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by

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# Self-Tracking and Gamification: Analyzing the Interplay of Motivations, Usage and Motivation Fulfillment

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**Abstract.** The usage of wearable self-tracking devices has emerged as a big trend in lifestyle and personal optimization concerning health, fitness, and well-being. In this context, gamification elements have the potential to contribute to achieving desired user behavior. However, it is not fully understood to which extent the users perceive their self-tracking motivations as being fulfilled through the usage of a wearable self-tracking device, and how gamification affects the interplay of self-tracking motivations, wearable self-tracking device usage, and motivation fulfillment. To address this research gap, we develop a conceptual model and validate it with survey research and structural equation modeling. We find that self-tracking helps users to unexpectedly fulfill motivations without previously striving for them and that significant differences exist between the gamification users and non-users with respect to their motivations by self-entertainment and self-design.

**Keywords:** Self-tracking, gamification, wearable self-tracking devices, motivation fulfillment, five factor framework of self-tracking motivations

## 1 Introduction

The engagement in self-tracking has recently emerged as a big trend in personal optimization and lifestyle [1]. Self-trackers regularly gather data about themselves – often related to their bodily functions and everyday habits – and then analyze the data to produce statistics and other analyses, such as images and diagrams [2], [3]. Devices used for this practice include for example smartphones, tablet computers, and so-called wearables. These wearable self-tracking devices benefit from sensors getting smaller as well as more compactly integrated [2]. Wearable self-tracking devices are, for example, smartwatches, wristbands, patches, clip-on devices, and jewelry or textiles with embedded sensors which measure bodily functions or physical activity [4]. The hype about self-tracking is also driven by the fact that “the new possibilities through

technology have opened up a world that offers new ways to get to know oneself and to gain a profound, fact-based understanding of collected self-related data” [5, p. 13].

In this regard, research on self-tracking has also emerged as a distinct stream within the IS community in recent years, studying various facets of the phenomenon [3], [6–8]. One of these facets is dedicated to understand the role of the user’s motivations to engage in the practice of self-tracking. Therefore, Gimpel et al. developed a five factor framework of self-trackers’ deep underlying motivations [5], while Baumgart and Wiewiorra [6] analyzed what motivations to start self-tracking drive different self-tracking activities and how different levels of self-control influence the tracking behavior of consumers and their expenditures. However, from an end-to-end perspective, a still unanswered question is to which extent the user’s initial motivations are actually fulfilled through the practice of self-tracking. We therefore aim to advance this research path by investigating to which extent the users actually perceive the motivations to self-track as being fulfilled by using their wearable self-tracking devices:

**RQ1:** *How does the usage of wearable self-tracking devices influence the user’s perceived fulfillment of the initial motivations?*

In the context of self-tracking motivation and motivation fulfillment, the practice of gamification should be considered. Gamification is a powerful method for motivating and influencing people [9]. Its term arose from the digital media industry [10] and describes the idea of using game design elements in non-game contexts [10]. One might think that gamification relates to only the motivational factor self-entertainment – below we do however argue theoretically and show empirically that gamification also significantly relates to other motivational factors. Within self-tracking experience, the application of gamified elements has the potential to change the user’s behavior [11]. For example, gamification elements such as rewards, levels, leaderboards, goal-setting, and feedbacks [11], [12] are attributed to facilitate the attractiveness of monotonous physical activities [13] and therefore motivate users to become more active [12]. Consequently, when investigating self-tracking motivations and motivation fulfillments, the concept of gamification should be considered as it can be expected to influence the relationships between Gimpel et. al.’s [5] self-tracking motivations, actual wearable self-tracking device usage, and fulfillment of the initial motivations. Therefore, we also strive to answer the following research question:

**RQ2:** *How does the usage of gamification elements within the wearable self-tracking device influence the interplay of self-tracking motivations, wearable self-tracking device usage, and motivation fulfillment?*

To answer our two research questions, we develop and test a conceptual model based on the research models of Gimpel et al. [5] as well as Baumgart and Wiewiorra [6]. Further, we investigate the influence of the motivational factors of the five factor framework on the self-tracking usage and ultimately the influence of usage on the motivation fulfillment. Finally, we integrate gamification usage as a moderator to test the effect on the interplay of self-tracking motivations, wearable self-tracking device usage, and motivation fulfillment.

## 2 Foundations

### 2.1 Wearable self-tracking device usage and motivations

Wearable self-tracking devices can be assigned to the category of personal information and communication technology (ICT) devices since they are mobile (used on, e.g., the user's wrist), are adopted by individuals for their own personal usage, and enable users to engage in various activities with one device [14], [15]. To understand the users adoption of these devices, device-specific research was conducted for smartwatches [16], [17] and for fitness-trackers [18].

Further, on a more comprehensive level, Pfeiffer et al. examined what factors drive the user's pre-adoption of wearable self-tracking devices, showing perceived usefulness, perceived enjoyment, social influence, trust, personal innovativeness, and perceived support of well-being to be the major drivers for the intention to use wearable self-tracking technologies [1]. In addition, Buchwald et. al. extended research in this area by developing a model explaining post-adoption of self-tracking devices and showed that self-tracking device usage is influenced by continuance as well as discontinuance factors [19].

In contrast to these adoption models which focus on the user's perceptions about the characteristics of the self-tracking technology and its usage, Gimpel et al. developed a five factor framework of self-tracking motivations. This comprehensive study identifies and characterizes the deeper underlying motivations of users to engage in the practice of self-tracking [5]. Those five motivations are:

- **Self-entertainment:** Being motivated by the fun and ludic aspects of self-tracking. Key drivers are the enjoyments of getting lost totally in self-tracking activities, forgetting about time while doing so or playing around with numbers, statistics etc.
- **Self-association:** Being motivated by self-individualizing aspects within a community as well as the prospect of community membership. Respective reasons causing self-tracking activities are such as the urge of comparing own results to others, helping or inspiring others, and presenting oneself to them.
- **Self-design:** Being motivated by the chances of self-optimization such as the desire to control, optimize or even manipulate certain aspects of one's life or the enjoyment of being one's own master.
- **Self-discipline:** Being motivated by the self-gratification possibilities of self-tracking. Decisive aspects are the facilitation of one's self-discipline, the motivation to keep on working for a goal and the chance to reward oneself.
- **Self-healing:** Being motivated by the possibilities of self-tracking to take care of one's own health. Major factors are the aspiration of being independent from traditional medical treatments and the distrust in the healthcare system as well as classical therapies.

Gimpel et al.'s results show on the one hand that more self-tracking motivation on any of the single factors enhances the number parameters tracked as well as the time spent on self-tracking. These two constructs are defined by Gimpel et. al as self-tracking activity. On the other hand, motivation from every factor is rather independent

from demographic factors (age, gender) and of personality traits (e.g. openness, conscientiousness or extraversion). Baumgart and Wiewiorra [6] further analyzed how different levels of self-control influence the tracking behavior of consumers and their expenditures for self-tracking software and hardware as well as what motivations to start self-tracking drive different self-tracking activities. They found out that the motivation of increasing one's performance as well as the number of tracked physical parameters are the key drivers of self-tracking usage frequency and accumulated expenditures. Further, customers that started self-tracking out of pure curiosity spend significantly more on self-tracking software, services and hardware and are at the same time more likely to track parameters from a wider variety of categories. Finally, they also showed that higher levels of self-control increase the odds of consumers tracking physical parameters and spending more on self-tracking software and hardware.

## **2.2 Gamification in the context of self-tracking**

Gamification is the use of game design elements in non-game contexts [10] for changing people's behavior and driving participation as well as engagement [9]. Gamification, often interchangeably called "gamified services" [20], "gamefulness", or "gameful design" [21], also aims at the enhancement of positive patterns in service use like increasing quality and productivity of user actions, social interactions, or user activity [22].

Gamification can be reached by integrating game mechanics or elements and game dynamics. These terms are closely related and sometimes used synonymously [9]. Game elements are composed of multiple facets of "game play" [23] in the form of various actions, behaviors, and control mechanisms. While literature offers a wide range of different gamification elements [12], [23–25], rewards, levels, leaderboards, goal-setting, and feedbacks are specific gamification elements particularly considered in the context of self-tracking [11], [12]. They are the means which are used to create a compelling and appealing user experience [9] and ensure the user's engagement and his continuance in system usage [23]. Thereby, game dynamics, e.g., status, altruism, or achievement, are defined as the desires and motivations triggered by game elements. They are the universal human needs across genders, cultures, demographics, and generations which appropriate sets of game mechanics aim to satisfy [9]. Overall, gamification elements can be seen as the means which are used to satisfy game dynamics and thus, ultimately, fulfill the inherent underlying self-tracking motivations.

As mentioned before, self-trackers strive for optimizing certain aspects of their lives [5]. Especially with challenging and difficult behavior patterns for such self-optimization, users' motivation needs to be maintained in the long run. This is where gamified self-tracking applications which are designed to change the users' behavior [11], [26] come into play. One possible underlying intention could be to motivate them to become more active by making physical activity more enjoyable [12]. For example, monotonous physical activities such as running workouts can gain attractiveness by more intensively integrating the user into the application [13]. Gamification is also able to contribute positively to the usage of self-tracking apps as long-term goals can be broken down into sub-goals that can be attained more quickly. The gamification

element challenges, for example, allows the user to repeatedly achieve short-term targets set by the application and might reward the user afterwards. A user planning to lose 20 kg by running might feel discouraged at first due to the long way to go. But as the application motivates the user to do single and short workouts step-by-step, the sub-goals are easier to realize. This supports the user's motivation to continuously strive for his goals [27].

Next to positive impacts of gamification on motivation in the context of self-tracking applications, also negative aspects have been identified. According to the self-determination theory of human motivation [28], competence, relatedness, and autonomy are the three innate psychological needs that determine motivation. On the one hand, intrinsic motivation gets enhanced when these needs are satisfied, but on the other hand, they diminish intrinsic motivation when they are thwarted [12]. Generally, game-play is voluntary as well as free of consequences and hence facilitates perceived autonomy, which is intrinsically motivating. But when it comes to gamified systems offering rewards or social comparison (e.g., leaderboards), their use is not necessarily voluntary or free of consequence. This might thwart perceived autonomy and hence intrinsic motivation [29]. Taken to a more general level, Nicholson [30] claims that by artificially integrating gamification elements into non-game activities, motivation will be reduced in the long run.

Besides the influence of gamification on motivations, Wellmann and Bittner [27] as well as Gal-Oz and Zuckerman [12], expanded the research stream by investigating the influence of gamification on the user's absolute, measurable goal achievement. They examined whether a gamified version of a smartphone app can affect self-tracker's physical activity. Wellmann and Bittner discovered that gamification elements within a running app can increase the user's movement behavior as their running distance was significantly larger [27]. In contrast, Gal-Oz and Zuckerman concluded that their gamified application which measures walking is only as effective as the version excluding gamification elements [12].

### **3 Conceptual development**

#### **3.1 Motivations and usage**

IS usage can be described as the "degree and manner in which an IS is utilized by its users" [31, p. 6]. While perceptions of characteristics of an information system (e.g. perceived ease of use or usefulness) in general and self-tracking-specific influencing factors of usage have been extensively studied before (e.g., [1], [19], [32–35]), we deliberately focus on the user's underlying motivations and assume that those influence the usage behavior of a wearable self-tracking device as well. For example, the desire for self-design concerning sleep-optimization can be fulfilled by an ongoing monitoring of sleeping patterns with a sleep-tracker, thus inducing its usage. Therefore, we adapt the previously described five motivational factors identified by Gimpel et al. [5] and hypothesize:

*The motivations for self-entertainment (H1.1), self-association (H1.2), self-design (H1.3), self-discipline (H1.4), and self-healing (H1.5) have a positive effect on the usage of wearable self-tracking devices.*

### **3.2 Motivation fulfillment**

After the initiation of wearable self-tracking device usage through self-tracking motivations, we assume that the continuous usage of a wearable self-tracking device leads to the perceived fulfillment of the initial motivations. For example, the initial motivation for self-discipline causes an ongoing usage of a device in terms of setting and controlling testable goals like the number of steps walked or calories burned. With the ongoing feedback of the device on these measures, the user feels his need for self-discipline being fulfilled by the device. In this regard, we define motivation fulfillment as the perceived fulfillment of the intrinsic desires reflected in the manifestation of a motivation. We further stay with five factor framework of self-tracking motivations [5], but now do consider the motivations fulfillment and hypothesize:

*Wearable self-tracking device usage positively affects the user's motivation fulfillment of self-entertainment (H2.1), self-association (H2.2), self-design (H2.3), self-discipline (H2.4), and self-healing (H2.5).*

### **3.3 Moderating effect of gamification usage**

Gamification has often shown to have positive effects on motivation [9], [11–13], [27] and distinct goal achievement [27] in the context of self-tracking. A literature analysis as well as a self-conducted analysis of the top 20 iOS applications within the category of health and fitness has shown that levels, rewards, challenges, and leaderboards can be considered as the most relevant gamification elements [11], [12]. To adapt this characteristic of gamification to the context of self-tracking, we conjecture a moderating impact of gamification usage, which influences the effect of motivations for self-tracking on the actual wearable self-tracking device usage. Consequently, we suppose the positive effects of gamification on motivation to be predominant and posit:

*Gamification usage positively moderates the effect of the motivations self-entertainment (H3.1.1), self-association (H3.1.2), self-design (H3.1.3), self-discipline (H3.1.4), and self-healing (H3.1.5) on wearable self-tracking device usage.*

As gamification can also, in general, enhance system usage [13], we adapt this characteristic of gamification to the self-tracking context. We assume that the user's continuous usage of wearable self-tracking devices leads to a satisfaction of her or his motivations and therefore hypothesize gamification usage to also moderate the effect of wearable self-tracking device usage on motivation fulfillment. Again, we suppose the positive effects of gamification on motivation fulfillment to be predominant and hypothesize:

*Gamification usage positively moderates the effect of wearable self-tracking device usage on the motivation fulfillment of self-entertainment (H3.2.1), self-association (H3.2.2), self-design (H3.2.3), self-discipline (H3.2.4), and self-healing (H3.2.5).*

## 4 Survey design and procedures

We chose a quantitative-empirical research approach to validate our conceptual research model because it allows for a statistical generalization on the basis of results which are representative of the whole population at a lower cost than collecting the data for the whole population [36]. To this end, we crafted a survey instrument. We began this process by using, wherever possible, established and validated measurement scales and adapted them if necessary to ensure that the focus of our study is centrally reflected in each of the statements. Each of the item statements was measured with a seven-point Likert scale [37]. All constructs are measured reflectively.

To further enhance the survey instrument’s comprehensibility and validity, we conducted a pretest with six researchers and incorporated their qualitative feedback. Ultimately, we used our survey instrument to collect empirical data via an online-survey tool.

### 4.1 Construct operationalization

We measure both self-tracking motivation (M) and motivation fulfillment (F) based on the five factors self-entertainment (SE), self-association (SA), self-design (SDe), self-discipline (SDi), and self-healing (SH) [5]. We utilize all items from [5] to measure both the current self-tracking motivation and motivation fulfillment. For the measurement of current self-tracking motivation, the items represent answers to the originally proposed question “I am self-tracking because...” (Table 1 lists all items) and range from “strongly disagree” to “strongly agree”. For each item, this question regarding self-tracking motivation was immediately followed by an evaluation of the phrase “I actually fulfill this goal by self-tracking.” to capture motivation fulfillment. The answer-options range from “not fulfilled as I expected” to “fulfilled way more than I expected”. In addition, we added the scale item “not applicable as not a goal of mine” in the motivation fulfillment.

**Table 1.** Operationalization of self-tracking motivation [5]

Constructs	Items
	<b>I am self-tracking because...</b>
Self-entertainment (SE)	... I enjoy getting lost totally in self-tracking activities.
	... I like playing around with numbers/statistics etc.
	... I like playing around with my smartphone/technical device etc.
	... I enjoy forgetting about time while doing so.
	... it is fun and entertaining.
Self-association (SA)	... I want to help/inspire others.
	... the way I'm doing it is interesting for others/might help others.
	... I want to compare my results to others.
	... I want to present myself to others.
Self-design (SDe)	... I want to control what I'm doing with my life.
	... I try to manipulate certain aspects in my life.



	... I enjoy being my own master.
	... I'm interested in how certain things in (my) life interact.
	... it helps me to optimize the way I'm living.
Self-discipline (SDi)	... it motivates me to keep on working for a goal.
	... It allows me to reward myself.
	... it facilitates my self-discipline.
Self-healing (SH)	... I don't trust in the healthcare system/classic therapies.
	... I want to be independent from traditional medical treatments.

Further, we self-developed two measurement items for wearable self-tracking device usage (WSTDU) based on Burton-Jones and Straub [38], Davis et. al [39] as well as Venkatesh and Davis [40]. The answer-options range from “Less than few times a month” to “Almost 24 hours a day”. Regarding gamification usage, we differentiate between active self-tracking users if they at least use one of the four considered gamification elements rewards, levels, leaderboards, and challenges and those who do not engage with any of these elements. Thus, gamification usage represents a binary variable. The final operationalization of wearable self-tracking device usage (WSTDU) and gamification usage is shown in Table 2.

**Table 2:** Operationalization of wearable self-tracking device usage (WSTDU)

Constructs	Items
<b>WSTDU</b>	On average, how frequently do you (passively) collect data with your wearable self-tracking device?
	On average, how frequently do you actively engage with your wearable self-tracking device (e.g., for data analysis)?
<b>Gamification usage</b>	Do you use the gamification element <i>Rewards / Levels / Leaderboards / Challenges</i> within your wearable self-tracking device? [Four items, one each for the four gamification elements]

## 4.2 Data collection

We collected data by administering our survey instrument to current active users of wearable self-tracking devices. This means that it was a prerequisite that the users actively use their device to track their fitness, health, or well-being to increase the validity of the responses. Users who do not yet use or have already stopped using their devices were excluded from the survey. We explained to the participants the concept of self-tracking and the function of the different gamification elements to receive more valid responses. To gather our data, we offered English and German versions and distributed the invitation message to participate in our study in online social networks (e.g., Facebook), online business networks (e.g., Xing and LinkedIn), instant-messaging services (e.g., WhatsApp), and the e-learning system of one of the authors' universities. We decided to openly circulate our invitation to allow for a snowball effect within social media. Overall, we received 359 responses. We excluded non-self-tracking users and incomplete answers (270 in total) which left us with 89 remaining

responses. Of these 89 respondents, 53% indicated that they are actively using at least one of the four gamification elements. The average time of usage for the wearable self-tracking devices was 20 months. 84% use smartphone apps for self-tracking, 33% an activity tracker, 17% a smartwatch and 10% another form of device or application. On a seven-point Likert scale ranging from light user (1) to heavy user (7), 52% of the sample group consider themselves as medium self-tracking user type (4) or higher. On a seven-point Likert scale ranging from strongly disagree (1) to strongly agree (7), 64% either agree (6) or strongly agree (7) to be interested in trying out new technical devices. 57% agree or strongly agree that they actively take care of their health and well-being and 51% that they see themselves as sportive.

## **5 Data analysis and results**

We tested measurement properties and hypotheses with a partial least squares structural equation modeling approach (PLS-SEM) and multi-group analysis (MGA) [41], [42] using the software SmartPLS Version 3.2.6 [43]. Even though PLS-SEM has its limitations [44], we chose it as an established approach in the IS research discipline and for our study especially due to the relatively small sample size [45], [46].

### **5.1 Measurement model**

Concerning outer loadings, we set the critical threshold at 0.70 [47]. The outer loadings of the fourth item of self-entertainment motivation and motivation fulfillment, the second item of self-discipline motivation and motivation fulfillment, and the third item of self-design motivation and motivation fulfillment are lower than 0.70. We excluded them from our measurement model. The first two items of self-association motivation and the last two items of self-association motivation fulfillment exhibit lower outer loadings than 0.70 as well. Due to the nature of our measurement model, dropping these items would lead to an asymmetric inconsistency between the constructs. We therefore further examined the data and the operationalization of the construct. The results suggest that the operationalization may describe two different facets of self-association, one more directed towards altruism, the other more towards self-presentation. Hence, we decided to not further consider the results of self-association. Furthermore, the first item of self-entertainment motivation and the first and fifth item of self-entertainment motivation fulfillment do not reach the critical threshold of 0.70. But as they still exceed 0.60, which is deemed high [48], we considered them as marginal and did not exclude them from our measurement model. All other items, including active as well as passive use frequency of the construct wearable self-tracking device usage are greater than the critical threshold. Adhering to standard validation guidelines [49–51], we tested the reflective measurement model in terms of internal consistency reliability, indicator reliability, convergent validity, and discriminant validity. The internal consistency reliabilities (composite reliability) of multi-item scales modeled with reflective indicators is 0.81 or greater, suggesting that scales were reliable. In addition, the Cronbach's Alpha values are, except for self-

association, 0.70 or greater, hence showing a good internal consistency of our scale. The average variance extracted is consistently greater than the critical threshold of 0.50. Hence, we conclude that convergent validity has been established. Further, to check for discriminant validity, we applied the Fornell-Larcker Criterion as a conservative measure [52]. The square root of each construct's AVE is greater than its highest correlation with any other construct, hence discriminant validity has been established, too.

## 5.2 Structural model

To assess the significance levels of our structural model including the MGA, we applied bootstrapping with 5,000 sub-samples (no sign changes). Table 3 presents the results for the entire group and for the sub-groups of gamification users and non-users. Relating to the 20 hypotheses posed, 4 could not be tested due to measurement problems with self-association. Of the remaining 16 hypotheses, 7 are supported by the data. These seven hypotheses are discussed in the following. In that, we apply a 10% significance level which appears reasonable given the relatively small sample size, especially in the subgroups. Our data support that the motivation for self-entertainment increases the wearable self-tracking device usage and the latter positively influences the user's self-entertainment motivation fulfillment (H1.1 and H2.1). Further, the multi-group analysis of gamification users and non-users shows a significant difference between the two groups, with a significantly higher effect of motivation for self-entertainment on usage within the group of gamification users (H3.1.1).

**Table 3.** PLS-MGA results

Hypothesis	Complete		Non-gamification users	Gamification users	Group delta
	n = 89		n = 42	n = 47	
	Path coefficients	R <sup>2</sup>	Path coefficients		
M-SE → WSTDU	0.276 **	0.163	0.092	0.428 **	0.337 +
M-SDe → WSTDU	0.195		0.423 +	0.041	0.382 +
M-SDi → WSTDU	0.115		0.027 +	0.137	0.110
M-SH → WSTDU	-0.076		-0.248	0.044	0.292 +
WSTDU → F-SE	0.242 *	0.058	0.238	0.297	0.059
WSTDU → F-SDe	0.326 ***	0.106	0.491 ***	0.235	0.256
WSTDU → F-SDi	0.321 ***	0.103	0.434 ***	0.218	0.215 +
WSTDU → F-SH	0.139	0.019	0.244 *	0.168	0.076

Significance levels: + 10%, \* 5%, \*\* 1% \*\*\* 0.1% | n = number of cases

Self-design shows significant results as well: Wearable self-tracking device usage significantly increases the user's self-design motivation fulfillment (H2.3). Additionally, within the multi-group analysis, the influence of motivation for self-design on usage is significantly higher in the group of non-gamification users (H3.1.3).

Also, our results reveal that wearable self-tracking device usage significantly increases the self-discipline motivation fulfillment (H2.4). Finally, the multi-group analysis results show that the influence of wearable self-tracking device usage on the self-discipline motivation fulfillment is significantly higher in the non-gamification group (H3.2.4).

## 6 Discussion

Taking a comprehensive look at our results, we acknowledge the relatively low  $R^2$  values of the dependent variables. However, the results are reasonable since our study specifically only aims on the user's deeper underlying motivations of self-tracking and does not take the user's perceptions about the characteristics of the self-tracking technology and its usage into account which were analyzed in other dedicated acceptance studies [1], [19]. Looking further into the details of our results, self-entertainment is the key motivation to engage in the practice of self-tracking as it is the only effect on wearable self-tracking device usage that is significant. Users seem to be driven by the entertainment possibilities which allow them to experience fun and play around with their collected data and statistics. Concerning the multi-group analysis, the effect is even more pronounced among gamification users and significantly differs from that of non-gamification users. This observation confirms that the playful elements of gamification reinforce the urge to self-track due to ludic motivation.

In contrast, the motivations self-design, self-discipline and self-healing are not found to drive wearable self-tracking device usage per se. However, the MGA shows that the motivation for self-design has a significantly higher influence on usage for non-gamification users. A potential reason could be, that non-gamification users who pursue control and optimization engage in these activities with a more serious mindset, thus deliberately ignore playful gamification elements because they might not support or even distract them.

Moving on to the relationships between wearable self-tracking device usage and motivation fulfillment, results show that usage significantly increases the perception that the preexisting desire for self-entertainment is fulfilled. The users of wearable self-tracking devices feel that their wishes to entertain themselves are met in the process of self-tracking. For self-design and self-discipline, however, we observe significant positive effects of usage on perceived motivation fulfillment without significant preexisting connections between their motivation and usage. Hence, users might not necessarily start self-tracking due to a striving for self-design or self-discipline. Nevertheless, as soon as they are active wearable self-tracking device users, they seem to realize positive effects such as being able to take control of and optimize their lives, gaining knowledge about interactions of certain things within their lives (self-design), facilitating their self-discipline, or being motivated to keep on working on goals (self-discipline). A further look at the group of non-gamification users reveals that they clearly and highly significantly perceive their motivation for self-discipline as better fulfilled than gamification users. This fact seems counterintuitive; however, a possible

explanation here might also be that gamification elements do not support motivation fulfillment but rather distract the users from it.

## 7 Conclusion

The purpose of this study was to create a basis for future research regarding the analysis of the interplay of self-tracking motivations, usage and motivation fulfillment. Therefore, our paper investigates how Gimpel et. al's [5] motivational factors for self-tracking influence the actual usage of wearable self-tracking devices, to which extent the users actually perceive these motivations as being fulfilled in the process of using them, and how gamification affects this interplay of self-tracking motivations, wearable self-tracking device usage, and motivation fulfillment. We found the motivation for self-entertainment to represent the crucial driver of wearable self-tracking device usage and ultimately usage as important driver for the motivation fulfillment of the three factors self-entertainment, self-discipline, and self-design. Further, both the motivation as well as the motivation fulfillment are moderated by gamification usage. Gamification users are more motivated by self-entertainment, non-gamification users more by self-design. In addition, non-gamification users tend to have higher levels of motivation fulfillment, except for self-entertainment. Hence, in designing self-tracking devices and apps and potentially integrating gamification elements, one should carefully consider the diverse effects of gamification.

Our study has three main limitations: First, as common in research on motivation, survey responses are self-reports. Second, our results are based on a relatively small sample size of 89 respondents which may distort the results. Future research on this topic should be built on a broader database which enables more precise and refined results. Additionally, multiple surveys at different points in time would enable empirically validated statements on continuous usage. Lastly, the influence of gamification is only explained based on the distinction between gamification users and non-users. For future research, the differentiation between the four major gamification elements would allow for more detailed insights of the influence of gamification use. Additionally, coming research could combine the research on self-tracking motivations with the research on the user's perceptions about the characteristics of the self-tracking technology which might further increase the understanding of the phenomenon.

Generally, our research contributes to the domain of self-tracking and gamification as it advances the understanding how the usage of wearable self-tracking devices influences the user's perceived fulfillment of the initial motivations, and how gamification elements affect this interplay. Thereby, we found evidence that next to the motivation of increasing one's performance [6], striving for self-entertainment is a key driver for using wearable self-tracking devices, and that the usage ultimately increases the perceived fulfillment of the user's motivations for self-entertainment, self-discipline as well as self-design. Furthermore, gamification elements might not support motivation fulfillment but rather distract users of wearable self-tracking devices from it. Our findings have three additional main practical implications: First, potential users of wearable self-tracking devices should be aware that self-tracking might help them to

fulfill motivations which they have not previously been aware of. Second, we suggest that designers and manufacturers of wearable self-tracking devices consider addressing the entirety of motivational factors. This might improve their product attractiveness and let them reach more customers. Lastly, the use of gamification elements should be up to the user as their mandatory usage might not always support usage and motivation fulfillment.

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