TOWARDS A MEASUREMENT SCALE FOR SELF-TRACKING: ATTITUDES AND USER CHARACTERISTICS

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Abstract

Self-tracking, or the desire to quantify one's own behaviour by means of personal information systems, has developed from a niche activity for early adopters to a mass phenomenon. Despite its increasing spread in society, however, little is known about the drivers of technology adoption and use in this specific domain. Addressing this gap, the research-in-progress at hand aims to (1) theorize on the role of self-tracking attitudes – defined as specific consumer attitudes in the self-tracking context, and (2) present a research plan with the goal of developing a self-report scale capable to measure self-tracking attitudes. We present the results of a first literature review and of 24 explorative expert interviews conducted to identify relevant cognitive, affective and conative concepts related to self-tracking attitudes. The results constitute a first step to develop a measurement scale that aims to contribute to adoption research and the development of successful self-tracking systems.

Keywords: Self-Tracking, Quantified-Self, Attitudes, Technology Adoption and Use.

1   Introduction

One of the major trends in the domain of information systems (IS) for personal use is the surge of individuals tracking various aspects of their life, including their physical activity, nutrition, sleep, driving behaviour, pregnancy, child development, or expenditures (Li et al., 2010). The self-tracking industry is growing rapidly. Pedometers, heart rate recorders, exercise trackers that monitor physical activity and vital signs, sensor kits for smart homes that keep track of personal energy consumption, and smartphone applications that record driving behaviour enter the market almost every day (Swan, 2012; Economist, 2012). Wearable devices, in particular smart watches, have reached mainstream popularity (Fox and Duggan, 2013; Insight CC, 2014; Hay, 2013; Bradley, 2015; Snyder, 2015). Current applications are mostly prevalent in the health and fitness domain (Fitbit, Jawbone, RunKeeper, etc.) but companies and investors also see great potential for applications in the other areas of private life already listed above (Li et al., 2010; Rooksby et al., 2014). The trend is also reflected in the growing user community of self-tracking. Current statistics on meetup.com, a leading portal for people to meet peers with similar interests, indicate that the number of members of self-tracking groups has increased by factor nine in the last three years (Meetup.com, 2015; Swan, 2012), and a handful of fitness tracking applications such as Nike+ Running (Morschheuser et al., 2014; Khovanskaya et al., 2013), Fitbit App (Wright, 2013) and Withings App (Ranck, 2012) are rapidly gaining popularity and combine with Under Armour an Runtastic almost 300 million users (AFP, 2015; Garber, 2015; Perez, 2015; Sawers, 2015). Hence, the community of users has moved from a scattered group of highly specialized tech-savvy early adopters to a broad population (Snyder, 2013). Forecasts predict prosperous times for market players in 2019 with a market value of 25-50 billion USD and 160-245 million units sold (Smith, 2014; Insight CC, 2014; Intelligence, 2015). As such, the proliferation of self-tracking is

an example of ISs that rapidly gain further ground outside traditional firm boundaries and are entering the mass market.

However, various market research studies reveal diverse hurdles to adoption (including price, design, consumer attitudes, and short-lived interest), raising the question on the drivers and barriers of technology adoption in this specific domain (Insight CC, 2014; Intelligence, 2015; Nuviun, 2015; Rooksby et al., 2014; Lupton, 2014; Shih et al., 2015). Yet surprisingly little is known about the adoption of self-tracking applications and devices (Sjöklint et al., 2015; Yoo, 2010).

Leading scholars and practitioners interested in this new phenomenon rely on general IS concepts and models, in particular the Technology Adoption Model (TAM) and related models (Venkatesh et al., 2012; Davis, 1985; Yang and Yoo, 2004). Following the fundamental notions of these widely-used frameworks, one may hypothesize that individuals who engage in self-tracking, as compared to non-trackers, may share certain opinions, beliefs, or attitudes that uniquely contribute to the adoption of these systems. For that reason, we derive the following research questions for the overall project:

(1) What are the unique attitudes that individuals share who a) use and b) who do not use self-tracking devices and applications?

(2) How can we measure these attitudes in a reliable and valid way?

More concretely, the goal of this Research-in-Progress article is to answer the following research question

(3) What insights on attitudes towards self-tracking exist in literature and among self-trackers as well as non trackers?

The overarching goal of our research is to develop a self-report instrument to measure attitudes towards self-tracking. By doing this, we follow Sjöklint et al. (2015) who challenge the application of current IS theories in the domain of wearables. Attitudes towards a specific technology constitute one of the major antecedents to the adoption of knowledge sharing systems and self-management tools (Casimir et al., 2012; Esmaeilzadeh et al., 2011; Kwok and Gao, 2005; Nam et al., 2011). At the same time, however, existing consumer attitude scales (e.g., Davis (1985), Nickell and Pinto (1986), Joyce and Kirakowski (2015), Yang and Yoo (2004), Igbaria and Chakrabarti (1990), Wixom and Todd (2005)) often cover a specific domain or technology (e.g. General Internet Attitude (Joyce and Kirakowski, 2015)), or may be classified as insufficient or inadequate when regarding the phenomenon of self-tracking (see section 2.2 for a detailed discussion). Hence, our approach is to follow the three classical steps established in psychological and IS literature for scale construction: Qualitative item generation, quantitative purification, and validation (e.g. Churchill (1979), Lewis et al. (2005), Smith et al. (2014), Mackenzie et al. (2011)).

In this research-in-progress contribution, our methodological approach and preliminary results from the first phase will be described. The paper is structured as follows. Section 2 presents the theoretical background and results of our first literature review iteration. Section 3 outlines the methodological procedure we will follow in the process of scale development. Section 4 presents the results of explorative interviews with 24 experts. Finally, we summarize and critically review the preliminary research results, underline the contribution of our work, and give an outlook on the next steps.

2 Theoretical background: Self-tracking and attitudes

2.1 Self-tracking

Self-tracking is defined as "*the practice of gathering data about oneself on a regular basis and then recording and analyzing the data*" (Lupton, 2014, 77). Other terms such as lifelogging, quantified self-tracking, quantified self (QS), personal informatics, or personal analytics are used interchangeably

(Choe et al., 2014; Lupton, 2014; Li et al., 2010). With the goal of understanding and scanning the research on self-tracking, we conducted a literature research (keywords: "self tracking", "quantified self", no time period selected due to the limited results) accordingly to typical methodological approaches in IS (Webster and Watson, 2002; Brocke et al., 2009) and current practice (Bengtsson and Gerfalk, 2011). We proceeded in three steps: First, the AIS Senior Scholars' basket of eight journals was screened. The search only resulted in four hits (three in MISQ and one in ISR). Since there were no substantial results, the search was extended to IS conferences (ICIS, AMCIS, ECIS) due to the novelty of the subject and the longer time to publish for journal papers. The following hits resulted from the research on the AIS database: ECIS (results from 2000-today: 7), AMCIS (results from 1995-today: 11), ICIS (results from 1980-today: 1). Finally, we expanded the scope of research to psychology and HCI (human computer interaction) conferences via ACM Digital library. For CHI and CHI AE proceedings, the keywords resulted in 81 hits, for MobileHCI and BCS-HCI into 21 hits, and for UbiComp into 92 hits.

As one of the few articles that directly study the phenomenon of self-tracking, (Gimpel et al., 2013) developed a five-factor-framework and psychometrical scale of self-tracking motivations, yet their focus is limited to the healthcare domain and to the motivation of individuals who already are consider themselves as active self-trackers ("I'm self-tracking because…"). Sjöklint et al. (2015) conducted 42 interviews to study user experience with the adoption and use of wearables.

They conclude that individuals tend to use wearables not as a pre-commitment device (e.g., to restrain or motivate a future behaviour (Hoch and Loewenstein, 1991)), but as a way to reflect on their behaviour. For that reason, they stress that current IS theories won't be easily applicable for wearables. In the HCI domain, our literature review identified a growing body of work on self-tracking. While these contributions enhance the basic understanding of the phenomenon, they are mostly concerned with the novelty of the technology and with prototypes of specific applications (mainly in the health and fitness domain). Most of those contributions are experimental in nature, not deeply rooted in theory, and draw on interviews with early, tech-savvy adopters that have close ties to the HCI domain to identify motivations, styles of self-tracking, pitfalls and barriers, the role of social aspects, and design aspects (Choe et al., 2014; Li et al., 2010; Lupton, 2014; Rooksby et al., 2014; Shih et al., 2015; Epstein et al., 2014; Karkar et al., 2015; Rapp and Cena, 2015). The existing literature offers very few insights into self-tracking as a mass-phenomenon or into the attitudes of basic users (no early QS adopters). A measurement scale that adequately captures consumer attitudes towards self-tracking activities and the adoption and use of self-tracking technologies is missing. We hope to fill that gap by developing a psychometric scale that is rooted in theory and builds upon a much more diverse sample of interview participants in order to support future research in this field. Following the statement of Rooksby et al. (2014) that "*it seems unlikely that cognitive models can explain […] tracking*", we take a different approach in understanding self-tracking behaviour by including the concept of attitudes that incorporates cognitive, affective, and conative components.

2.2 Attitude and self-tracking scales

As a core element of IS research on technology adoption (Lee, 2010; Williams et al., 2009), the concept of attitudes plays an important role in many models explaining the adoption and use of different ISs (Davis et al., 1989; Ajzen, 1991; Fishbein and Ajzen, 1975; Yang and Yoo, 2004; Jensen and Aanestad, 2007). The concept of attitudes is derived from (social) psychology. Attitudes are defined as "*an individual's positive or negative feelings (evaluative affect) about performing the target behaviour*" (Fishbein and Ajzen, 1975). Thus, attitudes indirectly influence the behaviour of individuals (or at least their intention to engage in a behaviour). Attitudes are multidimensional. They consist of an affective (*emotions, feelings*), cognitive (*beliefs, thoughts, and attributes)*, and conative (*past behaviour or experiences*) component (Maio and Haddock, 2009). Understanding the attitudes towards self-tracking should help predicting the self-tracking behaviour of individuals and consequently identifying

potential users or customers. An in-depth understanding of attitudes towards self-tracking is also a natural step towards improving self-tracking IS, towards fostering their adoption, and allowing users to reap the benefits of IS usage.

Attitudes play an important role in the IS literature on technology adoption (Swanson, 1982; Yang and Yoo, 2004). In a first round of literature research in the top IS journals, we found various methods and tools to measure attitudes. First of all, we identified TAM/TPB/TRA-related attitudes for individual technologies (Wixom and Todd, 2005; Yang and Yoo, 2004; Kim and Malhotra, 2005). Second, specific attitude scales such as the General Internet Attitude scale (Joyce and Kirakowski, 2015), Attitudes towards Microcomputers' usage (Igbaria and Chakrabarti, 1990), attitudes towards general technology (Edison and Geissler, 2003) with 10-25 statements that specifically address a certain domain or system. However, the literature lacks an adequate measurement scale that covers consumer attitudes towards the common set of features shared by many self-tracking applications across various domains (including the voluntary and autonomous character of those activities, the generation and analysis of statistics, and aspects like control or optimization (Gimpel et al., 2013; Wolf, 2010)). Concerning self-tracking scales, to the knowledge of the authors, only the psychometric scale developed by (Gimpel et al., 2013) exists (see section 2.1).

3   Methodological Approach to Scale Development

3.1   General Methodology: Construct Development

We follow the construct development process by Smith et al. (2014), as they already integrate four major approaches from IS literature with modifications according to Lewis et al. (2005) and MacKenzie et al. (2011). The overall process chosen can be divided into three major stages (Figure 1). In a first stage, literature reviews and interviews are conducted to capture the nature of the conceptual domain, theme, and definition (Lewis et al., 2005). The results of a first qualitative analysis are consolidated in a preliminary set of items. Once the first set of items is collected, content validity will be assessed. A group of experts will then screen and pre-test the set of items in order to add, delete, or modify items (Lawshe, 1975). This aims at ensuring that the developed construct draws "*from the theoretical essence of what they propose to measure*" (Straub and Gefen 2004, p. 387). Finally, a model specification will be drawn (reflexive or formative constructs, see Petter et al. (2007)).

In a second stage, the first preliminary instrument will be tested in the field with the goal of purifying it through exploratory and confirmatory factor analysis. Stage three will consist of the instrument validation. It will include tests for validity (content, internal, and construct), reliability, and generalizability (definitions and further information see Petter et al. (2007), Straub and Gefen (2004), Bagozzi (1993), Churchill (1979), MacKenzie et al. (2011), Lewis et al. (2005); Hinkin and Tracey (1999), Haws et al. (2012), Hoehle and Venkatesh (2015)).
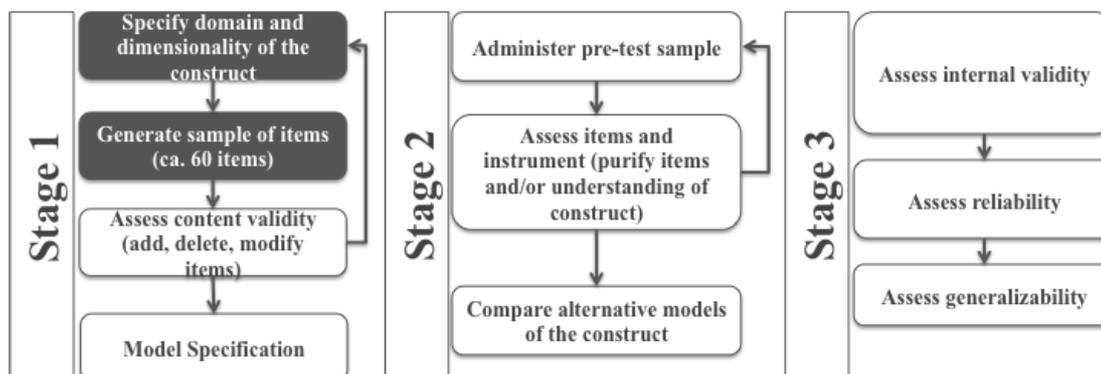

Figure 1.   Three stages of construct development adapted from Smith et al. (2014)

In this paper, we describe preliminary results of stage 1. We conducted 24 interviews and a first literature review. These qualitative sources contribute to the domain and dimensionality specification as well as the item generation. The detailed procedure employed for the expert interviews will be described in the following.

3.2 Explorative Interviews for Stage 1

As outlined above, a first step in our approach to develop a measurement instrument for attitudes towards self-tracking consists of qualitative interviews. On the one hand, they will serve as input for the domain and dimensionality specification. On the other hand, we will excerpt possible items from the interviews.

We chose open individual narrative interviews (in person and per Skype/telephone/Google Hangout, duration on average 40 minutes) in order to support our exploratory research on attitudes towards self-tracking (Bortz and Döring, 2006; Jäger and Reinecke, 2009; Stier, 1999). For that reason, a third person technique was adapted to overcome possible difficulties in expressing the interviewee's thoughts, emotions, and opinions. That is, rather than asking for their opinions directly, interviewees were requested to project their attitudes on a peer (Donoghue, 2010). We used a semi-structured interview format with three central questions: (1) What personality traits, attitudes, and opinions drive self-trackers? (2) What personality traits, attitudes, and opinions drive non-trackers? (3) Do you engage in self-tracking and do you like this activity (or not)? Prior to the interviews, participants were ensured confidentiality and anonymity (Jäger and Reinecke, 2009; Myers and Newman, 2007) and were asked for their agreement with regard to audio recording (23 agreed to have their voice recorded).

To gather insights from early-adopter/heavy users, we recruited nine participants from the QS-Meetup community (we contacted those whose contact information was publicly available on the Internet). To diversify the panel and overcome elite bias (Myers and Newman, 2007), we added 15 participants (out of 32 contacted individuals identified through an online research for blogs, web sites, and articles, and Facebook): dietary consults, sport and fitness researchers, a historian, sociologists/HCI researcher/historian psychologists, students, and journalists. In total, the sample comprised seven female and 17 male participants, aged between their early 20s to late 60s. The interviews were conducted in two rounds and two countries: the first one took place in Switzerland (Basel/Zurich) and the second one in Germany (Bamberg/Nuremberg).

Following best practices in qualitative research, the sample was as heterogeneous as possible (Robson, 2011). In this regard, our approach also differs from prior attempts to investigate self-tracking in a qualitative way (e.g. Choe et al. (2014), Rooksby et al. (2014)), given that authors in these studies largely focused on participants who already use self-tracking devices on a regular base, while we attempted to also include non-adopters outside the QS community in order to focus on the differential thoughts and opinions of adopters vs. non-adopters. Data was recorded via audiotape and transcribed later. In ten of 24 cases, a second researcher was integrated in the process to increase evaluation objectivity. The key findings of the interviews are summarized in the following.

4 Preliminary Interview Results

We conducted a content analysis of the memory notes and four transcripts. First of all, six interviewees could not clearly narrow down a specific persona (precise demographics) of a self-tracker. In the course of the interviews, they realized that their ideas of a typical self-tracker (young male in his thirties, technical background) were not confirmed when thinking about peers actually engaged into self-tracking. As an example elderly relatives or friends were engaged into self-tracking even though they do not show a high technology affinity. Furthermore, P18 (participant number 18) stated: "*women just do not show such a great affinity*", however, later in the interview he revealed: "*The Fitbits, the pe-*

dometers, have – I think – 60% women in their user groups. And also sleep trackers are really popular for women.". So, it is questionable if people interested in self-tracking share the same demographics.

Second, self-tracking is not bound to specific devices or technologies. When inquiring our participants, we revealed a wide range also including various analogue self-tracking methods: pen and paper based, apps, and excel sheets help to track a wide range of domains (including water drinking well-being, medication, mileage, financial expenditures, fitness levels, weight, and blood sugar data). Many participants were already engaged in analogue tracking before technology was perceived as a way to ease their measuring efforts.

Third, we identified different motives for different groups. Six participants categorized self-trackers into two to four segments. They mainly detected the following categories for self-trackers:

- Long-term users and pattern-seeking individuals: P12 defined them e.g., as individuals who "*compulsively record a number of* data *streams with no end date*".
- Goal-pursuing individuals: P12 defines individuals from that categorization as people who want "*to accomplish a specific goal within a limited time frame, e.g. the person who wants to lose 10 lbs over the course of six months and tracks their calories and activities*".
- Problem-solving individuals (in particular for medical purposes): P12 reveals that there are people who have "*a problem but do not know what causes it and therefore monitor a wide variety of potential factors*".
- Short-term users: Individuals who use the system out of curiosity and only for a short period of time (P4 states that "*once you know how much you walk on a usual day, then you don't need the numbers any more*").
- Sharing individuals: Even though, one part of the participants stressed the fact that, self-trackers do not need to share their self-tracking results, another particpant states that self-trackers tend to like to share their data (a mean to self-presentation and peer comparison).

Finally, we observed a specific affinity or aversion towards self-tracking. P4 underlines: "*I think there are people who just like taking measures or tracking. […] Twenty years ago I already went to the fitness center and there was some kind of document, which you had to fill out and you had to fill in measures, the measured time or number of steps or any data, of course, I did not enjoy it. I abandoned that pretty fast, but there were people who did that with very big meticulousness, they recorded always what they did.*". On the other hand, P16 states that there are people "*who reject that [self-tracking] or who are not into it*".

Another iteration of the content analysis will deliver a defined set of items (statements expressing positive or negative attitudes) for the first version of our instrument. Furthermore, the domain specification will be finalized and first dimensions will be set.

5   Discussion and Conclusion

In this paper, we described the current state of our research to develop a new scale to measure attitudes towards self-tracking. The first section of this paper reviewed the few existing insights from IS and HCI literature we were able to find on that topic.

Then, we explained our planned process of the construct development. Furthermore, we included first results from explorative interviews with 24 participants to clarify attitudes and opinions on self-tracking. Our key findings encompassed the observation that according to most interviewees, demographics (gender, age, education) may not well predict self-tracking behaviour. Moreover, technology merely seemed to enhance an innate tendency shared by many individuals to quantify their life: they tracked several metrics before the advent of dedicated tracking technologies. Furthermore, self-tracking is driven by different motives. The first round of interviews suggested a categorization into

five types of self-trackers. Finally, several participants underlined that some people clearly demonstrate a strong positive or negative attitude towards self-tracking.

We followed by the call from Rooksby et al. (2014) to contribute to the open discussion on goals, motivations, actions, and activities in the context of personal tracking. Furthermore, we enlarged current qualitative knowledge that mainly focuses on very active self-trackers (Gimpel et al., 2013; Choe et al., 2014; Rooksby et al., 2014). This helps to gain insights on categorizing personality types of self-trackers for example. Once the measurement instrument is fully developed, we hope to help to refine and contribute to current IS models that investigate the adoption and use of self-tracking devices, as requested by Sjöklint et al. (2015). Researchers and practitioners can profit from these insights. For example, the generation of Big Data through personal IS is strongly dependent on the adoption and usage of self-tracking systems. Insights on attitudes can help to better understand (potential) users. Due to the fact that attitudes also play a role in post-adoption issues such as continued IS (such as in Hsieh et al. (2008), Kim and Malhotra (2005), Sun and Zhang (2006)) other domains could benefit from a new scale on attitudes towards self-tracking. Furthermore, practitioners will gain increased knowledge about future users. This knowledge can help to support designers and developers to create self-tracking systems or to integrate self-tracking functions into product.

The limitations of our work mainly encompass methodological issues with regard to the explorative nature of the interviews – such as reliability, replicability, and transparency. We tried and will try to address these limitations by audiotaping, transcribing, and iterating the content analysis multiple times. Yet, systematic flaws such as social desirability, Hawthorn, self-presentation, self-disclosure and participation biases have to be taken into consideration, too. When it comes to the potential of generalization of our key findings, we are aware that our interview sample is not representative and could be enlarged. However, we rather aimed at gathering a diversified representation of attitudes towards self-tracking instead of one-sided thoughts, opinions, and feelings. Finally, the current state of our research as a research-in-progress reveals that we still need to strengthen the literature review for possible new insights (in other domains such as psychology) and elaborate the interview analysis. With these insights we will generate the preliminary item list, define the construct, and specify the measurement model followed by the purification of the item list (stage 2) and validation (stage 3).

Acknowledgments

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