Exploring UX Issues in Quantified Self Technologies

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***Abstract*—The Quantified Self is a movement that promotes the use of technology for self-tracking various kinds of personal information, such as physical activities and energy consumption. In this paper, we study the user reviews of quantified self tools, as reported on a quantified self community website. We perform a content analysis to categorize tracking tools, and to explore user experience (UX) issues related to quantified self technologies. From this analysis, we find various tracking categories, including body state (e.g., physical and physiological), psychological state and traits, activities (e.g., exercise, eating, sleep), social interactions, and environmental and property states. Furthermore, we find the key UX issues associated with quantified self technologies, which include data controllability, data integration, data accuracy, data visualization, input complexity, sharing/privacy, design/aesthetics, and engagement. The UX issues reported in this paper have significant implications for the design of quantified self technologies.**

I. Introduction

The Quantified Self is a movement that promotes self-tracking various kinds of personal information, ranging from physical activities to environmental information [1]. This movement goes by other names, such as personal informatics, self-tracking, personal analytics, living by numbers, and personal big data analytics [2], [3].

In recent years, it become increasingly popular to self-track personal data by using smart devices, such as Fitbit Flex and Basis B1 [4]. As related services and technologies become diverse and widely spread, it is important to understand what aspects of personal information can be digitized by which technologies and what the key UX issues are with respect to such technologies.

Various aspects of the use of quantified self technologies have been studied and reported. Li et al. [2] proposed a stage-based model of technology use for self-tracking, with the following stages: preparation, collection, integration, reflection, and action. They also reported the key barriers at each stage, such as lack of time and motivation, data integration, and interpretation. Choe et al. [5] analyzed video recordings of Quantified Self Meetup talks and identified quantified selfers' common pitfalls, which included tracking too many things (resulting in tracking fatigue), no tracking triggers/context (useful for data interpretation), and lack of scientific rigor regarding data interpretation. Rooksby et al. [6] showed that users often adopt multiple tracking devices (sometimes with the same functions), and self-tracking activities are often considered social and collaborative.

Unlike prior studies, we have specifically investigated UX issues related to quantified self technologies. ISO 9241-11 (clause 2.15) defines a UX as "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service [7]. Researchers have shown that UX dimensions of interactive products generally consist of pragmatic and hedonic qualities [8]. As ISO 9241-11 defines it, a pragmatic quality represents the usability aspects of a technology, e.g., effectiveness, efficiency, and satisfaction with respect to performing a task [9]. In contrast, a hedonic quality is related to an individual's intrinsic motivators of technology use, such as aesthetics, positive emotional effects (pleasure, fun, engagement), and self-actualization.

In this paper, we used multiple data sources for content analysis. As a primary data source, we examined the content posted on the *quantifiedself.com* site where quantified selfers share their knowledge and experiences [10], similarly to as earlier study [5]. The users on this *quantifiedself.com* site are considered to be an extreme user group, but their experiences as early adopters can provide valuable insights into the potential UX issues. We investigated the postings in the 'Tools' section of the website, in contrast to Choe et al.'s work, which examined the video recordings of the talks by quantified selfers [5]. Based on the popularity ranking provided on the website, we selected the top 100 tools out of 505 total tools for analysis due to time and resource limits. In this paper, "tools" refers to any kind of self-tracking products ranging from online services to wearable devices. We performed affinity diagraming to classify tools based on what kinds of personal information were quantified and by which methods [11]. Besides this data set, we also investigated the startup company lists [12] to discover more instances of state-of-the-art tracking technologies. Furthermore, we explored the UX elements of quantified self technologies, by investigating the reviews of the quantified self tools posted on *quantifiedself.com*. Prior studies showed that representative UX issues can be often found in the online reviews [13]. For this reason, we examined 209 reviews from the website and inductively extracted the concepts from the reviews.

Our results showed that there are various tracking categories, including body state (e.g., physical and physiological),

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psychological state, activities (e.g. exercise, diet, sleep), social interactions, and environmental and property states, and that users employed various tools for manual and automatic data input and visualization. In addition, we found key UX issues associated with quantified self technologies, i.e., data controllability, data integration, data accuracy, data visualization, input complexity, sharing/privacy, design/aesthetics, and engagement.

II. Tracking Categories

We found five major themes from affinity diagraming of the articles posted in the "Tools" section of *quantifiedself.com*. In our analysis, if a tool tracks more than one item, we only consider the primary item that it tracks. In the following sections, we describe each theme in detail, and Table 1 shows some examples of the themes.

A. Body Information

Body information includes physical and physiological measurements determined with sensing devices. Physical information represents the states of human body such as weight and height. For instance, *Withings Wifi Bodyscale*, which measures a person's body weight and transfers the readings via WiFi belongs to this category. Physiological signals are related to the living mechanics of a human body, e.g., electromyogram signal (EMG), respiratory volume (RV), skin temperature (SKT), skin conductance (SKC), blood volume pulse (BVP) and heart rate (HR). For example the *OptiMale Testosterone Health Check Kit* is capable of monitoring six hormones.

B. Psychological State and Traits

Psychological state is related to an individuals' mental well-being. We found that stress, mood, emotion, and brain performance belong to this category. Unlike body information, which can be automatically measured by sensors, psychological states are manually collected by the quantified selfers. The granularity of measurement varies widely from one tool to another. For example, *MoodPanda* allows a user to enter a user's current mood from amongst 11 level scales, while *MoodScope* supports only 5 level scales. In this category, many tools collect contextual information, such as reasons for the current feeling, physical activeness, location, and whom the users are with. This additional information is very useful for self-reflection, such that quantified selfers can act on certain aspects of their lives that they want to improve [5].

C. Activity

Activity is the most popular theme in quantified self analyses. Exercise, eating, and sleep are the most tracked activities in this category. Other tracked behaviors include web browsing, learning, exercising, eating, medicine intake, and TV viewing. The level of detail attained when capturing activities depends on what insights a quantified selfer seeks. A user can track running records using *RunKeeper* and analyze his or her sleep patterns with a smartphone [14]. In most cases, physical activities involving motion can be captured via wearable sensors, e.g., a GPS device via *RunKeeper* or an accelerometer with *Zeo Personal Sleep Coach*. In contrast, a user needs to record types and quantities of food manually with the *Lose It!* app.

D. Social Interaction

Social interactions include an individual's online and offline social interactions [15]; e.g., measuring online activity levels or one's influence over a social network. Various information visualizing techniques are used to visualize social network data, as extracted from social network services and email data. For instance, *Social Habit* analyzes social relationships and topics by analyzing an email data set.

E. Environmental & Property Status

Environmental items include a user's location, current environmental conditions (temperature, weather, etc), sustainability related information (electricity, water consumption, etc). With sustainability, electricity tracking is dominant; it can done either via automatic monitoring, such as with PICOwatt's *Smart Plug*, or via self-reporting such as with the *Wattzon* online tool. There are tools that can help users to track personal properties, e.g., money and vehicles. For instance, *Mint* app automatically downloads data from financial accounts and visualizes it to ease financial management. *MileageTracker* helps drivers to track gas usage and mileage as well as vehicle services.

F. Others tools and applications

We found many other tools that did not belong to any of the aforementioned categories. For instance, there are tools that can be used for general purpose life logging, such as journaling. In addition, *Facebook* and *Twitter* help users to easily archive everyday life experiences as they visualize individuals' experiences as a timeline or newsfeed. The *Memento app* is another tool for journaling that supports various information formats (text, photo, location) and automatic data import from multiple data sources (e.g. *Twitter*). Also, several tools takes the input from other services and then automatically extract information of interest for visualization. Examples include the *Daytum App*, which helps users to collect, categorize, and communicate personal daily data, and *Fluxtream*, which is a personal analytics tool that helps users to get a comprehensive view of self-tracking devices and to track daily habits. Additionally, *Quantter* extracts Twitter's hash tagged messages like "#run:5km". There are also other tools that integrate multiple data sets from different channels and help share information with other friends. In most cases, such tools do not have a logging feature itself, but merely aggregate the information for visualization.

III. Exploring UX Issues Related to Quantified Self Technologies

We collected 209 reviews that discussed quantified self tools. The average number of characters per review was 342, which is long enough to ascertain key issues regarding UX, as

TABLE I: Summary of Quantified Self Tools

Category	Sub-Category	Count	Examples
Body Information	Physical	2	Withings Wifi Bodyscale
	Physiological	4	OptiMale Testosterone Health Check Kit, HeartMath Stress Reduction Tools
Psychological State and Traits	-	5	MoodScope, Mappiness, MindSparke, GottaFeeling
Activity	Eating	8	Lose it!, FatSecret, 80 Bites
	Exercise	6	Fitbit, RunKeeper, Philips DirectLife, Basis
	Sleep	5	Zeo Personal Sleep Coach, Sleep Cycle
	Etc.	23	Miso, Voyurl, Vitality, Meditation Journal
Social Interaction	-	4	Klout, LinkedIn InMaps, NodeXL
Environmental & Property States	Sustainability	7	PICOwatt Smart Plug, WattzOn
	Location	4	Google Latitude, Foursquare, My Tracks, Moves
	Finance	2	Mint, MileageTracker
Others	-	27	Facebook, Daytum, Excel, Momento App, Fluxtream
Total		97	

documented in previous work [13]. The reviews were written from 2010 to 2011. An analysis of the reviews was conducted as follows. First, we extracted those sentences that expressed users' experiences (both positive and negative experiences with the tools). Then, we performed a content analysis to derive the key UX issues. Prior work [2] had uncovered various barriers over at different stages, i.e., preparation, collection, integration, reflection, and action. Our work differs from the prior work in that we focused on analyzing actual reviews to find common themes regarding UX issues of current quantified self technologies. For this reason, unlike the prior work, the UX issues we encountered were mainly related to the collection, integration, and reflection stages.

A. Data Controllability

Among the examined user reviews, we found many complaints regarding the inconvenience of data transfer. Self-tracking data is typically transferred to a computer for further analysis and visualization. It's known that some quantified selfers use a different tool for data exploration from data collection [5]. Our analysis showed that, while users' devices worked well in general, quantified selfers wish to have more flexible support for data transfer functionality.

Here is a user complaint about the *Zeo Personal Sleep Coach*'s lack of wireless data uploading capability:

> *"I use the Zeo almost every night. [...]* ***It'll get 4 starts as soon as I can wirelessly upload my Zeo data to the Zeo site.****"* [Zeo Personal Sleep Coach]

Similarly, another user complained about email-based data transfer.

> *"Sleep Cycle is most certainly worth its price! As far as I can tell, it is pretty accurate. [...]* ***The only real way to export data is through email which is kind of annoying.****"* [Sleep Cycle]

Similarly, the *Omron HBF-516B* body sensor does not provide an easy way of exporting logged data, as one user stated:

> *"[...]* ***Minus one star for not getting on the computer-integration bandwagon and providing a USB slot or wireless data upload feature like the famous Withings scale.*** *[...]"* [Omron full-body composition monitor HBF-516B]

Service continuity is also an important problem in that it can cause data loss during one's recording of life experiences. For instance, Google's suspension of *Google Health* disappointed one user.

> *"Never heard of it? Google Health has been permanently discontinued. All data remaining in Google Health user accounts as of January 2, 2013 has been systematically destroyed, and Google is no longer able to recover any Google Health data for any user. aah that's why;)"* [Google Health]

In this regard, users make it clear that data controllability should not be ignored when designing quantified self tools. This matter is deeply associated with whether a user goes beyond simple data collection or not. Consequently wireless synchronization with WiFi, Bluetooth and ANT is highly recommended for quantified self tools.

B. Data Integration

Since many users take advantage of multiple quantified self services, data integration is an important issue. As shown earlier, there are many services that aggregate self-tracking information from various sources. Even though we did not find direct comments on those service, we observe that people wish to integrate many self-tracking services, as the following quotations demonstrate.

> *"Twitter is a perfect tool for lifelogging! Twitter is a great place to meet new friends and self-quantifiers.* ***I connect my twitter account with many***

> ***quantified self tools like Quantter, Runkeeper, Fitbit, etc.***" [Twitter]
>
> *"I use facebook to interact with friends.* ***I have created fan pages for Geolocation tool and Quantter great Quantified Self tool. I have connected Fitbit and Runkeeper to facebook****, it's a good way to interact more with friends about datas I share [sic]."* [Facebook]

Quantified self is usually a long-lasting activity; e.g., tracking a user's mood over a year. However, it is unlikely that people stick with one tracker indefinitely, and thus, exporting/importing tracking data is considered to be very important [6]. Although a tool supports data export/import, there are still several obstacles that hinder the data integration across various devices.

Special care needs to be taken when integrating multiple data sources [16]. For instance, data samples from one source will affect the visualization of the other data sets. Likewise, heterogeneous units and value ranges across different sources need to be properly handled (e.g. performing standard normalization procedures).

We also found that many tools introduced proprietary measures (e.g. *Zeo Personal Sleep Coach*'s Z-Score, *Klout*'s Klout Score). This may cause a serious problem of data integration because the collected data from different tool may not be compatible with those from the other sources. We observed a user raised an similar issue regarding accessibility of raw data:

> *"Unlike Neurosky claims, you cannot actually see raw data with this app, it shows you 0 to 100 values that are not specified what they are (attention and meditation). I guess [they are] maybe alpha and beta waves?"* [Meditation Journal]

To deal with this issue, the raw data should be provided in a proper manner such as supporting raw data dump through API and providing a migration tool of the raw data.

The usefulness of data is increased if the tool supports open an Application Programming Interface (API) for data integration, as this user suggests:

> *"I love using foursquare whenever I go out to a venue or even sometimes a highway.* ***Because foursquare's API is available, there are lots of cool, free tools that can help you visualize your accumulated foursquare data in cool ways.*** *[...]"* [Foursquare]

C. Data Accuracy

There are a large number of reviews that speak about data accuracy. In particular, when measurements are collected from sensing devices, they are likely to receive more attention. For instance, one user praised the accuracy of the *Fibit* activity tracker as follows:

> *"I have had the fitbit for 2 months now, and have found it to be very helpful. It tracks my steps accurately, and the battery life is very good. [...]"* [Fitbit]

In contrast, there are complaints about the inaccuracy of *Sleep Cycle*; such as this user's complaint.

> *"Great app. Used it for couple of weeks at the same time as the ZEO.* ***However, I noticed Sleep Cycle isn't that accurate.***" [Sleep Cycle]

In addition, this user suggests why inaccurate results are produced by *Sleep Cycle*:

> *"Not as accurate because its not based on EEG. But on movement with accelerometers [sic]."* [Sleep Cycle]

D. Data Visualization

Data visualization is an important feature of any quantified self tool because it is a primary method of communicating information (i.e., data interpretation) to quantified self users. It affects user experience in the reflection stage, but it is considered as one of the barriers to quantified self [2]. It is interesting to note that even the simplest graphs are not understood by everyone (known as graph literacy)—approximately one third of the population in the US has low graph literacy [17].

Our analysis of visualization techniques (for 23 tools in total) showed the following characteristics. The time series graph, which used for presenting data changes over time, is the most frequently used visualization (8 out of 23 techniques). This visualization is of great interest to quantified selfers because they can easily track various progressions in their lives. However, the resolution of axis differs from one service to another, ranging from an hour to a week. Other visualizations included the pie chart (6), infographic (3), line graph (1), calendar (1), map (1), processed number (1) and interpretation text (1). The pie chart is used to show portions of items within a category. For example, the *Mint* app, which collects financial statuses from one's accounts, can show spending trends for categories of expenses such as food, education, home, and shopping. The infographic is a report-style and intuitive representation. Combining various information into a single document, it shows rich information in various formats. In contrast, *MoodPanda* shows distribution of feelings by location on a *Google Map*. As an alternative to graphic visualization, some tools use simple text to represent raw data. For example, *Zeo Personal Sleep Coach* provides a numeric score called a "Z-Score" which indicates how well users are sleeping. In this way, simple textual representation that summarizes key findings can help users to interpret their data.

Besides data interpretation, our analysis of user reviews revealed that aesthetics and "fun factors" are also considered to be important for user experiences, as the following user quotation reflect:

> *"Wolfram Alpha here too. Because it's already nice visualised."* [Give Me My Data]
>
> *"This is a really fun way to share a visual timeline with a friend - no words, only pictures. Only on Wednesday. I'm a fan!"* [PhotoWednesday]

The ultimate goal of quantified self is to take a data-driven action after reflection stage [2], [3]. We found that most visualization methods only deliver factual information. To better support a quantified self cycle for behavioral changes, the developers of a quantified self tool should consider expert knowledge, because quantified selfers may have superficial understanding of the results, and thus, they do not know what actions to take. For instance, when it comes to physiological signals, it is difficult to interpret the raw sensor data without advanced medical knowledge. If the measured testosterone level is very low, the tool should also recommend a user to take some food that increases its level or to visit a clinic.

One additional thing to note here is that many people keep track of data such as multimedia data (e.g., photos and videos) and unstructured text (e.g., manually typed activity names), which are hard to quantify. To visualize this kind of data, we can use only simple statistics (e.g., number of photos, count of items) or a timeline which just lists history data in chronological order. There should be novel methods that can help improve data collection as well as data analysis (e.g., text mining).

E. Simplicity of User Input

For certain types of data such as mental states or food intake, a user needs to type in information or select among predefined options. When users enter the data regularly, simplicity is a very important factor for usability. In our study, we found a group of users who did not want to spend too much time on entering data, as the following user stated:

> *"[...] The best moodtracker. I'd recommend it.* ***Still, it takes too much time to track it.****"* [Mood Panda]

Setting the right scale for user input is also important. For instance, *Mood Scope* provides 0-10 scales for mood collection, but one user complained about its wide range:

> *"After a couple days of testing it's still not the Moodtracker I was expecting.* ***I think it's not good that you can overthink your mood. [...] Also, for me it takes much time to track it.****"* [Mood Scope]

Simplicity of tracking also seems to be very important as mentioned in the following comment:

> *"This is a very light-weight tool I use to track my work hours on different projects.* ***I like that it's single-click tracking****, and colorful, too."* [Tally Zoo]

From these comments, we suggest that a simplified user interface for entering personal data should be considered, thereby reducing data collection time and mental effort for choosing the input values.

F. Sharing and Privacy

Previous studies [18] already investigated the benefits and barriers of data sharing, e.g., as a motivation for physical activity. Sharing provides advantages such as being applauded for achieving goals. We found users to be favorable with regard to sharing their data within a community. The community also plays an important role for self-reflection. For example, a person who tracks caloric intake might look to his or her community for a comparison target and advice [19]. The following quotations reflect this view:

> *"Quantter is very useful for me. I use it from the early alpha version few months ago. On Quantter, I can quantify all I want : sleep, weight, walk, activities (no limit).* ***On Quantter I share a lot and I meet lots of old and new friends who quantify. I help my friends to use Quantter and to quantt daily efforts to reach their goal. Quantter has both english and french spoken cool communities.*** *Feel free to join us [...]"* [Quantter]

> *"FatSecret is a place for people interested in food and diet. The web site has tools to help you achieve your exercise and diet goals. It has a food diary to help you plan keep track of what you're eating and an activity diary to record all the calories you burn with your physical activity. [...]* ***Additionally, the site has a strong community for some healthy competition and/or get motivation from friends.****"* [FatSecret]

Nonetheless, finding the right community to motivate oneself is very important to the quantified selfers [20]. The aforementioned findings were in line with previous work that showed the positive effect of strong communities.

Obviously, data sharing conflicts with privacy. One comment documents a user's concern about sharing location with friends.

> *"Rule no 1 if you have enemies, they will know where you are. [...]"* [Google Latitude]

Currently, the primary motivation for becoming quantified selfers is to improve one's health [5]. This implies that a large portion of data generated by the quantified self movement is health-related information, which raises serious privacy concerns. In everyday lives, wearable devices, such as smart watches, could be easily stolen; thus, personal information could be easily leaked. To attain a high level of privacy protection, user identification using physical and physiological fingerprinting can be used. One tool, the *Withings Wifi Bodyscale* demonstrates an exemplary practice that protects weight information even among family members.

> *"The Withings scale is awesome. I just think of it and use it as a regular scale (with body fat estimate).* ***Only this scale secretly logs my weight so that I can occasionally see how if I'm trending up or down. It doesn't stop there! It also weighs my wife and son too! And it knows who is who! My wife's data is safely hidden away so only she can access it.*** *[...]"* [Withings Wifi Bodyscale]

G. Design

When it comes to quantified self hardware, design is an important issue, as wearable devices are generally regarded as fashion items (e.g. watches).

> *"The Fitbit One is a great product.* ***Great designed****, works as it should. Long battery life, clear design, motivational messages that actually seem to work, like: I like you! At least this is what our test person said about the messages. You wear it, but aren't bothered by it. It wakes you up in the morning (silently) by vibrating on your wrist, this without waking up anyone else in the room/your bed."* [Fitbit]

Besides a good-looking design, size and shape matter. In the following comment, a user commented that these aspects can affect sleep quality.

> *"[...] Form factor issue 1:* ***the bulky size of the base station unit makes it very cumbersome for travelers to consistently track their data.*** *Form factor issue 2:* ***more importantly for me, the hard plastic headband piece disturbs my sleep.*** *[...]"* [Zeo Personal Sleep Coach]

Software design and usability issues are also considered to be important, as this user states:

> *"****Doesn't look that fancy*** *but it doesn't have to because you close your eyes during meditating ;)Great app when you are new to meditating. Used it for QuantifiedJan.nl as well. Available for iPhone and Android"* [Insight Timer]

H. Engagement

Engagement is an influential factor when quantified selfers choose what tools to use, and fun is a key driver to building strong engagement with users in that it helps the users to achieve their goals. The importance of fun is reflected in the following quotes:

> *"[...]* ***Still the product is so much fun, that it really engages you in tracking regularly. For me, that's the really important thing.****"* [Withings Wifi Bodyscale]

> *"I tried Mappiness during weeks.* ***Interesting but not very fun to be prompted each day.****"* [Mappiness]

> *" I would give it four stars, but the truth is I only open the app about once a month or so."* [Momento]

Rewards, such as virtual badges, are another frequently used technique to promote user engagement, as found in an earlier work [21] and reflected in this user statement:

> *"****Klout is a fun way to boost your ego. You get badges for doing nothing, YES I like badges****, but I also like dogs, and ducks, and turtles. Awesome to know about Klout is that it gets every little detail from your social environment. [...]"* [Klout]

Unfortunately, the ubiquity and convenience of quantified self techniques may lead to over engagement. In some cases, users may be overly concerned with their states. Designing techniques that help users to not only track themselves but also to change their behavior via self-reflection requires the inclusion of detailed guidelines about how users should interpret their data, as the following user quote makes clear:

> *"The Withings scale is super sleek, and feels almost magical as you see your weight appear on the screen in a different room. The reason to give it 4 stars was that* ***I found myself stepping on it twice a day, and becoming overly concerned about weight fluctuations.*** *So I've switched back to just weighing myself at my yearly doctor checkup."* [Withings Wifi Bodyscale]

IV. Discussion

We have analyzed a wide selection of items quantified by various quantified self tools, and we have identified the UX issues related to the tools discussed. The hierarchical categories that we found are useful when a novice quantified selfer plans which part of our life can be quantified and improved. Furthermore, we performed affinity diagramming to draw a high-level structural view of the themes from the collected reviews. Based on our findings, we suggest design considerations by relating categories of tools to UX issues. Our findings regarding UX issues can be a useful consideration checklist for preventing UX pitfalls when designing a successful quantified self product or application. In the following, we discuss how our findings are related to the prior studies.

Our results on category classification indicated that the most popular category is activity (42%). Choe et al. [5] reported that physical activities are the most popular categories, followed by food, weight, sleep, and mood. Our activity category includes various kinds of activities such as eating, exercise, and sleep that cannot be captured in body information and psychological states. More refined categories would be necessary to better understand various quantified self tools, which is part of our future work. Rivera-Pelayo et al. [19] classified which aspects of life were tracked into four categories, i.e., emotional aspects, private/work data, physiological data, and general activity. Our classification covers more broader contextual aspects of tracking in that we included body information (e.g. physical, physiological), psychological states, activities, social interactions, and environmental/property status.

While a verity of tools were found in our dataset, there were sill some missing tools that were reported the previous work (e.g., clothes, alertness) [5], [22]. We suspect that this is because such tools may include general-purpose tools (e.g., Excel, Google Docs) or custom-built tools, which could not be found in the review pages of off-the-shelf tools. Investigating other information sources as in the previous studies will help us to explore user experiences on such tools.

The dimensions of UX have been widely studied in the prior studies, and the high-level dimensions include pragmatic, hedonic, and aesthetic aspects that are keenly related with the UX issues [8], [23], [24]. While such dimensions gave us insights into exploring the UX issues from the reviews, our goal was to uncover practical UX issues related to the design of quantified self tools. Thus, our results contributed to the body of knowledge for quantified self tool design.

The reviews in our data set had been written after sufficient experience of use from early adopters, and we showed that

such reviews were valuable sources of information for understanding practical UX issues. This approach is important because uncovering UX issues from such user groups with high level of expertise and strong usage motivation is considered to be very time-consuming and expensive [7]. Analyzing the reviews is a good starting point before researchers and practitioners conduct user studies on the quantified self tools of interest.

V. Limitations

Our data set was from the online sites whose users are mostly early adopters of quantified self tools. This data set greatly helped us explore emerging UX issues, but the early adopters may show different usage behaviors and could be more sensitive to particular issues. For example, other user groups may be less concerned with data controllability. To generalize the results, there should be further investigation on other user groups.

Although we investigated a sufficient number of reviews (n=209), it is possible that there could be other UX issues that were not reported in the work. The quantified self movement is still in progress, and we expect that there could be more number of emerging UX issues, which requires further investigation in the future.

The anatomy of the on-line reviews does not seem to deliver detailed information about situation of use, or of measurements [25]. For this reason, additional studies such as user interview or contextual inquiry should be conducted in order to capture the contextual aspects of user experiences.

VI. Conclusion

We investigated user experience (UX) issues related to quantified self technologies by analyzing data collected from *quantifiedself.com*, where quantified selfers share their knowledge and experiences. We chose this data set because *quantifiedself.com* users are generally early adopters, and their experiences can provide valuable insights into UX issues. We first analyzed popular tools to understand what aspects of personal information were typically digitized by which technologies. We found five major themes, namely body information, psychological states/traits, daily activity (exercise, food and sleep), social interactions, and environment/property states. We then analyzed the key UX issues related to the considered quantified self technologies. We found that the UX issues cover both pragmatic and hedonic aspects of UX, including data controllability, data integration, data accuracy, data visualization, input complexity, sharing/privacy, design/aesthetic, and user engagement. The reported UX issues have significant implications for the future design of quantified self technologies.

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