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# Gamified wearables, their uses, and challenges in human well-being

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## Abstract

Gamification is utilised to encourage behavioural change and advance desired attitudes in well-being. Well-being can be enhanced through the alteration of individual behaviours and social aspects. Wearables used for self-tracking are developing and growing their market segment. This essay explores how gamified wearables can impact physical and mental well-being. This essay explores how three main topics: 1) gamification, 2) well-being and, 3) wearables collide. The existing research indicates that gamification and wearables can impact well-being positively. However, the full potential of gamification does not seem to be harnessed yet. Findings need to be explained with awareness due to the relatively methodological limitations of many studies and investigated how gamification and wearable devices could be merged to provide long term, user-friendly approaches to personal well-being.

Keywords: Gamification, Wearable Technology, Well-Being

## 1. Introduction

The purpose of this essay is to determine how gamified wearables can impact the physical and mental well-being of their users. Wearables or wearable devices are technology one can wear. According to Follett (2014), although wearables are currently a buzzword in the technology industry, it already has a half-century history stemming from military purposes, expanding to the consumer market, i.e., healthcare, fitness, wellness, gaming, entertainment, music, fashion. Wearable devices are relatively popular in the well-being market, and they are expanding to other markets, such as gaming, music, and entertainment. Like persuasive technology, wearables can transform human behavioural and interactional paradigms with devices, the environment, and others (Follett, 2014).

Perhaps the most critical task of wearables is increasing knowledge about the body. The use of wearables and the user's experiences are strongly linked to human behaviour, influencing the relationship between gamification and wearable technology. Cultural differences and other aspects, such as personality, can affect how gamified wearables are seen and how they should be designed (Zhao et al., 2020).

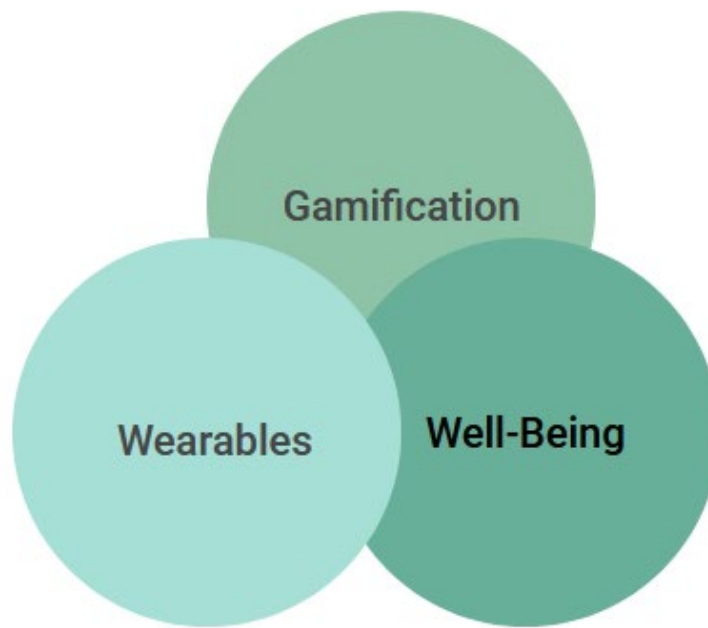


Figure 1. Main topics of the essay.

This essay will focus on three main topics (Figure 1) and their relation to each other. The essay begins with a look at the gamification in well-being, quantified-self, continuing with the gamified wearables, types of wearables and their uses, social aspects, and their connection to gamified wearables, and finally, evaluating the possible challenges of gamified wearables. The essay will reflect our thoughts on the theoretical papers before concluding the essay.

## **2. Literature review**

### **2.1 Well-being**

As a multifaceted and complex area, it is hard to form a generalisable definition of well-being. The research originated from the growing field of positive psychology (Simonton & Bauemeister, 2005) and distinguishes between two well-being perspectives, objective and subjective (Voukelatou et al., 2021). Objective well-being uses measures such as gross domestic product (GDP), whereas subjective focuses on people's assessment of their quality of life (e.g., happiness, life satisfaction) (Voukelatou et al., 2021). Ruggeri et al. (2020) further included achieving personal goals in subjective well-being. Morozova and Gurova (2021) discussed the complexities of defining well-being. They pointed out how previous research included, among others, psychological approaches (Bradburn, 1969, in Morozova & Gurova, 2021), as well as combinations of physical and social well-being (Lindenberg, 1996, in Morozova & Gurova, 2021). They defined well-being as the subjective amalgamation of individual challenges and available resources. Well-being is a constantly developing concept, with continuous proposed additions and changes, further complicating a general definition. These changes range from suggesting new subcategories, such as digital well-being (Vanden Abeele, 2021), improving existing well-being measures by including more details, such as personal relationship to nature, social groups, and

government (Lambert et al., 2020), to new measurement methods (Ruggeri et al., 2020). Well-being has since become a topic in various disciplines, including positive organisational behaviour, humanistic management, and social innovation (Aksoy et al., 2019; Avey et al., 2010; Kabadayi et al., 2019). Furthermore, the decrease in physical activity and rise of unhealthy dietary habits (Kumar & Preetha, 2012) have increased the likelihood of contemporary well-being concerns, ranging from Non-Communicable Chronic Diseases (NCDs) to mental health (Sarbadhikari et al., 2018; Frenk & Gomez-Dantes, 2011).

As healthy habits comprise regular health, nutrition, and safety practices and contribute to physical, social, and mental health, well-being offers a holistic view integrating all aspects (Sarbadhikari et al., 2018). Johnson et al. (2016) stressed that as minor individual actions significantly better well-being, they are an essential target. We can thus speculate that gamified wearables would satisfy both sides, the more comprehensive commercial and medical concerns, as well as individual desires to develop lasting well-being habits.

For this essay, well-being is defined as a subjective valuation of physical and mental health, and perceived personal achievements, focusing on the application in gamified wearables.

## **2.2 Social Context**

As the social context defines the interaction between users and gamified wearables, it is crucial to consider cultural background, social norms, group identity, and behavioural and psychological patterns when evaluating gamified wearables.

A key consideration in gamification is human motivation (AlMarshedi et al., 2017). Still supported by research (Wang et al., 2019), Ryan and Deci (2000)'s self-determination theory (SDT) suggests that motivation can be distinguished between internal (i.e., driven by personal desires) and external (i.e., due to external forces). Furthermore, the authors proposed three innate psychological needs, autonomy, competence, and relatedness. Autonomy refers to the need to make independent decisions, competence represents confidence in one's abilities, and relatedness signifies a need to have feelings of belonging and connection to others. They are key factors influencing motivation. When these needs are met, intrinsic motivation and mental health are improved, but motivation and well-being decline when they are not met. Cultural differences between collectivist and individualistic societies could also be a factor to consider; however, Lambert et al. (2020) pointed out that due to spreading globalisation, there has been an increase in individualism worldwide, although without a significant decrease in collectivism. It is possible that technological advances, including wearables, provide an avenue to merge these two contexts, as they facilitate the exchange between cultures due to increased connectivity and reduced geographical constraints (Vanden Abeele, 2021). AlMarshedi et al. (2017) outlined multiple models of behavioural research. They concluded that behavioural components covered, among others, the motivation and ability to perform an action, psychological and social cues enabling an action, as well as the user's environmental background influencing their behaviour.

In the light of gamification, these behavioural models with social, cultural, and external factors may provide an all-inclusive experience for the user. Persuasive technologies showcase how social and psychological features influence technology and design decisions. They share some similarities with gamification, as both aim to guide a user's behaviour towards the desired change, yet without coercion (Hamari et al., 2014). Generally,

persuasive technology is one of many methods and theories used to change the behaviour of an individual or a community. Stepping further, many immersive technologies are trying to integrate gamification into their feature ecosystems. An example of this promising domain are those devices that monitor physiological status, such as heart rate or emotional stress. Their form can vary (e.g., bracelets, clip-ons, or bands) (Follett, 2014).

## **2.3 Quantified-Self**

The term Quantified-Self (QS) refers to the act of self-tracking and the community of avid self-trackers. The tagline of the QS movement is “self-knowledge through numbers”. (Sharon, 2017). The motivations of self-tracking are various (Swan, 2013). QS provides continuous, precise measures on users’ development. Therefore, it often aims to evaluate users’ performance in certain areas of interest so that individuals can better achieve progress. These areas can be related to well-being, productivity, or self-development (Hamari et al., 2018).

Hamari et al. (2018) suggest that systems and services we use daily have become more augmented with motivational designs (such as gamification and QS), which aim to positively engage people to use systems and the task they are attempting to accomplish the help of technology. Sharon (2017) implies that the future of self-tracking leans in the direction where individuals are more involved in their well-being. They can generate data on their well-being even to benefit clinical decision making and research. An enthusiastic approach to the topic is to move one’s health from the healthcare professionals to their own hands, as they will have tools to manage it. QS can personalise healthcare through biometric data (Sharon, 2017).

Wearables have a significant role in QS. They are used to gather data on one’s body. Additionally, most devices can be paired with applications in mobile devices to gain rich insight into users’ health patterns.

## **2.4 Gamification in Well-Being**

Gamification is an approach stemming from the domain of game design. Researchers have made several attempts to define the term and its relations to games and other related terms. The definition of gamification by Juho Hamari is practical and constructive. He notes that “gamification can be seen to pursue societal and individual advancement by seeking to make humans more capable” and that “gamification broadly refers to technological, economic, cultural, and societal developments in which reality is becoming more gameful.” Gamification may also aim to train skills, create motivational benefits or increase creativity, playfulness, engagement and happiness (Hamari, 2019).

Based on theoretical papers regarding gamification and thematic analysis, extrinsic and intrinsic motivational affordances are connected to three gamification engagement themes: goal-based, social-based, and rewards-based gamification. Goal-based gamification targets the need to feel competent. Social-based gamification elements relate to an individual’s sense of belongingness and fellowship among groups, whereas rewards-based gamification appeals to extrinsic motivation. Practising these mechanisms in gamification can positively enrich products, services, and information systems with game-design elements to influence users’ motivation, productivity, and behaviour (Deterding et al., 2011; Huotari & Hamari., 2012).

Recently, the gamification and well-being sector has received worldwide attention due to the ubiquitousness of devices, especially related to persuasive technologies. Persuasive technologies purposefully apply psychological principles of persuasion, including credibility, trust, reciprocity, authority and the service of changing users' attitudes and behaviour (IJsselsteijn et al., 2006). Well-being requires significant effort to maintain and does not potentially evoke people's interest. Alternative approaches such as entertainment and persuasive technologies are considered to provide a stimulus to effectively appeal to a broader audience (Zhao et al., 2016). Conventionally, game elements and mechanics have been conceptualised by gamification as an overpowering core drive in the individual's motivation and engagement in a non-game context.

Johnson et al.'s (2016) systematic literature review of empirical studies on gamification for health and well-being highlighted seven potential advantages, including supporting intrinsic motivation and a wide range of applicability. However, they pointed out that the effectiveness of gamification in improving health and well-being could not be significantly established.

Several gamified apps are available in online stores under the sub-categories of well-being, such as health and fitness. Cisco (2019) forecasted that seventy-two per cent of the global population would be mobile users by 2021. Therefore, many stakeholders have been racing to produce gamified apps to nourish users' well-being by converging on certain behavioural traits through motivating users to establish goals, provide increasing challenges with incentive mechanisms, e.g., game elements, progress, positive feedback, rewards, and social connectivity (Wickramasinghe et al., 2019). Lately, App Store Preview (2021) has promoted applications that help people connect with experts, social communities and build positive routines to boost their well-being.

As a result, the use of gamification in the well-being industry, relating to exercise, fitness, and health in general, has motivated individuals, stimulated their long-term behaviour, and turned complex challenges into more playful and engaging activities. However, previous studies have suggested that those game elements and mechanics, such as rewards, skill-matching game approaches, must be carefully combined and adequately applied (Wickramasinghe et al., 2019). A study by Nicholson (2015) conceptualised a meaningful recipe for gamification that well-being intervention studies should ensure some factors, such as storyline, exposition, and user's freedom and choice. The increasing pervasiveness of devices and the growing attention towards well-being has sparked the commoditisation of wearable devices in recent years (Zhao et al., 2016).

One example of how human behaviour and motivation (i.e., intrinsic and extrinsic) combine is BloodHero, a gamified mobile application to encourage blood donation. Gamification relies on four semantic components, comprising game elements, design, and non-game contexts with seven core elements: goal setting, capacity to overcome challenges, comparing progress, social connectivity, and fun and playfulness (Sarbadhikari et al., 2018). In BloodHero, initiatives and interactions beneficial to blood donation will generate points for the in-game leaderboard, typical gamification applications. Blood donors can interact with each other and patient users, share their stories or use this application to find someone compatible with their blood type for donation (Domingos et al., 2019).

## 2.5 Gamified Wearables

Wearables are electronic mobile devices embodied in gadgets, accessories, or clothes worn on the body (Ometov et al., 2021). Wearable devices and their associated, gamified health and fitness applications are gradually becoming a part of people's daily lives. Therefore, it is crucial to study the overlap of gamification, wearable technologies, and well-being to enhance physical and mental health intervention – which is now called gamified wearables.

Despite the increasing usage of wearables, there are diminishing engagement and discontinuance issues. To bridge the gap between wearables and well-being, rich data retrieved from forty interviews and online surveys conducted by Spil et al. (2017) stressed that the value of wearables and gamification was still unknown among potential customers. Although wearables' adoption and usage rates are relatively low, this rate of gamified health apps is more positive (Wickramasinghe et al., 2019). Thus, examining to what extent wearables can be exploited for interaction with gamification and whether this combination has the potential to improve well-being becomes critical.

Spil et al. (2017) established that the quality of gathered data could be improved through gamified wearables. Tong et al. (2015) suggested that game-based wearables encourage users to improve their quality of life by promoting physical and mental activities. While Cho et al. (2021) argue that three gamification methods have resulted in improved engagement. Goal-based game elements in wearables, as an intrinsic motivator, can offer feelings of competence, autonomy, and relatedness. Social-based gamification elements can influence emotional engagement in well-being, e.g., physical activity performance. Social incentives and external rewards, be they rewards-based, have remained an intensely controversial issue because of the unreliable effect of external rewards on the level of intrinsic motivation. In psychological study, people can gradually feel controlled by the rewards, and the locus of causality may be amended from internal to external. To nurture sustainable engagement with well-being and wearables, external rewards can be the premise of a gamified platform where more than one gamification strategy is applied. Based on reviewed studies, the idea of deploying gamified wearables for activities supporting well-being is practical, engaging and motivating due to the matching of the current user needs and existing technologies (Wickramasinghe et al., 2019). It can be concluded that gamified wearables are a new and substantial field of research in the light of well-being, although several issues related to users' long-term interest and motivational affordances have been revealed lately.

Follett (2014) reminded designers that wearables were complementary devices for existing device experiences. It is the premise of putting wearables for well-being into an ecosystem of existing devices to benefit the overall experience towards users' goals (Follett 2014). Psychological issues relating to social aspects can influence the way gamification is implemented within wearables. People with different personal preferences are affected by gamification in different ways. Thus, the knowledge about human behaviour and the influences of health habits and social impacts could answer how gamified wearables can increase physical, mental, and digital well-being.

## 2.6 Types of Wearables

Today, most users of wearables have some sort of combination of an activity tracker and smartphone. Moreover, the experience is often limited to the step count and heartbeat. The next generation of wearables goes beyond conventional sports trackers and smartwatches and involves extended reality (e.g. augmented reality, virtual reality) devices, smart clothing, and industrial wearable utensils (Ometov et al., 2021).

The classification of wearables can be viewed from various perspectives, like the application or battery type they use, et cetera. From the consumer point of view, the most intuitive way to classify them is related to the wearable placement on the body. The wearables can be divided into four categories based on body placement (Figure 2) (Ometov et al., 2021).

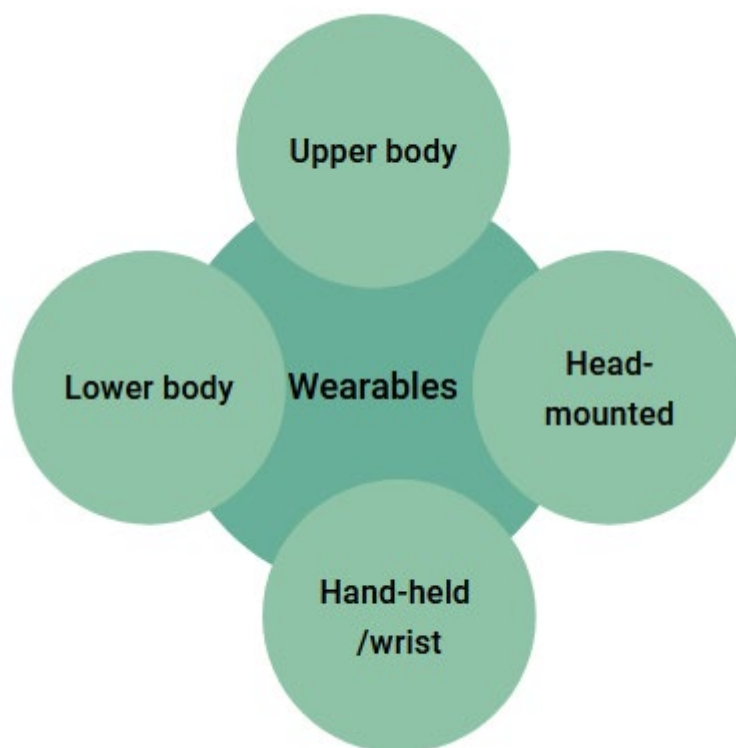


Figure 2. Wearables are divided by placement on the body (adapted from “A Survey on Wearable Technology: History, State-of-the-Art, and Current Challenges” by Ometov et al. 2021. p. 6.)

Wearables worn on the upper body can be divided into three groups: near-body (e.g., e-patches, smart bands, tracking sensors), on-body (e.g., EEG [electroencephalogram] monitors, posture correcting devices, smart clothes), and in-body wearables (e.g., implantables, tattoos). (Ometov et al., 2021) An example from this category is a posture trainer Upright Go S. The small wearable is designed for the office-workers to maintain a healthy posture while working on the computer. When paired to an Android or iOS application, the user can follow the statistics and get feedback on the patterns of their posture (Lawrence, 2021).



Head-mounted wearables include head-mounted displays, mixed reality glasses, masks, audio headsets, audio assistants, and neural interfaces (Ometov et al., 2021). Big tech companies like Meta, Xiaomi, and Apple are launching their models of AR glasses. HTC has followed this trend by launching its Vive brand with wellness-focused flow VR glasses for regular and business customers. The headsets are designed to promote health and mindfulness and leverage technology to guide wellness. The Vive Flow head-mounted device is designed for personal use with a sunglasses-like appearance and stereo passthrough cameras to blend into life seamlessly. All new HTC's VR headsets utilise the gamified apps on Viveport service, including personal wellness and "light gaming", apps for health, productivity. They aim to guide a user's meditation and well-being throughout the day (Greenwald, 2021). It can be concluded that gamified wearables are more a potential and supported well-being device than a conventional technology people can wear.

Hand- and wrist-held is the most common type of wearables. This category includes smartwatches, -wristbands and -rings, and gesture control devices (Ometov et al., 2021). Most of the gamified wearables for health also fall into this category. An example that also applies gamification is Fitbit. The company designs wrist-held gadgets which aim to empower the user to live a healthier and more active life. Their smartwatches and fitness bracelets can be enhanced with various applications to gamify wellness tracking (Fitbit, 2021).

Lower-body wearables include, for example, smart shoes, -socks, -belts, insoles, and -pants (Ometov et al., 2021). Sensoria Fitness (2021) posits that their Smart Socks can aid the users in improving the running factors, including speed and foot landing. When paired with an app, a virtual coach provides real-time feedback and even helps to prevent injuries. Users can set short- and long-term goals and follow their progress in the application.

As the examples show, the variety of wearable technology is great, and the devices are used to track and enhance wellbeing in multiple ways. The hope with these devices is that they would aid people to obtain healthier lifestyles and habits (Sharon, 2017). The gadgets are becoming more affordable, comfortable and their processing power, including data storage, processing capabilities, image resolution, and more, is improving.

## **2.7 Risks and Limitations in Gamified Wearables**

Change always comes with risks and troubles. A good scientific approach tries to investigate all sides of a phenomenon and not concentrate only on the positive. Various studies have assessed the risks and troubles in using wearables.

Privacy risks arise in any system that handles personal data, and health-related data is at the top of the list of data people want to keep personal. According to Xue (2019), the manufacturers' image of safe products raises the intention to use the devices. Still, the users are not aware of what kind of attacks can be made against their devices and are not doing much to prevent the potential threats. Smart wearables collect and transfer a large amount of personal data that can be valuable to different stakeholders. The data can be used to profile the user for advertisement or blackmailing purposes, for example. According to Mavroei et al. (2019), some design choices of gamification conflict with privacy requirements, and thus the privacy risk may increase when using gamified wearables.

Safety risks can be caused by the physical attributes of the devices and the way people use them. An example of a physical risk factor is radiation or electric shock caused by the near-body or on-body device. Smart glasses and other head-mounted wearables can cause headaches and dizziness (Xue, 2019). Several studies have concentrated on the risks caused by users interacting with smart devices while driving. The results show that, for example, smartwatches make driving more dangerous (Xue, 2019). It would be easy to speculate that adding immersive gamification would heighten these risks.

Performance risk means that the products might not work as expected. Data from several studies suggest that the higher the performance risk, the fewer people are willing to use the devices. An even bigger problem is if the health-related devices give wrong results (Xue, 2019). In a worst-case scenario, that might lead to severe mistreatment and even death. Even if the effects are not that dramatic, the benefits of gamified wearables disappear quickly if their measures cannot be trusted.

Social and psychological risks can coincide, affecting each other. Intelligent wearables can be considered intrusive and a threat to autonomy. Some recent studies suggest that it is possible to become addicted to the devices (Xue, 2019). Addiction to games is also a growing issue, and gamification uses the elements of games that increase addiction (Hyrynsalmi et al., 2017).

Other risks include time and economic loss and potential damage to the environment (Xue, 2019). Austen (2015) warned about the substantial mobile traffic generation of the wearables already in 2015. Data centres and data transmission networks each consume about 1% of global electricity. Most of the network data come from video streaming and games (IEA, 2021), both of which are rapidly growing in gamified wearables.

Although they come with some risks, wearables are not the only challenge in improving well-being using gamified technology. Gamification also presents some prevailing challenges, especially in regard to enduring positive change. In Singapore, a nationwide campaign attempted to increase physical activity. Free wearables were distributed, and typical features of gamification, such as daily rewards, game-like features, and different themed challenges, were used to encourage residents to increase their daily steps. Chew et al. (2021) analysed the data and found that although an increase in daily steps during the campaign suggested that physical activity did improve, this effect was only observed while daily rewards were awarded. Once no rewards were given, daily steps decreased again. This suggests that although a nationwide campaign using multiple technological and behavioural techniques did motivate many people to be more active, this motivation is not a long-term and lasting effect, as participants' external motivation was likely stronger. These findings align with Zhao et al.'s (2020) research into a personalised and gamified fitness assistant. They found that while pure gamification increased users' interest and engagement, the influence was brief. However, they found that personalised content had a positive long-term effect on the user's attention and activity level and helped maintain their habits. The personalisation was possible due to player modelling, considering users' behavioural patterns and adjusting accordingly to enable consistently good experiences. This study provides a possible link to overcome some of the challenges faced by gamified wearables.

### 3. Discussion

As mentioned in the literature review, a sedentary lifestyle affects well-being negatively. Many wearables, especially wrist-held trackers and smartwatches, aim to increase the activity of users' behaviour. However, the changes are not often permanent. Gamification can be used to create motivational benefits and increase engagement and happiness. The individual's motivation is essential for permanent change. In addition, mood and emotion are essential factors in motivation. QS practices create data and provide biofeedback. Feedback is one of the core elements of gamification. Therefore, QS is a good base on which to build more gameful wellness interventions. Gamification can increase the motivation to use self-tracking gadgets and applications. It can thus be suggested that gamified wearables can have a significant effect on well-being.

An initial objective of the essay was to identify how gamified wearables can impact physical and mental well-being. Wickramasinghe et al.'s (2019) qualitative and empirical analysis proved some fundamental guidelines for gamified wearables, such as game approach, rewards, and emotional support, evoked users' interest in the tool, and game approaches indeed have potential to the current well-being therapy formats and engage users to behave accordingly besides the therapy. In terms of business and organisation, Hammedi et al. (2021) studied that gamification interventions of technologies aiming to increase frontline employees' well-being hold promise in terms of their effects on job satisfaction and engagement. These new technologies, including artificial intelligence (AI), wearables devices, virtual agents, robots, fundamentally impact humans (i.e., front line employees) and their well-being. This example reinforces the belief of research on how technologies can affect human engagement-facilitating and well-being. To conclude, most of the mentioned literature emphasised the potential of using wearable devices for gamified well-being activities: making the intervention more engaging, i.e., creative, playful, and happy; motivating users towards more sustainable physical and mental well-being behaviours; receiving higher user satisfaction towards the application; social aspects influence user's preferences in choosing wearables and types of well-being activities.

Based on the searched examples, there are not many properly gamified wearables besides smartwatches and fitness trackers that would aim to increase well-being. However, most wearables for well-being naturally include game-like elements, such as feedback systems and goal-setting. It is interesting to see future innovations in other types of wearables that use gamification to increase well-being. For example, AR glasses may have great potential on this front.

If people rely on gamified wearables to benefit their well-being, it is essential to understand the risks of their use. The statistics show that criminals are interested in health-related data (Deyan, 2021), which makes privacy risks considered when discussing gamified wearables. More information is needed on the users' data security behaviour when gamification is involved in gathering and applying the well-being data. Does gamification increase the risky behaviour of the users? Another big question is the energy consumption of the wearables and how it will increase with the growing number of devices and the increasing technical capabilities. For example, AR glasses can use high-resolution graphics in gamified applications, which leads to higher consumption.

## 4. Conclusions

The purpose of this essay was to determine how gamified wearables can impact the physical and mental well-being of their users. Gamification, wearables, and well-being are still searching for a union as interventions rarely include all three phenomena. Previous studies indicate that wearables are already used in well-being, and there are many devices on the market, but the potential of gamification is still in early development. Inventing ways to implement existing and new technologies with the help of gamification can bring wearables to a new level. The diversity of the devices in the market will increase, and new technologies can also be utilised in devices for the consumer well-being market.

Gamification of wearables can increase engagement in activities that enhance well-being. In gamification, it is crucial to understand how behaviours occur and what motivates them. Theoretical studies explain the inherent attributes of behaviour and how they occur to modify or influence behaviour. QS provides biofeedback, which can be used to drive gamification. Furthermore, it is necessary to consider the influence of social aspects on individuals' behaviours. The literature on individual behaviour with different personal preferences explained the decision-making process and supported that gamification can positively impact health and well-being, particularly for health behaviours on wearables.

Although studies have shown the potential of gamified wearables, their use also has risks and limitations. The risks have been distinguished concerning privacy, safety and performance, and social, psychological, and environmental risks. These issues might lead to users turning away from the devices if they feel that the devices can inflict data security issues, physical damage, or psychological and social problems. So far, the biggest challenge of gamification is the lack of positive, lasting effects in its use. Often using gamification provides a brief boost in engagement. However, some possible directions could be used to bridge those challenges.

Future research could investigate alternative ways of using gamification. For example, it was found that personalised content kept the user's interest, while gamification provided the initial attraction. Future research could investigate how these two aspects could be merged to provide long term, user-friendly approaches to personal well-being. Another knowledge gap is if gamification increases the risky behaviour of wearable users. The growing energy consumption is also something that should interest both researchers and manufacturers.

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