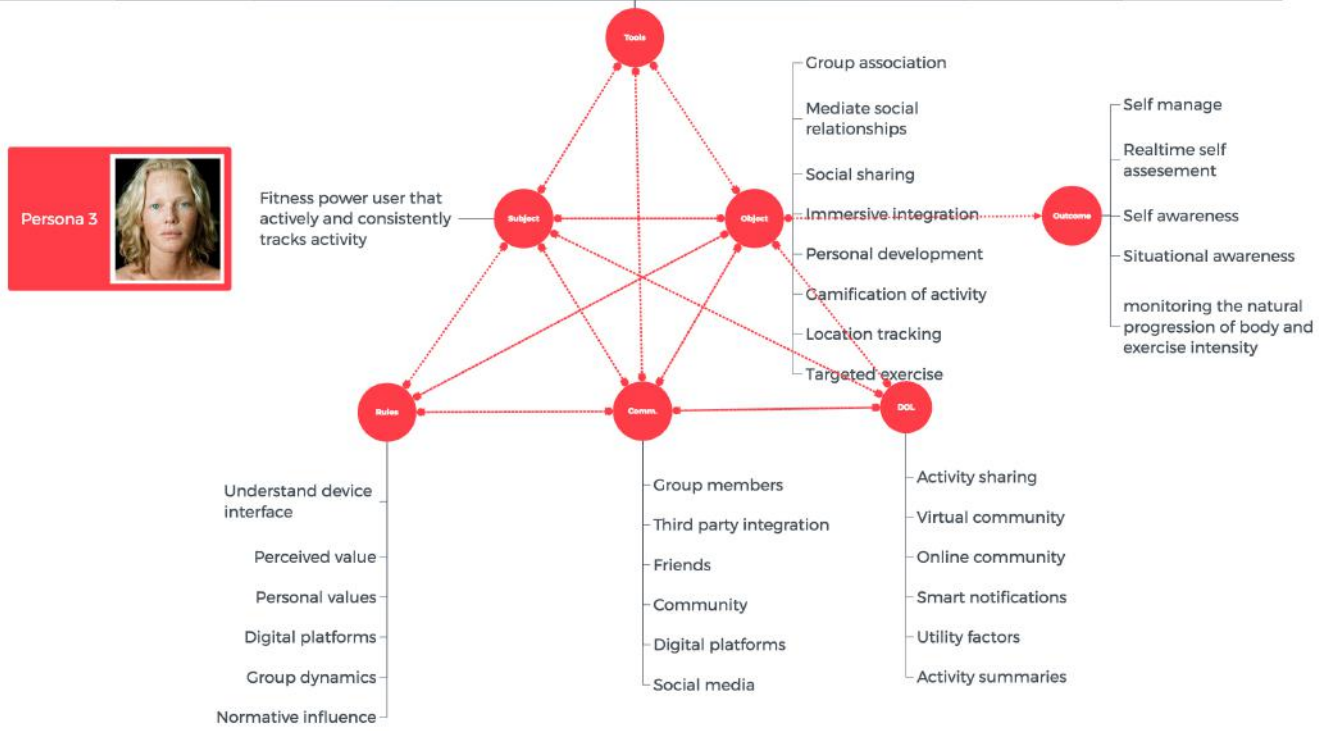


Figure 20: Persona 3 Activity System (Author, 2019)

4.7.1 Tools

The subject who is a self driven power user made use of several tools which included device utility factors and applications to assist in achieving targeted objectives . These tools included using immersive tasks and smart sensors to facilitate and inform the subject's interval training plan or focussed exercise routine. The exchange between the user's objectives and outcomes were closely located in that they both defined the subject's context of learning about themselves and their environment. This mediated relationship that occurred between the division of labor and community provided impetus for the subject to make the effort in achieving certain objectives. For example, during active participation in an outdoor event the subject made use of GPS tracking, smart sensors, heart rate monitoring and device glanceability as tools, which triggered in situ transformation. These tools allowed for the emergence of new contexts, which provided real-time self assessment, situational awareness, monitoring progress and exercise intensity. The utilisation of advanced device features through end user customisation allowed for participation in online challenges as a method of comparative analyses. This sharing of activity and progress on public forums was experienced as a community of action which generated new experiences. This is echoed in the following quote,

“So with Fitbit the community is huge. Once you get into the challenges then you just get invited the whole time and then you competing against people from America. Some of the things I use to do would be, the challenge would start in American time zones, whoever starts the challenge that's the time zone it starts at. So if it starts at midnight, so if its in the states at midnight then it would start at 6 am here or in some cases like 3 am or 4 am just depending on which side. So some mornings I would wake up literally at 3 am and just start going you know” (Participant 6, 2018, p.2).

Third party software integration and wireless connectivity acted as tools that allowed for seamless tool mediation to occur by understanding device interaction and the associated rules of online participation within these digital social platforms.

4.7.2 Subject

The subject refer to a fitness power user that actively and consistently tracks activity that would typically engage in multiple sports successively resembling ultra running, swimming and trail running. Furthermore, the subject took part in events that stretched over an extended time. As such the division of labor was shared by device utility factors, detailing extended battery life to ensure achieving targeted objectives. These included immersive integration, personal development and engaging in targeted exercise. The subject also actively captured and logged all events and activities which were uploaded to an online fitness community or digital social platform for public view and comment. This illustrated a shared power dynamic between the community and the rule of normative influence. This power relation was reinforced by the action of publishing captured data as a means to validate personal performance and personal benchmarking. This is echoed in the following quote,

“Yes because its making it relevant because if you don’t have information to upload then its irrelevant you’ve got nothing to show. So for instance with this Ultra-trail Cape Town you want to record that because you know its relevant. . . I’ve been constantly running, I do a lot of events and races and that’s my lifestyle and I enjoy it. It gets me outside, I’m not saying the watch necessarily gets me outside but it is a tool that helps me to capture information to get the analytics and then also potentially managing but also have these social sharing features which are big aspects of it. For me its just a tool that helps me with data, capturing data but also its one way of sharing an experience with other people” (Participant 7, 2018, p.4).

The subject’s main focus was in monitoring their natural progression and exercise intensity which expanded their social context to include the object of Gamification as a form of extrinsic motivation. Outside of its socio-cultural context however this action of incentivised activity through the accumulation of points caused tensions as a result of personal values and its perceived usefulness, which was deemed a rule under the subject’s activity system.

Data overload or too much device feedback lead to temporary device abandonment in that device feedback was perceived as negatively impacting the subject’s perspective during an event, which as an outcome within the subject’s activity system went against achieving situational awareness.

4.7.3 Object

The object changed over time according to the rules of personal values and perceived value. In a sense the object of group association and the mediation of social relationship through social sharing created a usefulness that was negotiated internally.

For example, the rule of normative influence and social group dynamics changed the subject’s perspective influencing their desired outcome to self manage and obtain self awareness in as much that such comparative influence was relevant to the subject’s setting. In the subject’s activity system, the object was operationalised in a collective manner where the real activity was transformative and often embedded into a particular space, that was not linear but developmental. This developmental space occurred between the rules of normative influence, the communities of social media and digital platforms; and the objective of personal development. These activity elements oscillated to include a division of labor, such as virtual communities, smart sensors, activity sharing and activity summaries to generate a sense of accountability that garnered ownership on part of the subject. This apparent relational complexity however was born out of the subject’s pre-existing desires and goals to maintain a consistently active lifestyle which subsequently encompassed a comparison and sharing with or between communities, tools and activity elements.

4.7.4 Division of labour

The associated power dynamics and assigned roles of responsibility in order to achieve an activity were determined by established outcomes. The action of uploading, and publishing captured quantified data on social platforms meant that the power dynamic shifted in favour of virtual communities and activity sharing in that such action was seen as a means to validate performance.

In the case of taking part in events, smart notifications and utility factors such as extended battery life shared a distributed power dynamic, which even though they may be seen as tools became a division of labor in that they defined how development should happen and the means that would facilitate such development. The following quote illustrates this notion,

“I got into this position where I was winning and I was flat out and I was also tired in a way. I thought I’m not going to look at my watch because my watch is going to tell me how much longer I have to go and I didn’t want to know that because it was going to play with my mind. So I was like let me rather not look at my watch I’m just going to sit this out at this pace because I knew it was at least 24 km. With the Ultra which is 3 times the distance and it’s slower much slower at times and even if you feeling shit a lot of time I still looked at my watch to see where I was. Not so much the case but more how far I’ve run. So it depends on the distance as well” (Participant 7, 2018, p.5).

4.7.5 Rules

Rules served a core objective that guided different ways of interaction through device usage and its associated platforms in order to create structure and awareness around the subject’s pre-existing self management plan.

Rules were applied to increase performance taking into consideration the developmental processes that occurred when activities took place within specific socio-cultural context with established cultural norms and technological requirements. In the event where the subject captured, logged and uploaded data to an online fitness community or platform for public view and comment certain rules imposed criteria that required regular logging of data. This also caused tensions in that over time the subject became overwhelmed. This is echoed in the quote below,

“It was cool in the beginning but then I reached a point now where I actually haven’t been on Strava for over a month. I’m talking like for two years like every single day just like full into it but then I needed a break and I’ve kind of taken a step back because it’s daunting when someone is watching you the whole time” (Participant 6, 2018, p.5).

4.7.6 Community

The subject engaged with a number of mediated social practices through virtual communities, digital platforms and social media. These active engagements involved the sharing of activities with other users in visual narrative form or as logged statistical data.

Such mediated practices were structured by their social and institutional context that facilitated social interaction through online platforms and software applications. The subject was influenced to form new goals and aspirations by competitively tracking activity within a social network. This expanded community of engagement in turn instilled in the subject a sense of belonging by being able to compete remotely via online challenges. This brought about self awareness and comparative analysis around user activities and goals by being able to share and compare within a community.

Furthermore, the subject's extended practice meant that they engaged in additional outdoor activity, utilising more advanced device features such as third party software integration in order to upload captured device as well as Gamifying activity. The below quotes echoes this,

“With running especially, the main platform for people to share their experience is Facebook, Instagram and Strava. Those are the three. I wouldn't think of any other ones that would really share your run experience other than having conversations with people or that person, that's obviously a big one as well” (Participant 7, 2018, p.4)

“...the social element which is the Strava element when the data goes into a platform that has an influence from a social level because it becomes more Gamified and it becomes almost competitive whereas before I wasn't really sharing much and I wasn't really so competitive or Gamified” (Participant 7, 2018, p.3).

4.8 Persona 4: Incentivized millennial user who is extrinsically motivated and low to moderately health conscious

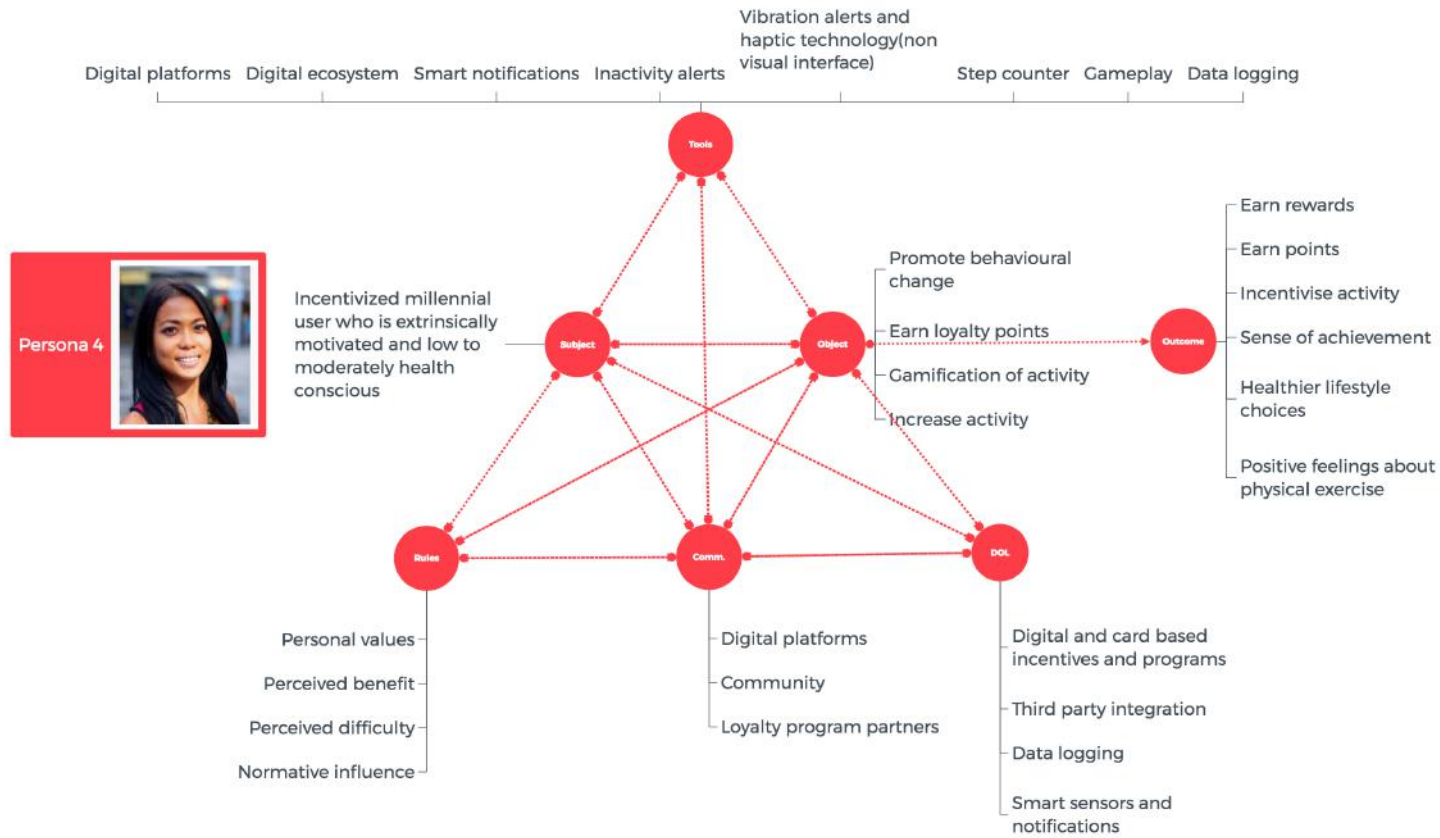


Figure 21: Persona 4 Activity System (Author, 2019)

4.8.1 Tools

The subject who was extrinsically motivated and was low to moderately health conscious made use of numerous tools such as smart notifications and digital platforms with the aim to facilitate an objective to Gamify their lived experience. This method of mediation using tools allowed the subject to incentivise their activity in order to influence an action to increase their level of physical exercise. The subject which was goal orientated made use of tools in order to accumulate points or rewards.

This mediated relationship although influenced by its contextual external environment was indirect and was based on the subject's internal activity. As such interactions were adjusted internally by the subject in relation to their current reality with an intent to manipulate their external environment in order to earn rewards and points. This in turn led to a sense of achievement that brought about positive feelings regarding physical exercise and led to healthier lifestyle choices. This is illustrated in the quote below,

“I found it really awesome because it made me more excited to do exercise and when I reached my 10 000 points I was happy about it. I felt fit. It made me want to take the stairs instead of the elevator. It made me want to go for a walk instead of a drive, so it was very positive, it changed my behaviour” (Participant 1, 2018, p.1).

The subject engaged in actions that were shared by a community. Such activity was targeted and benchmarked against a community of practice which the subject deemed valuable in that it would yield a number of obtainable points. These actions were carried out making use of the following tools, smart notifications, inactivity alerts, vibration alerts and haptic technology and data logging.

Tensions occurred between the object and division of labor due to lack of technological integration and the subject's inability to monetise loyalty points or rewards gained. This had an adverse effect on the subject's perceived value in relation to device use that would lead to device abandonment.

4.8.2 Subject

The subject refers to an incentivised user who was extrinsically motivated and was low to moderately health conscious. The subject used tools such as gameplay and logging of activity in order to transform all activities to either an incentivised platform or reward based system. This mediated developmental process was shared by the community and division of labor to reach an objective of Gamification which expanded to include specific outcomes.

The associated outcomes included incentivising activity and instilling a sense of achievement. It shared a power dynamic with the division of labor that led to healthier life choices. This meant that the subject had to relinquish power in trusting technology and digital incentive based platforms to ensure activities were logged and quantified.

This created tensions where captured activity data from their device, shared on a social platform, caused concerns in terms of data sharing and privacy. The following quotes illustrates this tension,

“I think knowing that Big Data is being collected by your watch there’s this trade-off for you knowing when you leave home, how fast your heart’s beating when you need to go to sleep. You are also contributing to this Big Data and it is not always intentional and you’re not always intentionally wanting to do it” (Participant 3, 2018, p.3).

“The issue that I have... is that other people have access to my data. Big data is the new currency so now somebody has got access to my data and that is a concern” (Participant 1, 2018, p.5).

4.8.3 Object

The object was perceived as a distributed and developmental process that engaged in action with the intent on enabling usefulness and value through a means of incentivised engagement. The object responded to the subject’s needs of validating exercise as an activity that can be monetised. This also meant that the subject’s goals and level of exercise were targeted and benchmarked against a digital loyalty platform in relation to its accumulated reward or points value.

The object was also perceived as a problematic space where tensions occurred due to a lack of technological integration and the inability to log and sync loyalty points on its digital platforms. This is shown in the following quote,

“I used to go to gym and I was going to get the points and eventually going to log the points but it never got to that point because for whatever reason the user experience of connecting the phone to the point system I didn’t get it” (Participant 1, 2018, p.1).

4.8.4 Division of labour

The division of labor detailed the use of digital incentive based loyalty programs and the use of smart notifications and sensors to capture and log quantified data. The use of these methods determined the scope and structure of the developmental process. It also determined the type of tools and specific action to be taken together with the associated rules. One such rule related to the subject's perceived value and intentions on integrating technology within their everyday life for the purpose of incentivising such activity. The below quote offers and explanation,

“If you just had to look at the phone and when I using it at its peak looking at that particular time then I can say that it definitely changed my behaviour, it made me a lot healthier a lot more motivated to get fit. You know like I said earlier it made me walk more. I can remember going clubbing one evening and it was 3 o clock in the morning and I made 10 000 steps and I was like how did I do 10 000 steps in 3 hours and it was just so awesome because my goodness I made 10 000 steps. And it would do a little buzzing thing and I was like ok cool I could just chill for the rest of the day” (Participant 1, 2018, p.3).

4.8.5 Rules

The rules of the subject's activity system persisted with an overarching aim in that activity and interactions where directed to accommodate the subject's perceived value and benefit in relation to device usage, as determined by the ability to incentivise activity and gain rewards in the process.

As such the codes of practice and the subject's behavioural norms were developed in favour of gaining extrinsic rewards. The rule of perceived difficulty served as a means to influence continued use in that the subject equated incentivised activity with a sense of enjoyment. This is echoed in the quote below,

“It [the device] would make me go for walks on the promenade. It would make me take the stairs instead of the elevator. So that's what I end up enjoying because now getting healthy was fun because I was getting points for it” (Participant 1, 2018, p.4).

Tensions occurred when the subject was unable to monetise activity due to the rule of perceived difficulty. This related to a disconnect that existed between engaging in physical exercise, gaining point or rewards and the inability to monetise earned rewards on the accompanying digital platform. The aforementioned is illustrated in the following quote,

“There’s a disconnect between me exercising and getting points and how do I cash it in” (Participant 1, 2018, p.2).

The rule of normative influence served to regulate the functioning and shared participation of the subject’s activity system where exercise occurred as part of a routine set by a third party loyalty partner in order to achieve points or reward markers.

4.8.6 Community

The community of the subject’s activity was the third party loyalty partners and the linked digital social platforms. As such the subject’s actions were structured by a social context but mediated and understood by the subject in relation to their objectives which in turn informed their aspirations or sense of self. The above-mentioned is confirmed in the following quote,

“So I’m all about points. My whole wallet is full of loyalty cards because I feel like I should be earning points for just buying products actually because I need to Gamify my life. I’m trying to Gamify my life to such an extent that I get more out of life” (Participant 1, 2018, p.2).

4.9 Summary

In this chapter I reported on findings as obtained from individual interviews and thematic content analysis. My primary data analyses identified seven themes which emerged from the obtained results. In providing a rich and descriptive analysis of my initial explanatory findings I made use of Activity Theory in asking questions of eight participants. Results obtained from these eight participants were reduced to four personas using an Activity Theory framework. In this chapter I also highlighted some of the contradictions and tensions that occurred between the various wearable device activity systems in relation to personal use and its associated elements as represented within my four personas.

5 Discussion

5.1 Introduction

In this final chapter I review my research objectives and the relevant findings which emerged from my study. I also provide a justification for this study by stating its contribution with regards to research into human interaction design and wearable devices, and cultural historical activity theory (CHAT).

This study has aimed to explore the patterns of behaviour and affordances that emerge through user interaction with wearable fitness devices. However, in this much contested and ever changing field of research no claim is made that all questions were addressed as it presented itself during the research process. As such this chapter also includes sections on methodological reflections, substantive reflections, scientific reflections and recommendations for further study.

5.2 Research objectives

The main objective of this study was addressed by using the following processes,

- Exploration of current literature and content analysis to identify critical areas of research in respect to the affordances that users gain from smart devices
- Presentation of personas linked to wearable device use as developed using cultural historical activity theory (CHAT)
- Tensions and contradictions in wearable device activity systems

5.3 Summary of research

This study explored user acceptance and patterns of behaviour associated with wearable device use. The study responded to a growing academic concern in that these persuasive technologies, in particular smart watches, represent the most popular type of wearable devices that hold the potential to motivate and influence behaviour (Fritz, Huang, Murphy and Zimmermann, 2014) and (Chuah, Rauschnabel, Krey, Nguyen, Ramayah and Lade, S, 2016:276)

In applying CHAT as an analytical lens I asked questions of eight participants. Results obtained were developed into four personas as means of outlining human interaction and the mediating factors accompanying wearable device use. In the section below I discuss the overarching themes that emerged from these four personas.

5.3.1 Lifestyle Management

A key usability factor of wearable fitness trackers is their ubiquitous ability in using smart sensor technologies, to assimilate and present contextual information for the accumulation and observation of personal quantified data (Li et al. 2010). This study found that people adopt and accept these wearable fitness devices for a number of reasons. Primarily, user acceptance and usage were ascribed to a devices ability in playing an intermediary and supportive role between users and their objectives. As such users' were likely to adopt and use these devices if it allowed them a means of accessing relevant information or in that it supported a number of lifestyle factors that impacted on a user's overall sense of self or well-being (Rooksby et al. 2014) and (Li et al., 2010).

For example, persona 1, in transitioning from being an unhealthy patient to actively monitoring and managing their health and recovery process, made use of several tools that allowed for quick access to pertinent health information in relation to their health goals. The real time immediacy of information provided by these devices in supporting the user's lifestyle management tasks brought about self awareness and a means self-reflection. In the case of persona 2, the device allowed for the modification of behaviour and the potential development of new activities. In a manner the device performed a participatory function based on the users need to capture and accumulate information that would inform potential action or behaviour. As such the device did not directly influence user behaviour but instead shared a mutual interest, in the form of device affordances such as activity summaries, that permitted structured engagement in an already established system of activities. Rooksby, Rost, Morrison and Chalmers, characterises this use of activity tracking within everyday live as lived informatics where tracking often occurs within a social or collaborative setting (2014:1163).

Similarly, persona 3 used their device to assist in achieving targeted objectives as a means to self assess and provide them with the ability to learn more about themselves and their environment. As such device usage patterns changed over time based on the user's personal values and the perceived value derived from device use. This is supported by Li, Dey, and Forlizzi and their stage based model outlining personal informatics systems. These include Preparation, Collection, Integration, Reflection and Action.

In the case of persona 4 the device was used in a mediated manner contingent upon whether such interaction would facilitate a means to Gamify their lived experience. In essence device tools and affordances such as step counters were engaged with as a means to quantify and incentivise user activities. This is supported by Li et al., suggesting that an effective personal informatics system needs to consider all parts of the involved system to ensure prolonged, committed user engagement (Li et al., 2010).

5.3.2 Self-efficacy

With regards self-efficacy, persona 1 made use of activity summaries, smart notifications and sensors, using their device to aid them in realising their personal goal of maintaining good health and attain physical rehabilitation. By providing detailed physiological information associated with specific physical activities they utilised device tools in a mediated approach to stay active, healthy and positive. and This is supported by Hartson's functional affordance where the functional characteristics of a system or device adds purpose through interaction in order to facilitate user intentions and goals (Hartson, 2003). This includes the operationalised variables such as activity summaries, smart notifications and sensors that enable use and utility.

The real time immediacy of information through high quality interactive displays and haptic feedback both informed and validated the user's decisions and behaviour in relation to their environment. The accumulation of quantified data was perceived as valuable and relevant in its ability to influence or direct actionable thought. This allowed for new context of experience to emerge or self efficacy to occur in that they became aware of new ways to improve activities based on the knowledgeability of a situation as brought about through device interaction and reflection on quantified data. In the case of persona 2 the device performed a significant aspect in developing potential capabilities that could yield additional outcomes. This is supported by Li et al. and their collection phase, referring to the period where users actively accumulate quantified data. This usually incorporates different stages of introspection and self reflection, involving interaction with people and the user's environment (Li et al., 2010).

For persona 3 the realisation of self efficacy occurred as a mediated and developmental phenomenon through the utilisation of device features such as, smart sensors, activity sharing and activity summaries. It included the user's pre-existing goals in maintaining a consistently active lifestyle which encompassed active engagement, comparison and sharing with or between communities. This sharing within a community environment generated a sense of accountability and self belief that garnered ownership on part of the user in that it was perceived as a means to validate personal performance. This also meant that users were more likely to increase their performance as activities took place within specific socio-cultural context with established cultural norms. This is supported by Li et al. and their integration stage where quantified data is transformed and reflected upon. They also point out that barriers experienced during this phase, are dependant on the ease of integration and amount of effort users experience as they transition from capturing the data to reflecting on the captured data (Li et al., 2010). This was illustrated by persona 3 where device feedback caused tensions and a lack of integration as it was perceived as negatively impacting on their perspective during an event in that device feedback did not take into account the user's in situ targeted objectives.

With a prevailing objective to incentivise individual activity, persona 4 made use of smart notifications, smart sensors and digital platforms with an intent to manipulate encounters with their external environment in order to earn rewards and points. This goal orientated perspective led to a sense of achievement that brought about self belief regarding the ability to be physically fit, leading to healthier lifestyle choices. This is supported by Ajzen in their The Theory of Planned Behaviour, who contend that intention and individual response can be oriented by understanding the attitudes linked to personal situations or control beliefs and perceived behavioural control (1991:206).

5.3.3 Affordances

The application and definition of device affordances were found to be directly proportional to an individual pre existing state as it pertained to their level of experience, self determined goals and physiological capabilities. In a sense the perceived functional affordances of these wearable fitness devices in supporting user objectives served a less than dominant role. What became apparent was that the functional affordances of these devices were operationalised amongst other elements. Furthermore, that operational knowhow and purpose equated to levels of potential functionality that may provide personalised user affordances. This is supported by Norman (1999) who makes distinctions between that of perceived affordance and real affordance, where the real affordance is the range of potential action and perceived affordance the visible perception of such possibility. What is not apparent in Norman's model are the individual and environment factors that exist outside of the physical object or product that assist in operationalising these device affordances.

For example, persona 1 used the functional affordance of a heart rate monitor in order to relay pertinent health information. Such an affordance however was coupled by a cognitive or psychological affordances in that such interaction provided mindfulness and self reflection to occur. Additionally, these device affordances transitioned and adapted according to the user's own will to integrate such affordances in accordance with their own objectives, to stay healthy and positive. This is supported by Hartson's definition of a physical affordance where the physical interaction with an object supports the users' physical intention in relation to the desired activity or functionality (Hartson, 2003).

Similarly, persona 2 made use of functional affordances which included step counters, push notifications and vibrational alerts as a means to allow for quick access to ad hoc information within specific socio-cultural settings. These however served primarily as an extension of the user's base device. These device interactions provided cognitive affordances whose responsibilities were purposed and distributed to improve the user's decision making process by reflecting on captured device data. This is supported by Hartson who states that cognitive affordances are partially shaped or impacted by social convention as its meaning or interpretation depends on recognisable and relatable indications such as office etiquette or decorum (2003).

As a physical affordance, persona 3 made use of their device to assist in achieving physical targeted objectives. The utilisation of advanced device features through end user customisation allowed for participation in online challenges as a method of comparative analyses, indicating a functional affordance that enabled additional device utility, detailing extended battery life to ensure achieving targeted objectives (Hartson, 2003). Furthermore as a result of these functional and physical affordances that allowed for the sharing of activities on a public forum, generated a sense of accountability that garnered ownership on part of the user, illustrating the occurrence of a supportive sensory affordance. According to Hartson this can be thought of as a supportive component connected to human senses (Hartson, 2003).

As an incentivised user who was extrinsically motivated, persona 4 applied smart notifications and digital platforms as a perceived affordance that would facilitate their objective to incentivise their physical activity to earn rewards or points. This meant that the user had to manipulate their existing experience according to an external environment in order to earn rewards and points, illustrating a cognitive affordance, as well as enabling a physical affordance in that the device allowed for physical interaction which supported their incentivised intentions.

5.3.4 Perceived value

Device adoption and acceptance were found dependant on an individual context and their perception of needs being met or solutions gained in relation device interaction. This is supported by Karahanna et al. who state that individual attitudes are influenced by perceived usefulness, image, compatibility, visibility, and result demonstrability (Karahanna et al. 1999:188). The concept of perceived value was largely understood by users as a generative construct that are composed of both objective and subjective factors. Objective factors were those factors that were inherent to their device or became apparent through device usage. These included vibrational alerts, smart notifications, that would notify users of incoming messages or discreet communication or haptic feedback that draw user attention through touch. According to Karahanna et al., this relates to the perceptible results that can be communicated as consequence of adopting a system or device (Karahanna et al., 1999:188).

Other objective factors include size and proximity. In the case of wrist worn wearable fitness devices users had a perceived benefit of quick easy access to information, additionally by applying end user customisation, a means to change and adapt what was displayed in relation to context. This process of customisation also allowed users a means to accommodate their routine or objectives by making use of device stimulus or haptic feedback as silent communicators to indicate action or initiate responses. This is supported by what Karahanna et al. terms visibility where the degree to which a device's permutations are evident to users bear relevance to their perceived behavioural beliefs in a particular system (Karahanna et al., 1999:188).

Subjective factors were those inherent traits linked to individual interest, motives, customs, physiology or emotional states.

For example, persona 1 who used their device to aid in physical rehabilitation perceived their device as valuable based on its ability to provide pertinent health information, which they could easily access within varied social scenarios. Perceived value included a perceived usefulness in that device interaction and feedback provided self awareness and reflection to happen parallel to activities.

Other subjective factors linked to users perceived value where the related functional features, such as being able to control music from their device while socialising. This indicates a perceived enjoyment gained from device interaction. This is supported by Karahanna et al. who views compatibility as the level of integration that a particular device or system offers within typical user activity (Karahanna et al., 1999).

For persona 2, a perceived benefit equated to an increase in functionality relative to the associated ease of device use, convenience and usability that extended the capability of their base device. Furthermore, perceived value included a perceived usefulness in that captured data was deemed relevant in its potential ability to influence or direct actionable thought. Active engagement with their device extended to include shared systems of development such as an office setting or social setting i.e. gymnasium. As a method of executing activities, such as checking incoming messages without becoming overt, persona 2 used their device to provide flexible solutions within social interactions, indicating the perceived value gained in terms of maintaining social image or decorum. This supports what Yang et al. describes as perceived value, as an individual's or customer's overall perceived trades and gains as pertaining to device and interaction (Yang et al., 2016). Zeithaml further expands on the notion of perceived value as "the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" (1988:13).

As predominantly linked to their personal motivations and customs, persona 3 perceived value as the associated gains from utilising functional features such as GPS tracking, smart sensors, heart rate monitoring and device glanceability as it allowed for or triggered in situ transformation during an athletic event. Participation in online challenges as a method of comparative analyses also provided perceived social benefits that all served to enhance their sense of self or sense of achievement.

Moreover, persona 3 experienced a perceived value in the sense that active engagements involved the sharing of activities with other communities in visual narrative formed which provided perceived enjoyment. This perceived enjoyment was born out of their pre-existing desire to maintain a consistently active lifestyle which included a comparison and sharing with or between others. This led to trying new things due to normative influences and a perceived usefulness attributed to device functionality such as water resistance, providing the ability to go for a swim between participating activities (Li et al., 2010).

Being extrinsically motivated, persona 4 perceived value as an ability that would facilitate their intentions to manipulate their external environment and activities in order to earn rewards and points. This was achieved by using device smart notifications and digital platforms with the aim to Gamify their lived experience, indicating both a perceived usefulness and enjoyment that contributed to their perceived value in relation to device usage. This is supported by Sweeny et al. showing perceived value as a generative construct that could exist both conceptually or independently of the device (2001).

5.3.5 Community and Normative influence

Community engagement or normative social influences were found to play a significant role in influencing user adoption and maintaining extended personal use across multiple groups or context. Such community engagement brought about aspirationalism due the effects of normative social influences or social conformity that lead to the adoption of new behaviours or experiences. As such device engagement generated a social affordance in that users could communicate and compare personal values, objectives and beliefs in comparison to social convention or groups. As an affordance it also permitted users to self-reflect and self-evaluate by social comparison. By making use of device usability factors such as step counters and smart notifications that supported comparative analysis between community group members users' were able to measure and validate personal goals or experiences (Zeithaml, 1988 and Sweeny et al., 2001).

For example, in the case of persona 1 the sharing of activity summaries within an online community provided self-affirmation by virtue of uploading workouts and self-progress on a public forum. This public or community sharing also ensured that self monitoring took place to ensure personal well-being in part due to the motivation gained from social interaction. Similarly, in persona 2 the community setting directly impacted the level of device usage and its associated user behaviour. Using smart notifications, vibrational alerts and push notifications persona 2 used their device predominantly within a corporate or personal environment to provide information as the need arose but would function as a potential opportunity of action or reflection. In a corporate setting the device was used as a means to maintain office etiquette or decorum by allowing access to messages or executing activities without becoming overt. In a sense the device provided persona 2 flexibility in response to social or professional interactions without compromise in terms of access to information. The tracking and capturing of quantified data by was seen as a source of relevant information that could inform decision making or influence behaviour. This meant that regular device interaction became a community of action in that the accumulation of data gathering supported self reflection alongside the contextual relevance of device data which influenced how day to day activities were executed. This is supported by Mansi et al who found that goal setting and self monitoring supported through motivational feedback or prompts could be effective in increasing physical activity (2015).

Device usage also assisted persona 2, in the event of tracking fitness and performance, to engage with various community groups, social norms and context. In the case of regular gymnasium use, which had its own structured context and external environment, persona 2 was able to quantify their own level of activity and in a sense structure their own developmental process.

Persona 3, who was a self-motivated power user made use of device utility factors such as GPS tracking and smart sensors. These features were used to track personal physiology during an outdoor event and uploaded to an online fitness community or digital social platform for public view and comment. Community sharing was seen as a way to validate personal performance and provided motivation in achieving certain targeted objectives. Persona 3 often used their device when taking part in online or offline challenges where logging of quantified data informed a method of comparative analyses within specific socio-cultural or group contexts. This generated new experiences within the user's developmental process such as visual narrating their experience using statistical data on a digital social platform in order to share an experience.

In the case of Persona 4, who was extrinsically motivated, community played an important role as third party loyalty partners or digital social platforms in Gamifying their lived experience. Personal activity was targeted and benchmarked against a community of practice that would yield a number of obtainable points or rewards. These actions were carried out using smart notifications, inactivity alerts, vibration alerts and haptic technology and data logging. Actions were structured according to a community or social context that would serve their objectives in achieving points or reward markers. This sense of usefulness and value through incentivised engagement within a community setting brought about positive feelings regarding physical exercise and led to healthier lifestyle choices in that it determined the scope and structure of the developmental process.

5.3.6 Self-awareness, Reflection, Goals and Motivation

Persona 1 used device utility factors such as a heart rate monitor and smart sensors to access pertinent health information. In aiding physical rehabilitation, this generated self awareness by allowing continuous reflection to occur on captured data, ensuring the incremental adaptation of behaviour over time.

Persona 1 using their device in a social setting also experienced a feeling of well-being and emotional connectedness brought about by being able to share an experience with others. This came about in that they were able to curate their environment such as controlling their playlist from their device without interruption. Self reflection also occurred in that quantified data were uploaded onto a social platform to indicate progress which instilled a sense of achievement. Such social interaction also provided motivation to stay active, healthy and positive. The real time immediacy of information that was easily attainable through the device's high quality interactive displays assured that physical exercise or activities did not compromise the user's physiological capabilities and limitations, avoiding potential physiological stress. This meant that they were always aware of their physical state and could transition or adapt their behaviour as a result of device feedback and usage. This is supported by Mansi et al. who suggest that smaller incremental goals that seem achievable and manageable by an individual are more likely to yield actual behavioural change (2015:6). For persona 2 knowing that the device was constantly capturing useful information for later reflection provided peace of mind. As such persona 2 became aware of their own developmental process in that captured data were mediated according to their contextual relevance.

This process informed their own decision making based on whether it provided opportunity for action or reflection in relation to individual choice, needs and environment. For example, where the goal was to decrease sedentary behaviour, development was only initiated based on their knowledgeability of a situation or context of progression as afforded by device feedback or quantified data.

This knowledgeability of a situation or context of progression meant being conscious about activities or structured exercise where a device's activity summaries or quantified data formed part of a training plan or self-structured routine. This also drove goal orientated engagement such as taking part in fitness challenges or social events. Taking part in a social event provided additional motivation for their actions. This is in part supported by Locke and Latham who found that challenging goals had a direct and positive correlation with high achievement outcomes, provided individual ability is capable of achieving set goals (2002:706).

For persona 3, self awareness and reflection occurred during active participation in an outdoor event. This was made possible by using GPS tracking, smart sensors, heart rate monitoring and other device features to monitor progress which would trigger in situ transformation based on the contextual relevance of relayed information. This also provided real-time self assessment, generating situational awareness, monitoring progress and exercise intensity. The sharing of quantified data, as captured by their device, on a social platform became a means to validate performance. This formed part of a goal to maintain a consistently active lifestyle which subsequently encompassed a comparison and sharing with or between social groups or communities.

In the case of persona 4 their device formed part of an aim to Gamify their lived experience. It entailed using accumulated quantified data which were transform either on an incentivised platform or reward based system. This act of earning rewards or points served as both a goal and motivation that generated a sense of achievement that brought about positive feelings regarding physical exercise leading to healthier lifestyle choices.

5.4 Conclusion

5.4.1 Methodological reflection

This study made use of a narrative approach in exploring current users' patterns of behaviour and the affordances gained from device interaction. In order to delimit potential interview questions and topics in the qualitative interview schedule I directed specific questions to an online Apple Watch User Facebook group. A pilot study was done amongst the Apple Watch User Facebook group members, answering a questionnaire on personal use. Data collected via the online questionnaire served as the basis for my interview protocol (Survey Monkey, 2018). These explorative findings, combined with the results of the content analysis study applied to the literature, contributed enormously to simplify and streamline the focus and direction of the qualitative interviews with participants. Participants interviews were guided by an protocol to ensure the context of collected data and sources of information related to the research objectives. I used the snowballing sampling technique to engage willing participants, interviewing each participant for 60 minutes. This allowed enough time to cover scheduled interview questions as well as for any naturally occurring data in understanding personal context and device usage (Ritchie, 2013:57). Audio recordings were transcribed and the text analysed and formatted using an inductive approach (Thomas, 2016: 237). These were categorised under specific themes in line with the research objectives taking into account the conceptual variances and variables influencing user engagement and practices. I made used Activity Theory in asking questions of eight participants which were reduced to four personas using an Activity Theory framework. As the research had shown this positioned device affordances and patterns of behaviour as a dynamic, socially constructed phenomenon whose mediations were understood through the operationalising between various elements. It also highlighted some of the contradictions and tensions that occurred between the various wearable fitness device activity systems in relation to personal use and its associated elements.

5.4.2 Substantive reflection

As discussed under chapter 4 and 5 the study concludes that wearable devices support several behavioural strategies that influence or shape behaviour. This is supported by Fritz, Huang, Murphy and Zimmermann (2014) emphasising that these persuasive technologies that collect, track and record user data over time, hold the potential to motivate and influence behaviour.

Subsequent to this study it was found that user acceptance and usage were ascribed to a devices ability in playing an intermediary and supportive role between users and their objectives. As such users are likely to adopt and use these devices if it allowed them a means of accessing relevant information or in that it supported a number of lifestyle factors that impacted on a user's overall sense of self or well-being. This resonates with Rooksby, Rost, Morrison and Chalmers (2014) and Li, Dey and Forlizzi (2010) who speaking of personal informations or lived informatics states that user reflection and self-monitoring in its application varies, largely as consequence of dynamic and changing user motivations, their environment and personal preferences.

This study also found that the affordance of wearable devices in motivating smaller incremental goals that seem achievable and manageable by an individual or receiver are more likely to yield actual behavioural change as supported by Mansi, Milosavljevic, Tumilty, Hendrick, Higgs and Baxter (2015). This entailed either using accumulated quantified data which were transform on an incentivised platform or where activity summaries or quantified data formed part of a training plan or self-structured routine or it drove goal orientated engagement.

Moreover, the socio technical affordance of these devices ability in permitting social actions and exchanges to occur between multiple user groups across different platforms have been found to be drivers that effect device adoption. Moreover, its a motivating factor that can cause users to adopt new behavioural traits due to a perceived need to conform in the interest of gaining social acceptance. This is supported by Mao and Palvia (2006) who found that the intention to use information technology is forecaster for real behaviour, however social and cultural context plays a role.

5.4.3 Scientific reflection on the contribution of the study

This content analysis application to the literature regarding the affordances of smart devices, contributes immensely to the future study of wearable fitness trackers and the current constructs and categories that are directing scientific discussion in peer-reviewed journals and books on this very important topic. This study also aids in providing a better understanding regarding the variables related to specific use and context of wearable fitness devices and their related value to user practices, aiding in the advancement of existing knowledge around the topic. Using Activity Theory to underline and bind this study in answering the research question, namely What are the user affordances and patterns of behaviour associated with wearable fitness devices? I asked questions of eight participants which were reduced to four personas using an Activity Theory framework. I also presented some of the tensions and contradictions that users experience when engaging within their various individual wearable fitness device activity systems. My primary data analyses also identified seven themes which emerged from the obtained results, these include adoption, lifestyle management, affordances, self-reflection, community/normative influences, motivations/self-efficacy and goal setting and incentive.

5.4.4 Recommendations

This study has shown that the functional affordances of wearable fitness devices were operationalised amongst various elements. Furthermore, that operational knowhow and purpose equated to levels of potential functionality that may provide personalised user affordances. Recommendations for further research should include an exploration of how wearable technology, in particular wrist-worn activity trackers, activate external or environment factors that exist outside of the physical object or product and how it may facilitate personalised user affordances. Furthermore, how the notion of community may be further supported by these devices in supporting user objectives as being part of larger or diverse contextual environments. Additionally, regarding policy and practice it would be beneficial to uncover in more detail and with a larger sample size what some of the contextual, environmental and device conditions are as they pertain to the use of wearable devices that contribute or directly affect adoption criteria and behaviour. As an example how wearable technology and its affordances may be utilised in supporting user health and their associated communities of practice.

6 Bibliography

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7 Appendix A: Persona 1

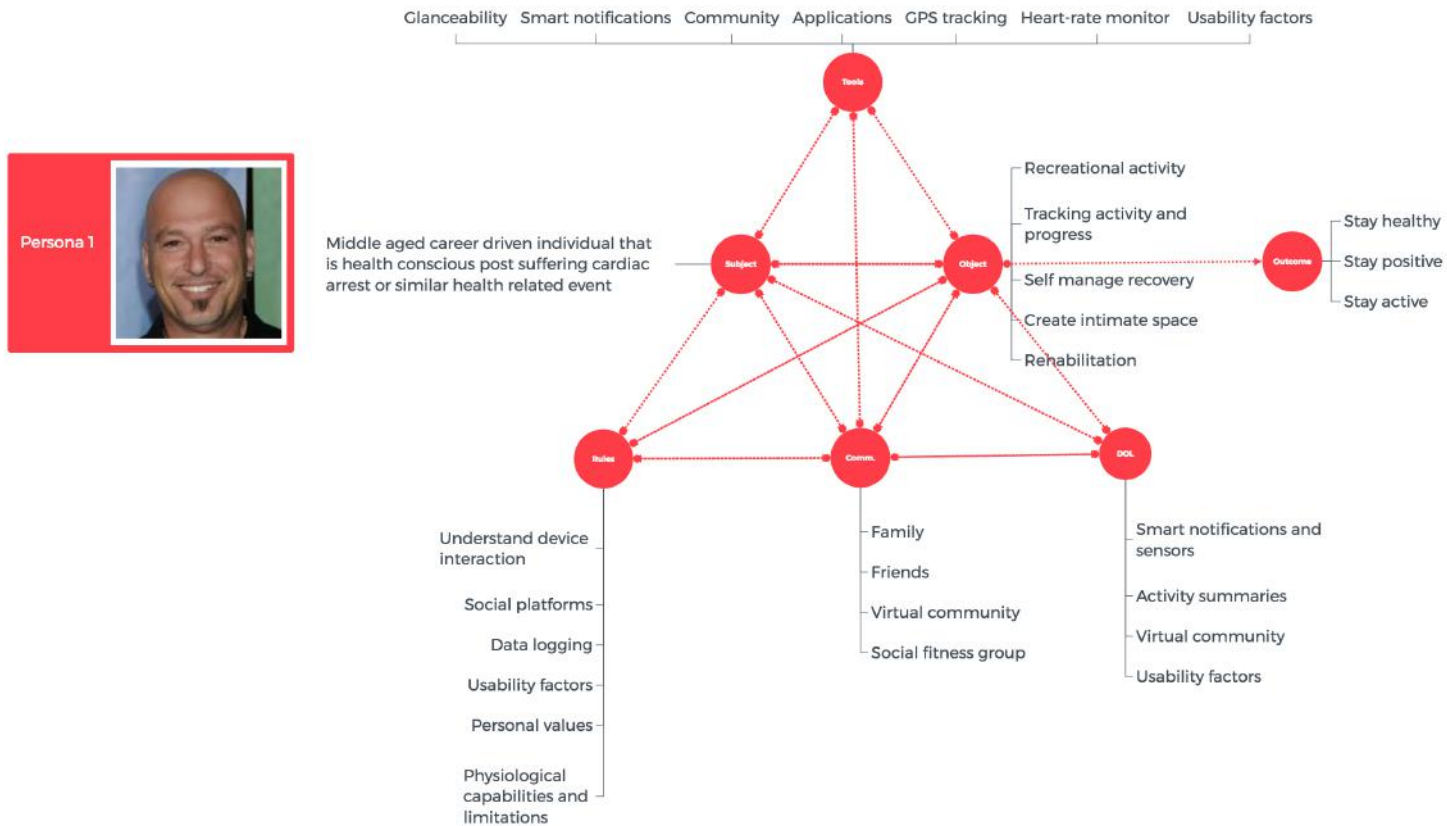


Figure 22: Persona 1 Activity System

8 Appendix B: Persona 2

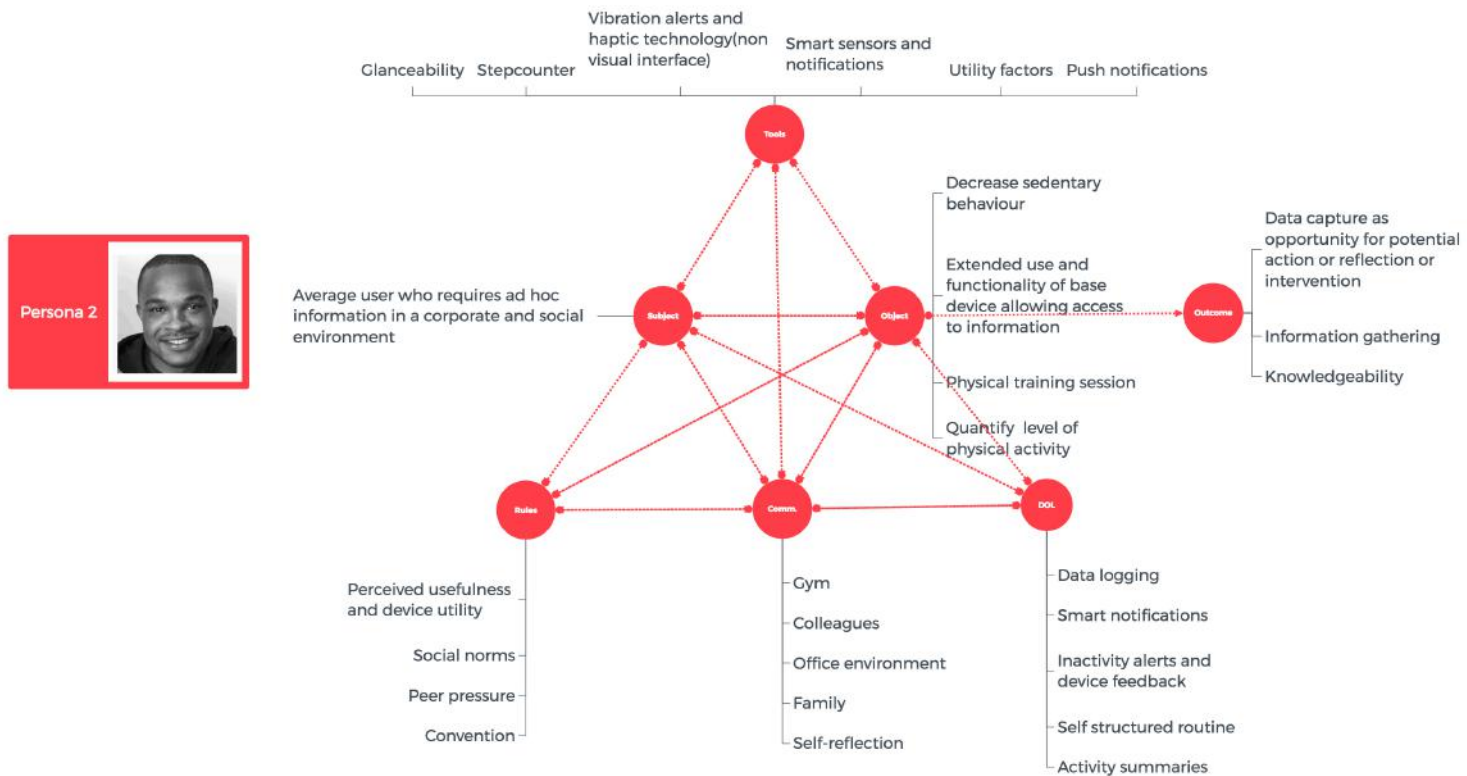


Figure 23: Persona 2 Activity System

9 Appendix C: Persona 3

Immersive tasks Utility factors Heart rate monitor Smart sensors Wireless connectivity GPS tracking Glanceability End user customization Applications Third party compatibility

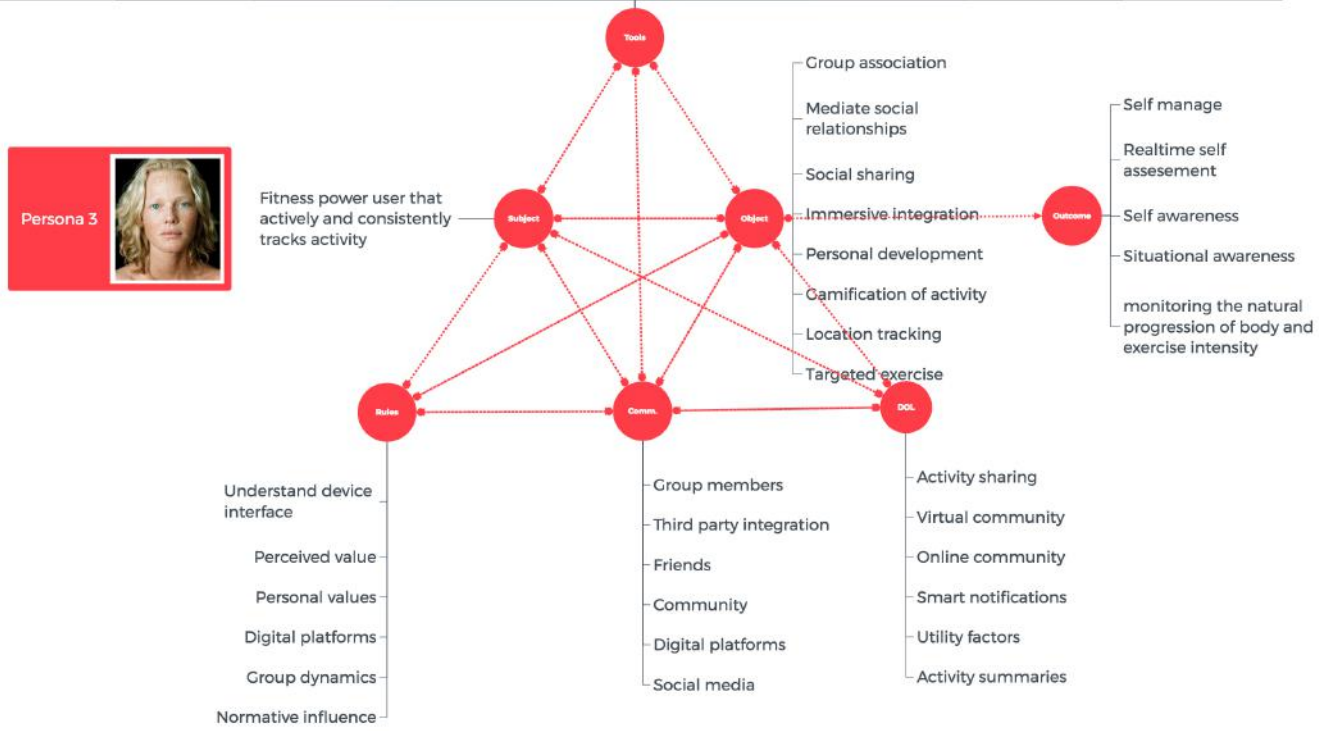


Figure 24: Persona 3 Activity System

10 Appendix D: Persona 4

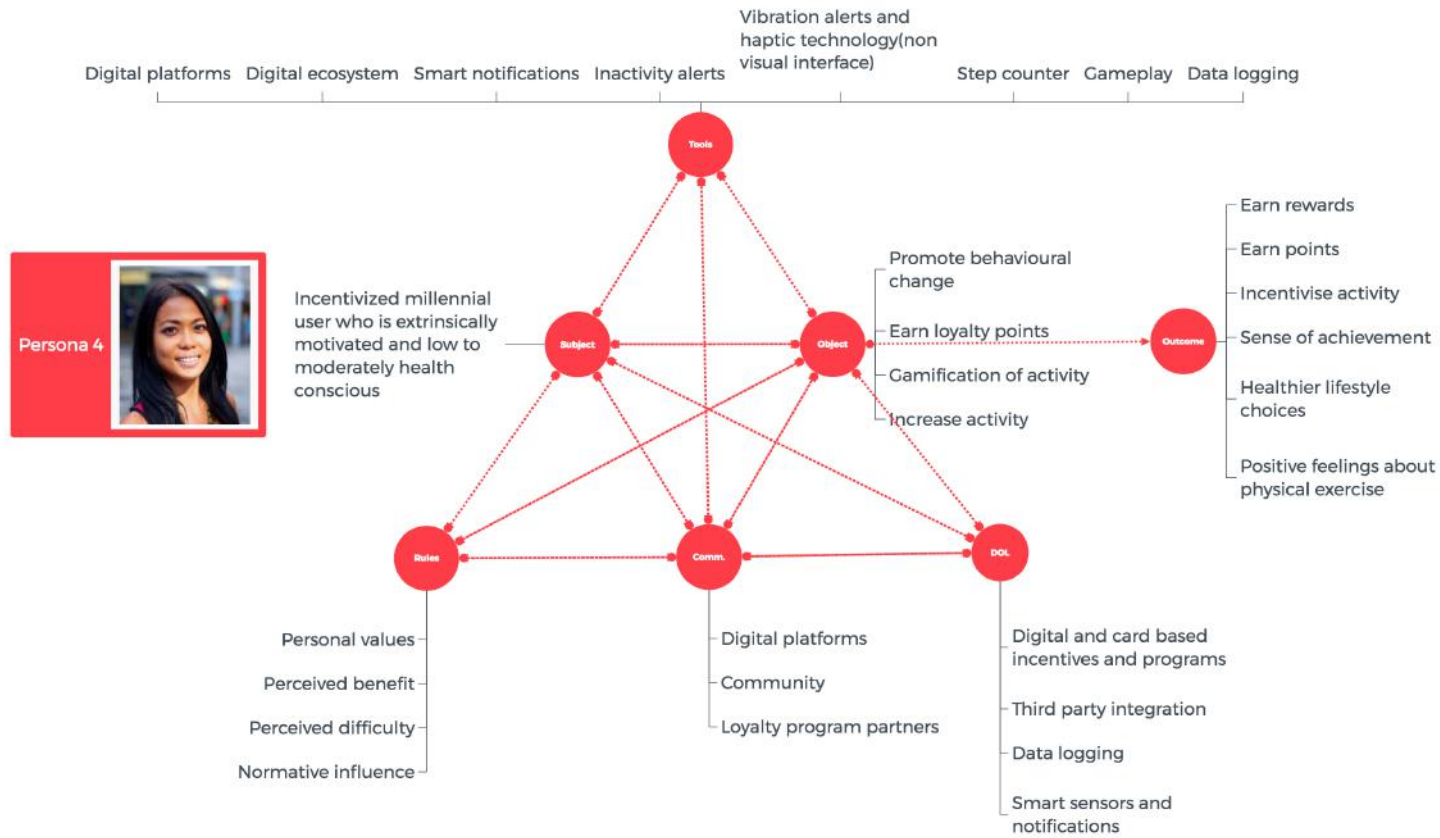


Figure 25: Persona 4 Activity System

11 Appendix E: Emerging Persona 1

Persona 1: The middle aged early adoptee of new technology that is health conscious post suffering cardiac arrest or similar health related event



Name: Hugh Wessels

Demographic: South African, middle male aged, ceo

Personality traits: Early adoptee of technology, tech savvy, health conscious, technology part of everyday life, dependent on technology to provide detailed information on health status, physically active for specific reason,

Motivations: Stay healthy, technology to improve and maintain life, care about safety of friends and family, uses technology in a supportive manner, having positive outlook on life, access to pertinent health information, assist self diagnosis, realtime feedback, technological integration,

Goals and frustrations: Tracking physiology, adaptive technology, extraneous information not linked to personal objectives causes frustration, limited functionality and usability factors, ease of use, ease of applying feedback and information, smart sensors, anxiety caused by over reliance on realtime captured data, lack of third party integration, disconnect between data and third party application and platforms,

Influencers: sharing progress online, reflecting on captured data, sense of achievement, self reflection, self awareness, peace of mind, dramatic life event, routine, ability to self manage, desire to be active, extend life, be healthy

Scenarios

Positive outlook on life and wants to stay healthy after having heart attack

Gets up at 5am on most mornings to cycle and exercise

Tracks heart rate when doing cycle and exercise activity using smart watch

Does intermittent checking of device notification via smart sensors to ensure heart rate and pace is at a normal level

Often will go out and cycle with friends in a peloton and will afterwards upload tracked data and share it on a social platform

Tracks progress through captured device data as a way to check fitness and heart function

Has a busy schedule and usually quite busy during then day and likes the ease of use and easy access to information that is provided device activity app and smart sensors

Has relatives and family staying in another city and uses watch apps to check weather in neighboring city

Gets frustrated when data syncing and uploading of data is not seamless due to a disconnect between device applications and third party software intergation

Likes sharing progress and status of recovery post heart attack with friend and family on social media

Likes cooking at home and will use the device to listen to and control music playback whilst preparing food

Staying healthy provides a sense of achievement which is gained by reflecting on captured data

Device serves a supportive role as user self manages recovery where the device helps in facilitating the users objectives to extend life span and to inform healthy+positive behaviour

Family is important to the user and for ease of mind use r utilizes device app and GPS functionality to track loved ones location when traveling alone at night

Figure 26: Emerging Persona 1

12 Appendix F: Emerging Persona 2

Persona 2: The average user who requires ad hoc information in a corporate and social environment



Name: Victor Rampedi

Demographic: 35 year old male, late adopter, Foreigner living in South Africa, married with kids, works in corporate, educated with postgrad qualification, travels a lot for work,

Personality traits: Limited user and engagement with device, using for 6 months, not actively tracking activity, primary use is to track fitness and performance, goes to gym fairly regularly, responsive to device feedback to a degree,

Motivations: Freedom of choice in relation to device data and actionable thought, informed objectives, being able to interpret device captured data, having peace of mind in knowing that specific data is being captured which may be useful at later stage, convenience and added usability, extended capability of primary device, convenience of glancing at information, applications

Goals and frustrations: not having the ability to make informed decisions based on captured data, irrelevant information in that it does not provide opportunity for action or reflection, accurate tracking activities using device applications, use to check emails and messages, focussed tracking for an event, using captured information to create structure and routine and potentially change behaviour,

Influencers: being conscious about exercise structure and daily routine, being mindful of captured device data, benefit of having activity captured and quantified, having quick access to information that can generate meaning and value, peer pressure,

Scenarios

Works in finance and corporate environment and attends meetings on a daily basis, using the device to discreetly glance at incoming messages and notifications

Uses device to mainly track fitness and performance when gyming

Tracks activity and captures data as a source of information that may later be used to inform decisions or influence behaviour

Makes decisions based on relevance of information which may lead to compliance or non compliance of device notifications

Uses the device to check emails and take calls when on the go or in transit

Travels alot which entails alot of walking between transport and will make use of activity app on the device to track and quantify the level of activity

Uses the device as an extension of primary or base device allowing user quick access to ad hoc information that provides peace of mind knowing that the device is constantly capturing useful information for later reflection

Takes intermittent breaks or after prolonged sedentary behaviour that entails actively and positively responding to device prompts

Device use and active data capture becomes part of the users everyday experience and part of an opportunity for potential action or reflection or intervention

Engages in exercise using the device as part of a self structured routine

Engages in fitness challenges or social events where the device forms part of training plan

Figure 27: Emerging Persona 2

13 Appendix G: Emerging Persona 3

Persona 3: The fitness power user that actively and consistently tracks activity



Name: Joanne Boyle

Demographic: Female, aged 36, triathlete, trail runner, ultra running, competitive, power user, been consistently active for seven years, being active is reward and motivating factor, using device for year and a half.

Personality traits: high intensity cardio and trail running exercise, outdoor person, not sedentary, motivated, driven, lifelogger.

Motivations: sense of community, engage with other people remotely via online challenges, engage in outdoor activity, utilize advanced features, sharing activity and progress on public forum, self awareness and comparative analysis around activity and goals, intrinsic and extrinsic rewards, being part of a fitness community, building community, compare and share with community.

Goals and frustrations: monitor pace, assist in training program for events, new levels of engagement, interval training, routine targeted exercise with specific objectives, requires extensive (B+) operational time, tracking speed, not tracking activity that could be shared on social platform for accumulated comparative analysis, using tracked data as validation within a social platform i.e. validation through sharing of activity data, taking part in indoor events, sharing an experience with others through an online platform by telling stories using text, photos and social media, data overload and device feedback negatively impacts perspective, create structure and awareness around activities for self management, using running features (speedometer) and GPS features (navigation) for tracking during activities, device dependency can lead to temporary device abandonment, motivated to change unhealthy habits, intermittent alerts such as messages and calls are seen as distracting.

Influencers: influenced by community, being able to see progress through activity tracking, GPS functionality being able to track activity in relation to geographical location and pace, Gamify activity on social platform, utility factors such as light weight design, real-time data capture and extended battery life, device facilitates more social interaction through online platforms and software applications customization of device, competitively track activity within a social network, virtual communities, extrinsically motivated by captured data as points, natural progression through being consistency active,

Scenarios

Self driven power user whose been active for a number of years doing triathlons, using the device and apps and built in training apps to prepare for events

Does interval training and focussed targeted exercise to achieve set objectives

Takes part in events that run over numerous hours that requires extensive battery life and device operational time

Engages in multiple sports consecutively like running, swimming etc.

During outdoor events user will track things like speed, pace, GPS location, distance, time etc.

All events and activities are captured and logged and uploaded to an online fitness community or platform for public view and comment

Captured data via device is used for comparative analysis that influences self driven training plan

Uploading of captured data on social platform is used as a means to validate performance and personal benchmarking

Does alot of running and uses speedometer and GPS function to track distance and performance

Activities are shared on social media platform and conveyed to other users as a story via pictures and statistical data in order to share an experience

Uses device and associated apps and platform to create structure and awareness around activities as part of self management plan

Data overload or too much device feedback leads to temporary device abandonment

Competes with other people remotely via online platform and captured device data

User is consistently active and motivated extrinsically with interest in monitoring the natural progression of body and exercise intensity

Figure 28: Emerging Persona 3

14 Appendix H: Emerging Persona 4

Persona 4: The incentivized millennial user who is extrinsically motivated and low to moderately health conscious



Name: Sarah May

Demographic: 33 year old female foreigner living and working in Cape Town, lives alone, academic, occasional local and international travel, unmarried, using device for less than a year, moderately health conscious, conscious consumer and price driven, not a power user,

Personality traits: frequent goal orientated user, links activity to loyalty program, recently became active and tracking of activity using device, uses device to track movement and sedentary behaviour, watches diet, exercises mindfulness during the day by taking a pause and breathing to take stock of things, intentional benchmarking of exercise in relation to device feedback and sensor data, aware of certain trade-offs like data exchange and sharing of personal information on a platform, occasional road runner, exercise as part of routine, design background,

Motivations: technological integration and intentional application to add value in day to day life, motivated by goals, being consistently active, data exchange as incentive, monetize activity, self motivated, increased activity as motivating factor, collects and takes part in customer loyalty programs, ease of use in adopting technology and ecosystem, motivated by smart notifications when part of incentivized goals,

Goals and frustrations: keeping a record of activity thats easily accessible, improve quality of life, privacy issues connected with sharing of data captured by device, create structure, device cost and expensive accessories for device, limited aesthetic choice and flexibility, targeted objectives, frustrated due to lack of technological integration and monetizing loyalty points, get personal value from device use, sees exercise as fun when its incentivized, Gamify life, not being able to sync activity,

Influencers: past outcomes influences future decisions, efficient application and use of technology, end user customization, ease of use use, good battery life, multi functionality of device, using technology to facilitate activities, lessen glanceability due to smart notifications, durability of device, associated guilt from device use and inability to act on smart notifications and sensors, device usage is influenced by user friendly interface and high quality display, influenced by brand ethos, wants face to face customer support, social norms,

Scenarios

Millennial living alone and well educated that is extrinsically motivated

Travels occasionally for work and pleasure and is a conscious consumer that seeks out loyalty programs that incentives activity

Goals orientated user when activity is incentivized through points or rewards

Uses device and app as part of integrated third party loyalty program where user activity is predominantly driven by some form of incentive or reward and not health related

Takes intermittent breaks and utilizes device app to practice mindfulness by engaging in device app such as breathing, standing etc.

When activity is incentivized user goals and level of exercise are targeted and benchmarked against reward system or number of potential obtainable points

Exercise happens as part of a routine set by third party to achieve point system or reward markers

Activity data is captured via device and shared on social platform which causes some concern in terms of data sharing and privacy

Exercise and activity are seen as valuable in as much that such activity can be monetized by the user.

User adheres to devices smart notifications such as move goals or stand goals when part of incentivized goals

Occasional running by user where activity is tracked and data captured and logged serving as a means to motivate further incentivized activity and reaching of set goals

Collect points as part of customer loyalty program

Experiences exercise as fun when its incentivized and a method to Gamify life but is frustrated as user is not able to sync activity,

Device usage is influenced by its user friendly interface and high quality display and brand ethos

Past outcomes of activity and exercise do influences future decisions as it relates to users perceived trades and gains in the form of its extrinsic motivations

Figure 29: Emerging Persona 4

15 Appendix I: Tensions Persona 1

Persona 1:
tension characteristics
Activity system

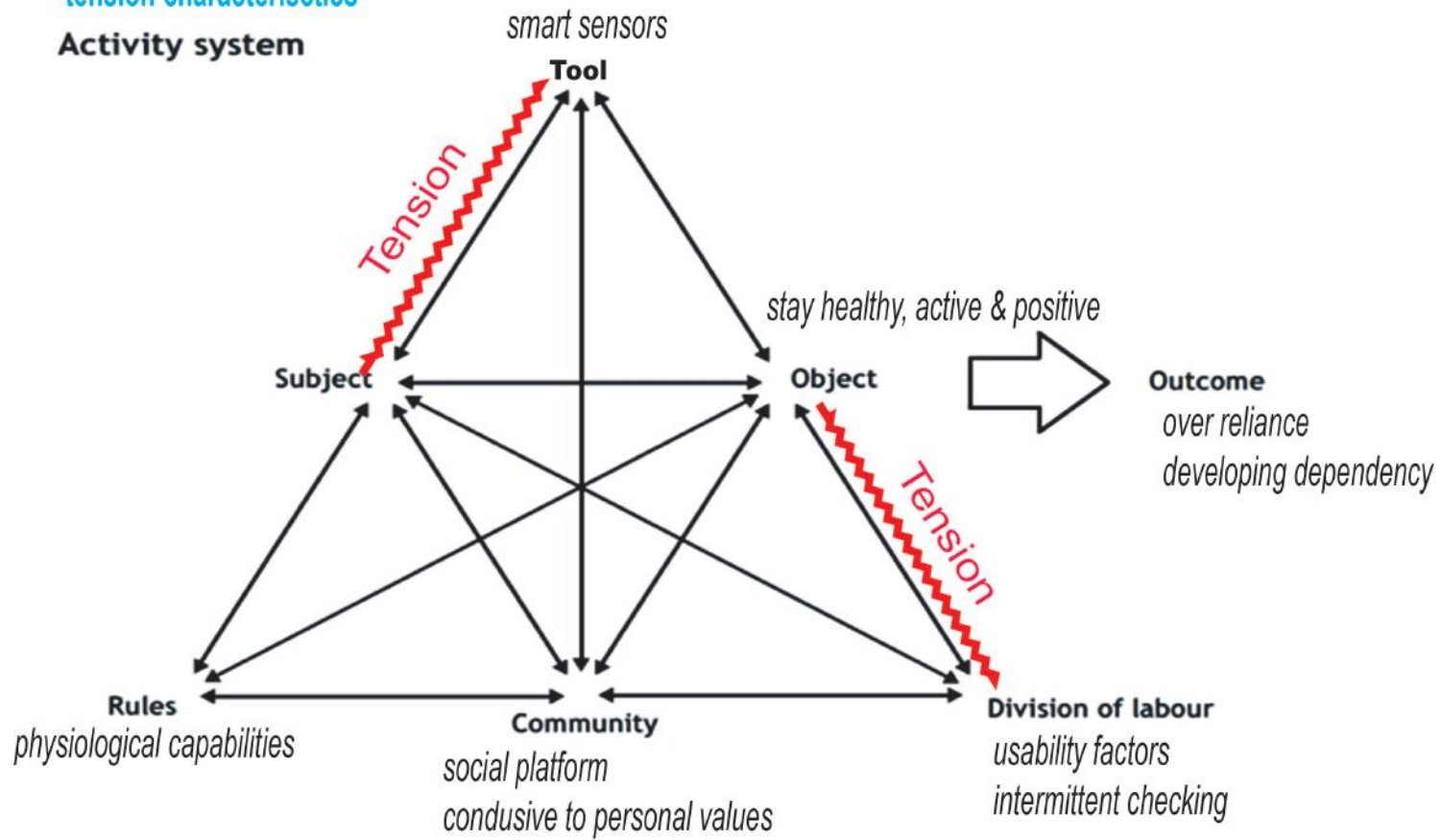


Figure 30: Tensions Persona 1

16 Appendix J: Tensions Persona 2

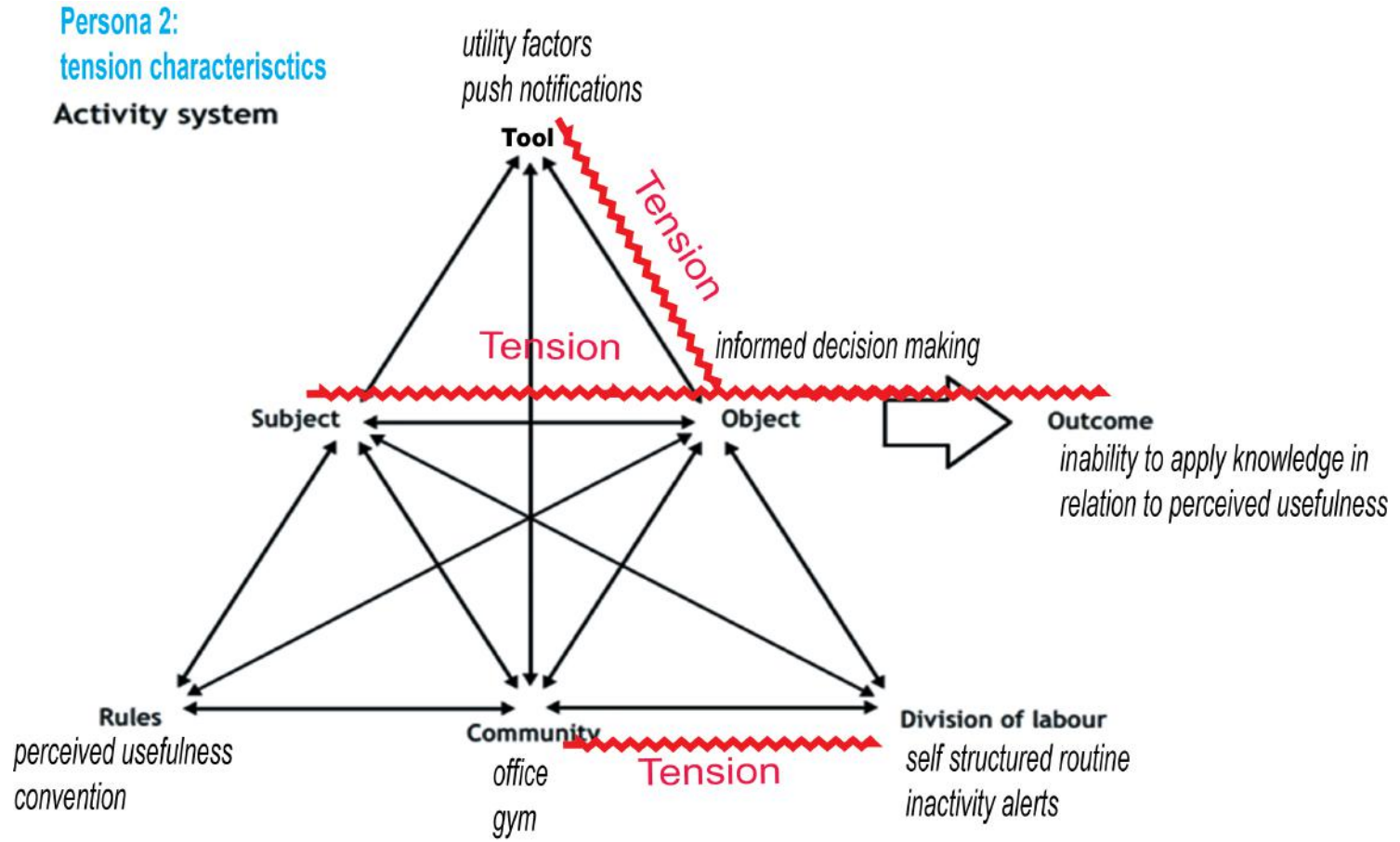


Figure 31: Tensions Persona 2

17 Appendix K: Tensions Persona 3

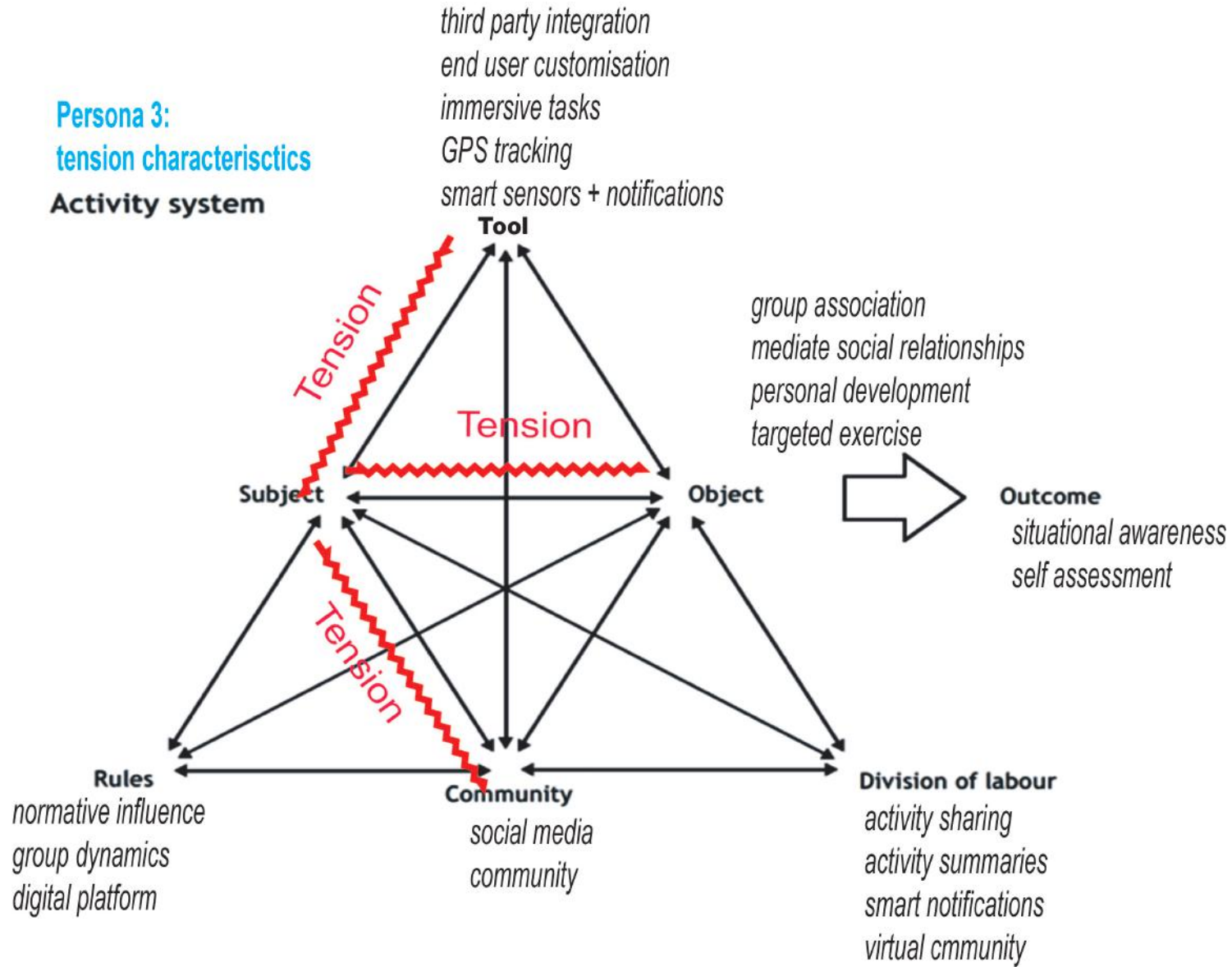


Figure 32: Tensions Persona 3

18 Appendix L: Tensions Persona 4

**Persona 4:
tension characteristics
Activity system**

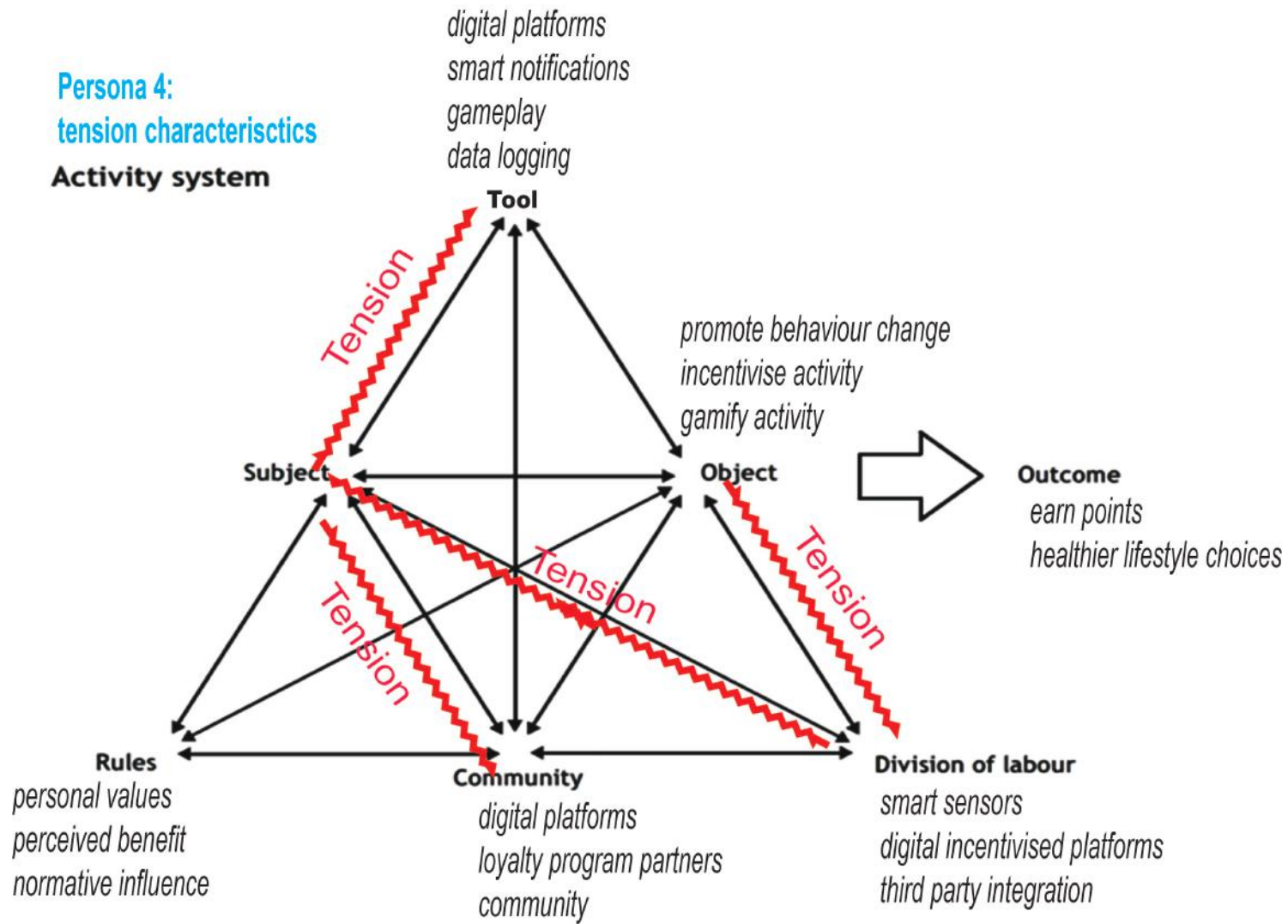


Figure 33: Tensions Persona 4

19 Appendix M: Consent form

FACULTY OF INFORMATICS AND DESIGN

Individual Consent for Research Participation

Title of the study: User acceptance and behaviours associated with wearable fitness devices.

Name of researcher: David Lucian van Staden
Contact details: email: dlvanstaden@gmail.com phone: 072 040 0472

Name of supervisor: Prof. Johannes Cronje
Contact details: email: CronjeJ@cput.ac.za phone: 082 558 5311

Purpose of the Study: To explore current users' relationships with wrist-worn wearable fitness devices and examine the potential affordances that smart devices hold for users in the future.

Participation: My participation will consist essentially of interviewee.

Confidentiality: I have received assurance from the researcher that the information I will share will remain strictly confidential unless noted below. I understand that the contents will be used only for M Tech thesis, journal article and that my confidentiality will be protected by using pseudonyms.

Anonymity will be protected in the following manner (unless noted below) Where applicable personal data will be anonymous or pseudonyms will be used to describe participants.

Conservation of data: The data collected will be kept in a secure manner. Data protection and sharing of personal data will be kept private and will be stored at a secure location in a controlled environment. Original data or a copy of the data will be kept for audit purposes.

Voluntary Participation: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Additional consent: I make the following stipulations (please tick as appropriate):

	In thesis	In research publications	Both	Neither
My image may be used:				
My name may be used:				
My exact words may be used:				
Any other (stipulate):				

Acceptance: I, (print name)

agree to participate in the above research study conducted by David Lucian van Staden of the Faculty of Informatics and Design, Industrial Design at the Cape Peninsula University of Technology, which research is under the supervision of Prof. Johannes Cronje.

If I have any questions about the study, I may contact the researcher or the supervisor. If I have any questions regarding the ethical conduct of this study, I may contact the secretary of the Faculty Research Ethics Committee at 021 469 1012, or email naidoo@cput.ac.za.

Participant's signature: _____ Date:

|

Researcher's signature: 

Date: 9 November 2018

Figure 34: Consent form

20 Appendix N: Interview request form



FACULTY OF INFORMATICS AND DESIGN

David Lucian van Staden
072 040 0472
dlvanstaden@gmail.com
20 Ventnor road
Muizenberg
Cape Town
7950

Dear Anonymous:

I am currently doing a Masters Degree (Mtech) in design of which the purpose of the study is to explore current users' relationships with their wrist-worn wearable fitness devices and to examine the potential uses that these devices hold for users in the future.

The research focuses on individuals who have already adopted these wearable fitness devices believing in the value that they afford. Understanding the variables related to specific use and context of wearable fitness devices and their related value to user practices will aid in the advancement of existing knowledge around the topic.

The research study forms part of the Faculty of Informatics and Design, Industrial Design at the Cape Peninsula University of Technology, which research is under the supervision of Prof. Johannes Cronje.

I am hoping that I could interview you for an hour to discuss your experience using your smart watch. I will be calling you within the next week to ask about the possibility of setting up a time for us to talk in person.

A handwritten signature in black ink, appearing to read "D. van Staden", enclosed in a light grey rectangular box.

David van Staden

Figure 35: Interview request form

21 Appendix O: Ethics clearance

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Office of the Research Ethics Committee	Faculty of Informatics and Design
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18 October 2018

The Faculty Research Ethics Committee hereby grants ethics clearance to Mr David Lucian Van Staden, student number 218343426, for research activities related to the MTech in Design at the Faculty of Informatics and Design.

Title of thesis:	User acceptance and behaviours associated with wearable fitness devices
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Comments:

Research activities are restricted to those detailed in the research proposal.

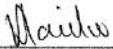
 Signed: Faculty Research Ethics Committee	18/10/2018 Date
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Figure 36: Ethics clearance