Competitive orientation as a basis for personalization of competition feature and its contents in mobile applications promoting physical activity

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Abstract

New technologies, such as web and mobile applications, propose a promising means for promoting healthier lifestyles. Behaviour change support systems (BCSSs) and persuasive systems are concepts that have been introduced to create a common grounds for studying such new technologies. Previous study has found that competition strategy, commonly used in persuasive systems, is perceived controversially both as motivating and demotivating for users. Furthermore, previous study has found that personalization of the system according to user characteristics can increase system persuasiveness. This thesis is one of the first studies to explore how the psychological construct of competitive orientation can be utilized as a basis for personalizing persuasive systems. More in particular, this thesis is the first study to explore how competitive orientation of an individual should be considered in the design of competition strategy. Two research methods were used: conceptual analysis and analysis of empirical data. Study results suggest that the competitive orientation of a user is one of the factors explaining the perceived persuasiveness of competition strategy. This study proposes that competition strategy should be personalized to match the user's competitive orientation. Furthermore, this study suggests that the persuasive systems design model should be extended to include a feature of self-competition to leverage the power of the self-developmental aspect of competition to motivate behaviour change.

Keywords
persuasive systems design, behaviour change support systems, competition strategy, self-competition, competitive orientation, personalizing, physical activity, mobile application

Supervisor
PhD, Professor and Dean, Harri Oinas-Kukkonen

Foreword

Dear readers,

I would like to take this opportunity to express my gratitude to a few key individuals who have helped me throughout my thesis journey. First and foremost, I would like to thank my thesis supervisor Professor and Dean Harri Oinas-Kukkonen for his support and thought-provoking conversations. His guidance and encouragement have been invaluable to me and helped shape the direction of my research.

Additionally, I would like to extend a heartfelt thank you to my friend Pekka Kähkönen who was a great help to me in testing the applications reviewed in the empirical part of my thesis.

I hope that my thesis will contribute to the advancement of the research field of persuasive systems. By presenting new insights and findings, I hope to further our understanding of how persuasive technologies can be designed and implemented to effectively influence human behaviour. Through this work, I strive to make a meaningful impact and drive progress in this exciting and rapidly evolving field.

I hope that readers of this thesis will find it interesting and meaningful. The research presented here is the culmination of many months of work and I am eager to share it with a wider audience. Thank you for taking the time to read my work.

Henna Hyypiö

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Contents

1. Introduction

Lack of physical activity (PA) is one of the leading risk factors for mortality (World Health Organization, 2020). It is also connected with poorer quality of life (Saunders et al., 2020). In Finland, only half of the adult population meets the recommendation of 2 hours and 30 minutes of daily physical exercise (Finnish institute for health and welfare, 2020). World Health Organization (WHO) reports that more than a quarter of the world's adult population is insufficiently active (World Health Organization, 2020). In addition to not engaging in enough physical activity, people are becoming increasingly sedentary (World Health Organization, 2020). Sedentary behaviour, in turn, is related to various health problems such as cardiovascular diseases and type-2 diabetes (World Health Organization, 2020; Saunders et al., 2020).

The impacts that inactivity has on people's health affect both individuals and society. Individuals' quality of life suffers from reduced wellness, and the costs generated by the treatments of diseases fall largely on society. It is estimated that the direct costs alone caused by inactivity constitute about 1,5-3,8 % of all direct healthcare costs in developed countries (Kolu et al., 2014). The direct costs include expenses that are directly attributable to patient care. Indirect costs that are hard to estimate include, for example, costs resulting from sick leaves and loss of productivity. A further investigation by Vasankari and Kolu (2018) revealed that the total costs of inactivity rise to about 3,2 – 7,5 billion euros per year in Finland alone.

The increasing sedentary behaviour and lack of physical activity are battled against with various health interventions. However, interventions, including face-to-face contact with doctors or other professionals, are expensive and not available to everyone. The development of technology and mobile applications can tackle these problems by offering cost-effective solutions with a wider reach (Nibbeling et al., 2021). The global smartphone penetration was estimated at 78 % in 2020 (Statista, 2020). In recent years we have seen an increase in mobile applications aiming to help people increase physical activity. Mobile technology proposes a promising means of delivering health interventions because of the high penetration rate of the devices and because people carry their devices with them almost all of the time.

Despite the prominence of mobile technology, there is still considerable room for improvement. Generally, intervention studies report only small to moderate increase in physical activity levels (Gal et al., 2018; Romeo et al., 2019). Moreover, previous studies have reported that application use tends to decrease over time (Joseph et al., 2021; Direito et al., 2020; Leinonen et al., 2017). It has been suggested that both intervention engagement and effectiveness can be increased by personalizing the intervention content to match individual characteristics (Tikka & Oinas-Kukkonen, 2019; Schroé et al., 2022; Oyebode, 2021). It has been proven, that people with divergent personality traits respond differently to various persuasive features (Orji et al., 2017). However, the need for more insight into the user characteristics that should function as the basis for tailoring is stressed (Lacroix et al., 2009; Enwald, 2020).

In the previous literature, the persuasive strategy of competition has been reported controversially as both motivating and demotivating for users (Orji et al., 2014; 2017). A study by Fukuoka et al. (2011) stated that competition was reported among one of the four most motivating system features by the study participants. On the contrary, most of the study participants in the D'Addario study (2020) expressed avoidance to competition feature. Moreover, one of the study participants had commented that he would rather

exercise for personal motives than for competing. He had stated that "Everything I do is for a comparison with myself: I like seeing my own improvements." Orji et al. (2017) have tried to address the issue in a study where they explored how persuasive system features should be tailored based on the BIG 5 personality traits of the users. The study confirmed that competition strategy does not motivate all users equally (Orji et al., 2017). However, the Orji et al. (2017) study was not able to take into account the multidimensional character of the competitiveness trait present in humans. It should be noted that individual competitiveness is not merely a desire to compete or a lack of it (Orosz et al., 2018). Competitiveness can emerge as being focused on the self and ability improvement instead of as a mere desire to compete against others.

To summarize the research motivation: first, previous study has reported the persuasive strategy of competition controversially as both motivating and demotivating for users. Second, previous study has found that intervention engagement and effectiveness can be increased by personalizing the intervention content to match individual characteristics. Finally, so far, it has not been studied how the multidimensional trait of competitiveness can inform the process of design and personalization of persuasive systems. Thus, the main research question of this thesis is:

- How and to what extent can and should competition strategy be personalized to consider the different competitive orientations of individuals?

This thesis has three sub-questions to help answer the main research question. Sub-questions are:

- What are the different ways competition strategy has been implemented in mobile apps promoting PA?
- To what extent has the competition strategy been personalized in mobile apps promoting PA?
- How do the different ways of implementing the competition strategy support individual differences in competitive orientation?

This thesis uses conceptual analysis together with analysis of empirical data to study the research problem. Empirical data from existing applications is gathered to form an understanding of the ways competition strategy has been implemented and personalized in existing applications, i.e., empirical data is gathered to answer the first two sub-questions. Conceptual analysis is used in creating new knowledge to help us understand the research problem by establishing connections between existing theories. The main research question and the third sub-question are answered by using both the conceptual analysis and the empirical data.

This thesis is one of the first studies to explore how the psychological construct of competitive orientation can be utilized as a basis for personalizing persuasive systems. More in particular, this thesis is the first study to explore how competitive orientation should be considered in the design of competition strategy in applications promoting PA. This study highlights the need to consider users' different competitive orientations when designing a persuasive system. To enhance the persuasive power of a system, the competition strategy should be designed to support different competitive orientations of users. Thus, the findings of this study can help designers in making decisions about the implementation of competition feature. Finally, this study proposes that persuasive systems should also leverage the power of the self-developmental aspect of competition to motivate behaviour change by offering a self-competition feature that allows the user to measure, track and compare his own results and thus, compete against himself.

This paper is structured as follows: Chapter 2 presents the conceptual background of this thesis. Chapter 3 presents the study setting and research methods. Chapter 4 includes the results of the empirical study and the conceptual analysis. Chapter 5 consists of discussion and implications. Finally, chapter 6 presents the study conclusions.

2. Conceptual background

This chapter presents the conceptual background of this study. The chapter is divided into three sections: 2.1. includes an overview on persuasive systems, 2.2 presents previous study on mobile applications promoting physical activity and 2.3 discusses competition research.

2.1 Persuasive systems

This chapter discusses behaviour change support systems (BCSSs), the persuasive systems design (PSD) model, which is used in evaluation and design of BCSSs, and personalization of persuasive systems.

2.1.1 Behaviour change support systems (BCSSs)

New technologies have enabled the creation of web and mobile applications aiming to influence users in various domains, such as adopting a healthier lifestyle. A concept of behaviour change support system (BCSS) has been proposed for the purpose of creating common grounds for discussing the emerging applications (Oinas-Kukkonen, 2010). A behaviour change support system (BCSS) is defined as "a socio-technical information system with psychological and behavioural outcomes designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception" (Oinas-Kukkonen, 2013). Oinas-Kukkonen (2013) has suggested that two key constructs should be included in the study of BCSSs, namely Outcome/Change matrix (O/C matrix) and Persuasive Systems Design (PSD) model. The O/C matrix helps in analysing and designing the intent of the system, whereas the PSD model helps in analysing and designing the persuasiveness of the system. The foundations of the study on BCSSs rely on theories related to behaviour change. Some of the underlying behaviour change theories (BCT) include the theory of reasoned action, theory of planned behaviour, social cognitive theory, goal setting theory and self-efficacy theory. (Oinas-Kukkonen, 2013)

The O/C matrix describes the potential outcomes and changes of the system. The potential outcomes include the formation, alteration or reinforcement of attitudes, behaviour or complying. A forming outcome (F-Outcome) means the establishment of a new pattern in behaviour, for example, in the domain of improving physical fitness, taking daily walks. An altering outcome (A-Outcome) means changing an existing way of handling an issue, for example increasing the level of daily physical exercise. A reinforcing (R-Outcome) outcome means reinforcing some current behaviour or attitude, so that it becomes more resistant to change. A change related to complying (C-Change) refers to the end-user complying with the request of the system. For example, a goal of a health application might be to make sure that the user takes his daily medicine. The goal of the behavioural change (B-Change) is to accomplish a more enduring change in the behaviour of the user. The most difficult goal to achieve is the change related to the user's attitude (A-Change). The aim of the attitude change is to influence the end-user's attitude, not just the behaviour. The change in attitude will lead to the most enduring behaviour change. The O/C matrix thus contains nine possible outcome combinations as presented in Table 1.

Table 1. **O/C matrix. From Oinas-Kukkonen 2013, p.4.**

	C-Change	B-Change	A-Change
F-Outcome	Forming an act of complying (F/C)	Forming a behavior (F/B)	Forming an attitude (F/A)
A-Outcome	Altering an act of complying (A/C)	Altering a behavior (A/B)	Altering an attitude (A/A)
R-Outcome	Reinforcing an act of complying (R/C)	Reinforcing a behavior (R/B)	Reinforcing an attitude (R/A)

A system may have multiple intentions at once, but different intentions often require different strategies to be adopted in the systems. Therefore, it should be carefully considered, which of the nine outcomes are targeted. (Oinas-Kukkonen, 2013)

2.1.2 Persuasive systems design (PSD) model

Behaviour change support systems can be evaluated and designed using the persuasive systems design (PSD) model proposed by Oinas-Kukkonen and Harjumaa (2009). The model discusses the process of evaluating and designing persuasive systems through three steps.

The first step in the design consists of considering the seven underlying postulates that should be addressed always when designing persuasive systems. The first postulate states that information technology is never neutral. The system will always influence the user, regardless of whether it is intended or not. The second postulate states that people like their views about the world to be organized and consistent. Moreover, users will be more likely to be persuaded if the system supports making of commitments. The third postulate states that the key strategies to persuasion are direct and indirect routes. Direct route to persuasion uses facts and information to persuade users. The indirect route uses cues to persuade the user. The fourth postulate states that persuasion is often incremental, i.e., it happens through small advances toward the target behaviour. The fifth postulate states that persuasion should always be open. This means that users should always be aware of how they are being influenced. The sixth postulate states that persuasive systems should always aim at unobtrusiveness. I.e., the system should avoid disturbing users at inconvenient moments. The seventh postulate states that the system should always be useful and easy to use. The system qualities related to the seventh postulate refer to general software qualities such as responsiveness and lack of errors. (Oinas-Kukkonen & Harjumaa, 2009)

In the second step of the model, the persuasion context is analysed. This includes analysing the intent of the system, the persuasion event and the persuasion strategy. Focal to analysing the intent of the system, is to determine what the intended behaviour change is.

The persuasion event analysis includes analysing the use, the user, and the technology context. Analysing the use context involves revealing issues that are related to the particular problem domain, such as promoting health and well-being.

Relating to the analysis of user context, the model elaborates on a few of the most important factors. These include considering individual differences related to information processing and paying attention to different kinds of user motivations. It is also noted that

the user could be approached in a more holistic way. A more holistic approach would include taking note of a variety of factors relating to the user when designing the system. These include for example user's lifestyle, cultural factors, personality, attitudes and interests.

The persuasion strategy analysis is concerned with the analysing the message. The message arguments should be determined along with considering the delivery route of the message. Direct and indirect routes can be in use simultaneously and they can be supported by numerous system features.

Finally, in the third step, the model lists 28 persuasive strategies for system content and functionality. The persuasive strategies are also known as system features. The features are divided into four categories, namely, primary task, dialogue, system credibility, and social support. The primary task features include reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. Dialogue support features include praise, rewards, reminders, suggestion, similarity, liking, and social role. System credibility features include trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. Finally, social support features include social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition.

The goal is not to implement all possible features, but to select the most suitable features for the system in question. The most suitable features can be determined by doing a careful analysis of the persuasion context as presented in step two.

2.1.3 Low-level and high-level personalization of persuasive systems

In a recent article by Oinas-Kukkonen et al. (2022) the researchers clarify the concepts of tailoring and personalisation. Indeed, there is confusion about the use of the terms in articles discussing behaviour change support systems (Enwald, 2020; Akker et al., 2014). The Oinas-Kukkonen et al. (2022) paper suggests that tailoring is actually low-level or weak personalization. Tailoring, i.e., low-level personalization, is equal to targeting at a certain user segment. High-level or strong personalization requires the system to offer contents or services that are truly individualized. Strong personalization is linked with the PSD model's user context and designing true personalized software features requires a careful analysis of the individual user. Factors that could be considered when analysing the user include lifestyle, life circumstances and experiences, user characteristics, motivations, behavioural aspects, self-efficacy, interests, attitudes and personality (Fukuoka et al., 2011; D-Addario et al., 2020; Oinas-Kukkonen et al., 2020; Oinas-Kukkonen & Harjumaa, 2009). Oinas-Kukkonen et al. (2022) also point out, that to be truly strongly personalized, the system needs to constantly keep learning and adapting to the user, since over time, users' goals, needs, wants and preferences might change.

Personalizing system contents provided to the users means that all users are receiving the same set of features and only the contents of the feature is tailored (Oinas-Kukkonen et al. 2022). An example of this approach would be a feature where the user sets personal goals and receives personalized feedback based on those. Thus, all users have the same feature that allows the goal-setting and delivery of feedback, but the contents of the feedback is personalized. According to Oinas-Kukkonen et al. (2022), this is the prevalent approach in current behaviour change applications but more than that could be offered. High-level personalization could be improved by extending it to personalizing software features. Personalizing software features requires determining which features are relevant

for the user based on individual user characteristics. Finding out relevant facts about the user could be done either by using different types of sensors or by asking information from the user with questionnaires. Sensors can be used to get, for example, location or behavioural data (Hardeman et al., 2019). Questionnaires can be used to gather various types of data about the user, his habits, personality, and other characteristics (Oinas-Kukkonen et al., 2022). However, Schroé et al. (2022) propose that questionnaires should be kept at minimum. Users might perceive them as time-consuming and inconvenient, and this might lead to even the user quitting the system use. To conclude, it is also important to note the difference between personalization and customization. Customization refers to the system modification by the user himself and can be viewed as a form of personalization (Oinas-Kukkonen et al., 2022).

2.2 Previous study on mobile applications promoting physical activity

To form an overview of the topic of interest, this chapter aims to summarize the most important findings from previous studies relating to mobile applications promoting physical activity in sedentary adult populations. Relevant papers were searched for in the Scopus database. Several searches were also run in Google Scholar using various key word combinations. Papers were also identified by scanning the reference lists of the already identified papers and by scanning the reading lists of relevant courses offering by the University of Oulu. Some articles were also included based on suggestions by the supervisor of this thesis.

Research on mobile applications promoting physical activity has studied the topic from various perspectives and using different study methods. Emphasis in reporting about the findings of the relevant papers is on the issues that are in focus of this thesis. These include findings related to the employment of persuasive features, findings related to personalization of the applications and findings related to competition feature. In addition, this chapter offers a brief look into the study on gamification. Gamified systems can be viewed as a subset of persuasive systems and studies positioned within the gamification literature offer interesting and important findings related to the competition feature, and thus should not be overlooked. However, the focus of this study is not in gamified systems and therefore they are addressed only briefly.

2.2.1 Effectiveness of mobile applications promoting PA

There are already quite a few meta-analyses that go through intervention studies to provide information about the effectiveness of mobile applications promoting physical activity. A systematic review and meta-analysis by Gal et al. (2018) included eighteen randomized controlled trials that were analyzed to evaluate the effectiveness of mobile applications on promoting physical activity. The physical activity in minutes per day and daily step count were assessed to indicate change in activity level. The analysis showed a small to moderate effect on physical activity. The researchers note, however, that most of the interventions enclosed in the study, also included other intervention components, such as counselling, which might contribute to the effectiveness.

A study by Romeo et al. (2019) also provides evidence supporting the effectiveness of mobile phone applications to increase physical activity. The review included only six studies in the final meta-analysis to determine the effectiveness of mobile applications for increasing physical activity. Four of the studies were included also in the Gal et al. (2018) meta-analysis discussed above. The Romeo et al. paper emphasizes that mobile

applications appear to have a significant positive effect on promoting physical activity over a short-term period (i.e. less than three months) and efforts should be put into designing application features that increase engagement with the application over a longer period of time. The study also suggests that it may be more effective to try to influence a person's physical activity level alone rather than target multiple heath behaviour goals, such as physical activity and weight loss, at once.

A systematic review by Pradal-Cano et al. (2020) included fourteen interventions in the analysis. Four of included studies were also analyzed by Romeo et al. (2019). Except for one intervention, all were successful in increasing the physical activity of the participants. Pradal-Cano et al. researchers agree on the notion of Romeo et al. (2019) that there are not enough long-term studies to confirm the effectiveness of mobile applications in promoting physical activity in the long run.

2.2.2 Use of persuasive strategies in mobile applications promoting PA

There are studies that focus on analyzing the features, i.e., persuasive strategies, used in mobile applications promoting PA: their frequency and effectiveness in increasing physical activity. A paper by Mollee et al. (2017) reports on the analysis of a total of 169 applications promoting physical activity that were found in Google Play Store and the iTunes App Store between May and June 2015. The applications were analysed using a framework developed by the research group for the purpose of investigating the technological features used in the apps. The review revealed that the apps differ greatly in the number of features implemented in them. The most commonly implemented features in terms of the PSD model were self-monitoring and social comparison. The researchers state that, based on their review, it is not possible to make any conclusions about which application features contribute most to the effectiveness of the applications.

A study by Matthews et al. (2016) reviewed 20 articles to identify persuasive features used in the applications promoting physical activity. The persuasive features were reviewed using the PSD model. Similarly, to the Mollee et al. study (2017), the Matthews et al. review found that self-monitoring was the most commonly used feature. Other commonly implemented features found in the study, belonged to the categories of dialogue support and social support. Of these, the most commonly used were suggestion and social comparison, respectively. The competition feature was implemented by showing the user their results compared to those of others. Some participants found the feature useful, but for those that felt there was no possibility of 'winning' the competition, the feature was not supportive. This finding was also established in a study by Nibbeling et al. (2020), where a number of study participants explained that they were not motivated by competition since they felt that they would lose anyway. Based on their study findings, Nibbeling et al. propose that developers should avoid the use of competition strategy for novice exercisers. Furthermore, Matthews et al. (2016) found one category of features that was lacking in most the applications, namely credibility support. Over-all, the top six most frequently implemented features were self-monitoring (in 14 applications), social comparison (8), suggestion (7), liking (6), competition (5), social learning (5), and praise (5). It was also noted, there were many applications, that did not utilize the well-known and proven features. The researchers conclude that persuasive principles should be further included in the design of mobile health applications, since they have been proven effective.

While providing a list of features that appear as most effective, a review by Aldenaini et al. (2020) also offers a comprehensive overview about the current state of mobile phone-based interventions focusing on promoting physical activity and reducing sedentary behaviour. The study reviewed a total of 80 articles between 2006 and 2019. The PSD model was used in analysing the persuasive features of the studied systems. The study revealed that there is a need to extend the PSD model to accommodate for new persuasive features that are emerging as the technology advances. The review states that self-monitoring, personalization, reminders, praise, reduction, competition, tunneling and a variety of social support features appear as the most effective persuasive strategies. However, the researchers point out that since the majority of the reviewed studies employed more than one persuasive feature, evaluating the effectiveness of individual features is complicated.

2.2.3 Factors contributing to user engagement

A range of studies inform us about the factors contributing to user engagement. As stated in the introduction of this thesis, application use tends to decrease over time. Studies have tried to find out what are the reasons user dropouts and how could the system support use continuation.

A focus group study by D'Addario et al. (2020) aimed to identify application features that are judged important in increasing users' engagement. The need for tailoring the application was indicated by the participants of the study. In the co-design method used in the study, participants expressed the desire for a mobile app that would be flexible and adapt to individual circumstances, characteristics, motivations and emotions. The app should also read and detect individual's behaviours and based on all this information deliver tailored exercise suggestions. Goal setting and feedback were application features, that were preferred by most of the study participants, whereas social comparison, exhibitionism and competition were less liked.

A very recent study by Schroé et al. (2022) reports the results of a digital health intervention study called MyPlan 2.0. MyPlan 2.0 health intervention included a website and an optional mobile application that aimed to promote physical activity or reduce sedentary behaviour. The aim of MyPlan 2.0 was to investigate the reasons contributing to intervention attrition, i.e., the reasons why participants stop using the intervention. In the beginning of the intervention users created a profile where they included information about their goals, how they wanted to reach the goals, and how they would mitigate potential hindrances. The feedback and suggestions provided to the participants during the intervention were tailored according to the data users gave in their profiles. The overall attrition rate of the intervention was 47,9 %, which according to the paper is similar to other interventions. The most common reasons reported to stop using the intervention were time-consuming questionnaires, not having time for the intervention, dissatisfaction with the content of the intervention, technical problems, already meeting the PA/SB guidelines and for some, medical or emotional problems.

2.2.4 Use of personalization in mobile application promoting PA

Fourth, some studies have their focus in finding out how personalization or tailoring of the system can be utilized in applications promoting physical activity. Monteiro-Guerra et al. (2019) identified 28 papers including 17 different mobile applications promoting

physical activity that used personalization in the system. The application features employing personalization were analysed using a conceptual framework developed by Akker et al. (2014). Features that were reported using personalization, in terms of PSD model, included praise, rewards, self-monitoring, tailoring (system provides tailored information content), suggestion, recommendation, social comparison, competition, co-operation and recognition. In one of the applications reviewed in the study, the competition feature was personalized by comparing the user's performance with peers that are similar in behaviour but perform slightly better. In another application, the performance of the users in the competition was ranked based on how well the users achieved their own predefined goals. The study concludes that evidence on the effects of individual personalization strategies is lacking since the system effectiveness is mostly tested and reported as a whole.

A paper by Graham and Thomas (2015) reports results of a just-in-time adaptive intervention called B-MOBILE. Just-in-time adaptive interventions (JITAIs) use mobile technology, such as smartphones, to detect user behaviour, which in turn is used for delivering most relevant intervention content, at a time during which it is needed the most, or most likely will lead to desired behaviour. In the reported B-MOBILE JITAI, a smartphone equipped with accelerometer was used to monitor the sedentary behaviour of the user. When the SB had reached a pre-determined threshold, a prompt to encourage the user to take a walking break was produced. The B-MOBILE JITAI was reported being effective in producing walking breaks among the study participants.

A systematic review of JITAIs by Hardeman et al. (2019) offers a wider perspective on the usefulness and effectiveness of JITAIs in promoting physical activity. The fourteen interventions included in the review used behavioural data to prompt breaks after sedentary periods or to suggest physical activities in opportunistic moments. The study found mixed evidence for intervention effects on physical activity and sedentary behaviour. There was also lack of effectiveness, for example, regarding cost-effectiveness and engagement. The review concludes that research into JITAIs is in its early steps.

A study by Nibbeling et al. (2021) set out to get insights into the needs, wishes and preferences of individuals regarding the practical operationalization of the persuasive strategies of feedback, self-monitoring, goal setting, reminders, rewards, and social influence. The study points out that persuasive strategies described, for example, by the PSD model are quite generic. Research does not explain how the strategies should be implemented in practice. The study results describe multiple ways of implementing the reviewed features and show that individuals clearly have different preferences regarding the implementation type and design characteristics of these strategies. The conclusions of the study call for group and individual level personalization of application features. Similar findings were provided by a study by Sporrel et al. (2021), which found that the implementation and design of a persuasive strategy influence its effectiveness.

2.2.5 Gamification in applications promoting physical activity

Gamified systems can be viewed as a subset of persuasive systems where persuasive systems being the broader concept can include gameful design elements (Krath & von Korflesch, 2021). Gamification refers to the use of game design elements, like trophies and badges, in a non-game context (Deterding et al., 2011). Kari et al. (2016) extend the original definition of gamification by suggesting that gamification should be viewed both as a process and as an experience. The process of gamification uses activities to implement game elements to a non-game context with the aim of creating a more gameful

and enjoyable experience for the user, and thus motivating the user to behave in a desired way. The experience of gamification, in turn, refers to the user's gameful experience which can arise also from non-gamified features. Thus, a system feature, such as competition, can be perceived as gameful regardless of the intentions of the designer.

Gamification has been used in a variety of application domains such as learning, sustainability, crowdsourcing, and fitness (Krath & von Korflesch, 2021). Kari et al. (2016) study reports on the use of gamification in exercise applications. The study includes an overview of previous research which suggests that gamification can have both positive and negative effects on motivation towards physical activity. Differences arise depending on the individual user and the specific gamification solution. Kari et al. also note that the person's competitiveness is one of the individual characteristics that affect how gamification is perceived. A study by Shameli et al. (2017) provides more detailed information about factors that contribute to competition effectiveness. The researchers analyzed a large set of data on walking challenges to evaluate how competitions affect physical activity. The study reports that during walking competitions physical activity of an average user increases by 23 %. The study found that physical activity increases for both men and women, across all ages, and regardless of previous activity level. Furthermore, the study findings suggest that the composition of participants in a competition affect the dynamics of the game. Competitions benefit from having an equal mix of men and women, and the participants' performance levels being as equal as possible.

2.2.6 Summary of previous study

To summarize the information presented in this chapter, it can be concluded that mobile applications promoting physical activity are studied by the academia form diverse perspectives. There is unambiguous agreement that enough evidence exists to prove that mobile applications aimed at increasing physical activity can be effective, but the full potential of the systems is yet to be reached. Also, we are lacking long-term studies to inform us about the effectivity of mobile application in promoting physical activity in the long run. The presented reviews, that together cover a large number of studies, seem to agree on the most common features employed by the applications promoting physical activity. Self-monitoring and social comparison are features that stand out as the most used. However, no common understanding about which features mostly contribute to the effectiveness of the applications exists. Researchers agree that personalizing the applications to match user characteristics, needs, etc., along with grounding the system design in known behaviour change techniques, are ways to increase the persuasive power, effectiveness and engagement of the developed applications.

2.3 Competition research

Competition is an interdisciplinary concept that is studied in various fields of social sciences, such as psychology and management, and biological sciences, such as genetics. Research has found that there are numerous biological and socio-cultural factors that affect individual competitive behavior, how an individual experiences competition, and what the outcomes of the competition are. The outcomes of competition refer to the emotional and cognitive consequences and the learning and behavioral outcomes (Fülöp, 2009). There is no theory that would combine the findings of different disciplines to create a coherent body of knowledge that would explain and predict competitive behavior. However, some factors have been suggested to be more prominent in determining

competitive behavior. These include the competitors' personal characteristics, such as competitiveness as a personality trait, and the structural characteristics of the competitive situation. (Fülöp & Orosz, 2015.)

Chapter 2.3.1 discusses competitive orientation which is a construct that describes competitiveness by considering different facets of competitive attitudes. Chapter 2.3.2 discusses some of the situational factors influencing competition.

2.3.1 Competitive orientation

Competitive orientation refers to a person's thoughts, emotions and behaviours in competitive situations. Competitive orientation is known to have significant effects on achievement motivation and performance in achievement situations. Individuals are different in terms of their competitive orientation, which can have an impact on a variety of practical settings, including education, health, organizations, and sport. (Orosz et al., 2018.)

Until the 1990s, competitive orientation was viewed as a unidimensional construct where competition was defined as a desire to win in interpersonal situations. During the last three decades, however, the fields of personality psychology, social psychology and evolutionary psychology have identified more dimensions of competition. Based on prior research, Orosz et al. (2018) argue that competitive orientation is a multidimensional construct that can distinguish four different competitive orientations: hypercompetitive orientation, self-developmental competitive orientation, anxiety-driven competition avoidance and lack of interest toward competition. Table 2 presents the different competitive orientations. Hypercompetitive orientation is strongly result-oriented and hypercompetitive individuals desire and prefer to work hard. The focus is in winning over others even in ways where end justifies the means. Self-developmental competitive orientation is focused on the self and the ability improvement. The focus is in personal growth and mastery of the task. Anxiety-driven competition avoidance orientation is associated with general anxiety related to the process of competition. Anxiety-driven individuals tend to avoid competition, while they fear failure. Lack of interest in competition orientation is related to the disinterest towards competition. Individuals with a lack of interest towards competition are less concerned with others' expectations in competitive situations. In other words, they do not care about winning or losing. While an individual might have a dominant competitive orientation, the different orientations can co-exist in an individual. In addition to the competitive orientation of the individual not being clear-cut, competitiveness can change over life-course (Jurišević, 2020). In any case, the individual competitive orientation has a role in a variety of settings including education, health, and sport. Furthermore, different domains have different levels of importance to individuals and depending on the domain importance, competitiveness takes different forms and consequences (Jurišević, 2020). (Orosz et al., 2018.)

Table 2. **Competitive orientations.**

Competitive orientation	Description
Hypercompetitive orientation	Strongly outcome-oriented, focus on winning over others.
Self-developmental competitive orientation	Focus on self-improvement, not concerned with rivals.
Anxiety-driven competition avoidance orientation	Tendency to avoid competition for the fear of failure.
Lack of interest in competition orientation	General disinterest towards competitive situations.

2.3.2 Characteristics of competitive situation

A paper by Fülöp and Orosz (2015) list characteristics of the competitive situation that affect weather the competition is constructive or destructive in nature. These include fairness of the competition, the individual's chances to win (equal/unequal), size of the reward and the reward structure, perceived resources (limited/unlimited) along with the competition time perspective (short/long). In other words, in addition to individual's competitive orientation, there are other situational factors that influence the outcomes of competition. This is also implied by a number of studies examining the effectivity of applications promoting PA presented in 2.2. For example, studies by Matthews et al. (2016) and Nibbeling et al. (2020) found that users who feel that they have no possibility to win the competition, find competition demotivating. Shameli et al. (2017) study found that competitions benefit from participants' performance levels being as equal as possible. These findings emphasize the need for achievable competition goals and a well-matched competition.

3. Study setting and research methods

This chapter presents research methods used in this thesis. This study uses conceptual analysis together with analysis of empirical data to answer the proposed research questions. Empirical data is gathered by examining a number of existing mobile applications promoting PA. More specifically, empirical data gathering, and analysis focuses on the implementation of competition strategy in the chosen applications.

This study has one main research question and three sub-questions to help answer the main research question.

The main research question is:

- How and to what extent can and should competition strategy be personalized to consider the different competitive orientations of individuals?

Sub-questions:

- What are the different ways competition strategy has been implemented in mobile apps promoting PA?
- To what extent has the competition strategy been personalized in mobile apps promoting PA?
- How do the different ways of implementing the competition strategy support individual differences in competitive orientation?

Chapter 3.1. describes the central concepts of this study and clarifies their relationships to form the setting for the data gathering. Chapter 3.2. describes the research methods more in detail.

3.1 Competition strategy, other related persuasive strategies, and self-competition as an alternative competitive setting

This study aims to explore how and to what extent can and should competition strategy be personalized to consider the different competitive orientations of individuals. Thus, to clarify the study setting, this chapter briefly discusses competition strategy in relation to other closely related persuasive strategies. In addition, this chapter proposes self-competition as an alternative competitive setting and describes how personalization is considered.

3.1.1 Competition strategy in relation to other related persuasive strategies

The PSD model was discussed in general in chapter 2.1.2. This chapter explains more in detail the PSD model strategies of competition, social comparison, praise and rewards. These strategies are quite similar and thus it is important to highlight their differences to clarify the study setting.

The persuasive strategy of competition is a feature that offers the user an opportunity to compete with other users. The competition feature could be implemented, for example,

by enabling users to compete over who takes the most steps in a predefined number of days. The winner would be rewarded, for example, with a badge, trophy or points.

Closely related to the competition strategy is social comparison. Social comparison offers the user an opportunity to view and compare results with other users but does not involve winning or losing (Oinas-Kukkonen & Harjumaa, 2009). This feature can be implemented, for example, by providing a leaderboard to show users where they rank relative to other users. A leaderboard highlights comparison and stimulates competition but does not directly reward users for outperforming others and thus is different from the competition strategy.

Rewards is a feature that enhances system persuasiveness by providing users virtual rewards for performing a target behaviour. A user could be rewarded with a trophy, for example, if they complete an exercise activity. I.e., earning rewards does not by definition include competing in any form, and thus, can be implemented independent from the competition feature. However, rewards are often applied in conjunction with the competition feature, as the winner is rewarded some kind of a prize, such as a trophy, points or a badge for winning.

Praise is defined as words, images, symbols or sounds that are provided to the user to give them feedback based on their behaviour. The application could for example send the user encouraging notifications for reaching an activity goal. Like rewards, praise does not involve competition, but similar encouraging messages could be provided to the user as a result of winning a competition. Table 3 offers a summary of competition strategy and the closely related strategies presented in this chapter.

Table 3. Competition strategy and other closely related persuasive strategies.

	Principle	Example requirement	Example implementation
Competition	A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.	System should provide means for competing with other users.	Users compete over who takes the most steps in a month and the winner gets a prize.
Social comparison	System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.	System should provide means for comparing performance with the performance of other users.	Users can compare information related to their physical activity via application leaderboard.
Rewards	Systems that reward target behaviors may have great persuasive powers.	System should provide virtual rewards for users in order to give credit for performing the target behavior.	Heart rate monitor gives users a virtual trophy if they follow their fitness program. Game rewards users by altering media items, such as sounds, background skin, or a user's avatar according to user's performance.
Praise	By offering praise, a system can make users more open to persuasion.	System should use praise via words, images, symbols, or sounds as a way to provide user feedback information based on his/her behaviors.	Mobile application that aims at motivating teenagers to exercise praises user by sending automated text-messages for reaching individual goals.

3.1.2 Self-competition to provide an alternative competitive setting

Previous literature shows that competing against others can have harmful effects on individual's intrinsic motivation (Frederick-Recascino & Schuster-Smith, 2003; Orji et al. 2019). This is even more true when the individual feels that he does not stand a chance to win (Nibbeling et al., 2020). Self-competition provides a promising solution to providing an alternative competitive setting which does not include competing against others. Providing a competitive setting of self-competition can serve as a chance to finding the balance between the individual's skill and challenge that is key to achieving flow and for making the experience intrinsically motivating (Michael & Lutteroth, 2020).

Examining the definition of self-competition can inform the process of creating design suggestions regarding a feature that allows the user to compete against himself. Self-competition is defined as a type of competition where the individual is competing to beat his own personal best performances (Bönte et al., 2018; Howe, 2008). It has also been suggested, that one of the important conditions for competing is the possibility to measure the performance (Hurych, 2007). Indeed, how do you compare performances, if they cannot be quantified in any way?

Previous chapter clarified the differences between the persuasive strategies of competition, social comparison, praise and rewards. All these strategies are also closely linked to the suggested self-competition strategy. However, competition and social comparison are most similar to the suggested self-competition strategy, since they all include elements of measuring and comparing performances. To differentiate self-competition from both competition and social comparison strategies, self-competition should offer the user an opportunity to compete against himself by providing a way for the user to measure, track and compare his performance with his own previous results.

3.1.3 Personalization of competition strategy

Personalization of the competition strategy can take place at the software feature level or at the system contents level as described by Oinas-Kukkonen et al. (2022) and discussed in 2.1.3. Personalizing the competition strategy at the software feature level would mean that only users who based on their user characteristics are determined to benefit from the competition strategy have this feature employed in their applications. Personalization of the competition strategy at the system contents level, in turn, would mean that all users have the (implementation of the strategy) competition feature, just the contents of the feature is personalized. In addition to examining the level of personalization also the depth of personalization, i.e., weather high-level or low-level personalization has been used, should be examined.

3.2 Research methods

This study uses conceptual analysis together with analysis of empirical data to form an understanding of the research problem. Combining these two methods helps form a well-rounded understanding of the topic. Chapter 3.2.1 discusses conceptual analysis and the suggested guidelines and explains how this thesis attempts to conform to them. Chapter 3.2.2 discusses the gathering and analysis of the empirical data.

3.2.1 Conceptual analysis

The purpose of conceptual analysis is to create new connections between existing theories, link research across disciplines and provide our scope of thinking (Gilson & Goldberg, 2015). To create new knowledge, conceptual analysis involves assimilation and combination of evidence from previous research (Hirscheim, 2008). There are two alternative starting points for a conceptual study. The first option is to start from a phenomenon that can be observed but is not adequately explained by existing literature. The second option is to start from a theory, argue its uncompletedness, and introduce other theories to fill in the gaps. (Jaakkola, 2020)

In this thesis, the starting point for the research is the observed phenomenon that the competition strategy in persuasive systems is perceived differently by different users; some users find it motivating while others find the feature right down off-putting. While the phenomenon has been observed in numerous studies, there is no adequate explanation for it (D'Addario, 2020; Fukuoka et al. 2011; Orji et al. 2014; 2017; Kari et al.2016). From this starting point it follows, that the choice of theories or concepts that seek to explain the phenomenon should be based on their fit to the focal phenomenon, and their complementary value in conceptualizing it (Jaakkola, 2020). To clarify the roles of different theories presented in a conceptual study a distinction between domain theories and method theories can been made. Domain theories are theories that provide the "data" analogous to data in empirical research. Domain theory refers to a set of knowledge on a substantive topic area that is situated in a field or a domain. Method theories, in turn, are the theories used for studying the domain theory phenomenon at hand. I.e., the role of method theories is to provide some new insight into the domain theory. Method theories can offer explanations to concepts and relationships in the domain theory. It this thesis, the theory on BCSSs and persuasive systems along with the concept of personalization in the context of persuasive systems represent the domain theories where the focal phenomenon examined in this study lies. Method theory explaining the phenomenon, in turn, is the construct of competitive orientation.

Conceptual studies often focus on proposing new relationships between constructs. Thus, the aim is to develop logical arguments about the relationships and argue why the concepts are linked. In order to do this, the researcher must provide a theoretical explanation for the suggested link (Jaakkola, 2020). Arguments, in turn, have three critical components: claims, grounds and warrants (Hirscheim, 2008). Claims refer to the statements that the researcher is asking the reader to accept as true. Grounds refer to the methods and data used by the researcher to convince the reader. I.e., grounds comprise the evidence to support the claim in for example the form of facts, statistics, examples, explanations, prior literature, and logical reasoning. Finally, a warrant links the grounds to a claim. Warrants are the assumptions underlying the argument. The claims, grounds and the warrants that constitute argumentation for the proposed explanation of the examined phenomenon are provided in the next chapter: results. Moreover, figures are often used in conceptual studies since they offer the reader a means to understand the researcher's view of how the constructs are related (Gilson & Goldberg, 2015). Thus, results chapter will also provide a picture of the of the suggested relationships between the examined constructs.

Jaakkola (2020) suggests four types of research design in regard to conceptual studies: theory synthesis, theory adaptation, typology and model. In many cases, mixing of two design approaches is a viable option. This thesis uses the approaches of theory synthesis and model. The main goal of the theory synthesis approach is to enhance the understanding of the examined phenomenon; to reveal connections and to explain. Theory synthesis studies can also try to explain conflicting research findings as in the case of this thesis. This thesis aims to explain and understand why competition strategy has been reported controversially as both motivating and demotivating for users. The starting point of the study is the observed phenomenon and previous literature can be argued to address some aspect of it. A study adapting a model design aims to build a theoretical framework that explains and predicts relationships between concepts. This thesis draws on the approach, but the goal is not to create a framework which focal purpose would be to predicting the relationship between constructs. Model design study often also aims to identify novel connections between constructs, introduces new relationships between constructs and explains why a sequence of events leads to a certain outcome. The starting point of the study can be either a phenomenon or a concept. Literature introduced in the

study should address the key elements of the phenomenon that is to be explained. (Jaakkola, 2020.)

3.2.2 Empirical data on competition strategy in PA applications

Existing applications are studied to form an understanding about the ways competition strategy has so far been implemented in mobile applications promoting PA. Also, existing applications are studied to form an understanding about how competition strategy has been personalized. Empirical data analysis will provide answers to the sub-questions:

- What are the different ways competition strategy has been implemented in mobile apps promoting PA?
- To what extent has the competition strategy been personalized in mobile apps promoting PA?
- How do the different ways of implementing the competition strategy support individual differences in competitive orientation?

There are thousands of applications available in the Google Play Store relating to physical activity. For example, a search including the following terms: 1) active, 2) endurance, 3) exercise, 4) fitness, 5) gymnastics, 6) muscle, 7) shape, 8) strength, 9) training and 10) workout, carried out by Paganini et al. (2021) using a web crawler in 2018 produced a total of 6159 search results. Google does not offer advanced tools for refining the search and the only input the user can give for searching the Play Store is the search term. Therefore, the applications to be reviewed in this research are hand-picked using the following selection criteria:

- Must be for the purpose of promoting physical activity
- Operating system Android (Researcher has access to these apps)
- Number of downloads exceeds 10 million
- Rating >= 4
- Language: English
- At least the trial period offered for free
- Intended for general adult population
- Must make use of the competition strategy
- Usable without further equipment/program

The selection of the applications is limited to Google Play Store since the researcher has an android device to test the applications. Applications promoting physical activity are searched in the Google Play Store by using key words such as activity, exercise, fitness, and steps. Potential applications for review are also identified by searching from the internet. Sites that have reviewed and rated several activity applications are utilized in the initial screening. Only applications that have an above 4 rating and number of downloads exceeding 10 million are selected as candidates for review. The application language must be English, and it must have at least a free trial period. The application must be intended for adults. Once these criteria are met, the application is downloaded and checked for further criteria. The application must be usable without any further equipment such as a heart rate sensor or a sports watch. Finally, only applications making use of the competition feature are selected for review. Figure 1 below depicts the screening process.

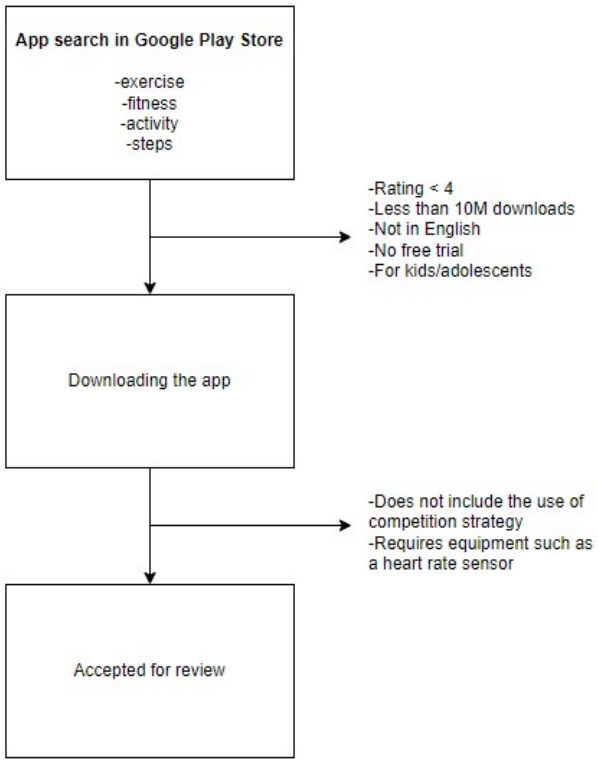


Figure 1. Application screening process.

Since the applications are hand-picked, it follows that the empirical study cannot be replicated. However, hand-picking the applications is a practical and feasible approach that considers the limitations of the available search tools on the Google Play Store. The selection criteria used for hand-picking is clearly defined and justified and aims to ensure the suitability and relevance of the applications for this research. By restricting the selection to applications that meet the stated criteria, it is possible to focus on a group of applications that are most relevant for the research problem. Hand-picking method allows for greater control over the selection process and ensures that the applications reviewed are of high quality and suitable for the target population.

The applications chosen for review are examined using the PSD model as a framework for analysis. Chapter 3.1.1 made a clear distinction between competition strategy and other closely related persuasive strategies. Moreover, chapter 3.1.2 introduced the concept of self-competition as an alternative competitive setting. Thus, data gathering is interested in the different ways competition strategy has been implemented in mobile apps promoting PA. In addition, it is studied if the applications chosen for review take use of self-competition strategy and if so, how has it been implemented. In addition, data gathering is interested in the level and depth of personalization of the competition strategy as discussed in 3.1.3. I.e., empirical findings aim to address the question of to what extent has the competition strategy been personalized in mobile apps promoting PA? The data is recorded to a table depicted below (Table 4).

Table 4. Competition and self-competition strategies in mobile applications promoting physical activity.

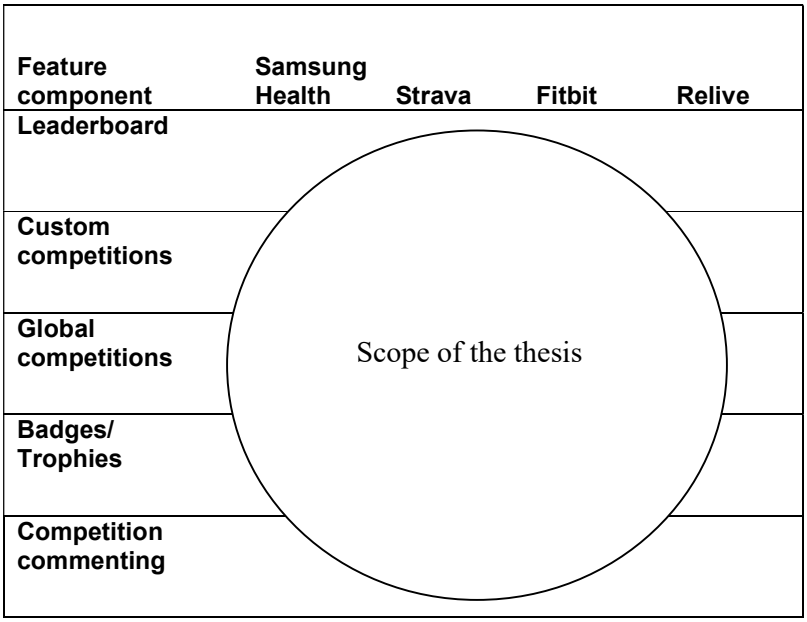
Application name	Number of downloads	Rating	Competition strategy implementation	Personalization approach in the competition strategy	Self-competition strategy implementation
App 1	-Number of downloads as informed in Google Play Store	-Rating in Google Play Store	*-Is competition strategy used in the application? If so, how is it implemented?*	*-How is competition strategy been personalized (level and depth of personalization)*	*-Is self-competition strategy used in the application? If so, how is it implemented?*

3.3 Data gathering

Four applications matching the selection criteria could be discovered and were included in the review. The applications were downloaded to the smart phone of the researcher for the review. The qualities of interest, as presented in Table 4, were explored. To ensure that rigorous data about the functionalities of the applications could be obtained, at least one walking activity was recorded by the researcher with each application. In addition, the competition feature of the application was tested by creating at least one competition with two participants involved. To enable testing of the competition feature with two users, a friend of the researcher was always asked to participate. This also gave information about the possible personalization of the applications. In addition to downloading and exploring the applications itself, the application web pages were searched for relevant information regarding competition and self-competition features and personalization of the application and its features. The applications were used by the researcher from a few weeks period up to a couple of months depending on the application.

Application information was recorded into an excel sheet presented in 3.2.2. In addition, details about the competition features were noted into a word document. Another excel sheet was created containing themes relating to the competition feature that appeared common to multiple applications. Competition feature details were then recorded into this excel sheet to allow for easier comparison, see Table 5.

Table 5. **Competition feature components.**



4. Results

This chapter presents the findings from empirical data and conceptual analysis. Chapter 4.1 presents findings from conceptual analysis, 4.2 from empirical data and chapter 4.3 discusses the findings considering results from both conceptual and empirical analysis.

4.1 Conceptual analysis

This chapter discusses how competitive orientation can inform the design and personalization competition strategy. Chapter 4.1.1 aims to create an understanding about how the persuasive system user's competitive orientation affects how competition strategy is perceived and what the implications are. Chapter 4.1.2 discusses how the construct of competitive orientation can inform the personalization of competition strategy. 4.1.3 presents a summary and a figure of the propositions based on the conceptual analysis.

4.1.1 Competitive orientations and the use of competition strategy

As stated in previous chapters of this study, prior literature has found competition strategy controversially as both motivating and demotivating for users (Orji et al., 2014; 2017). Competition research suggests that individual's competitive orientation is one of the biggest factors influencing the experience and outcomes of competitive situations, i.e., the emotional, motivational, behavioral and performance related outcomes. Thus, it can be reasoned that a user's competitive orientation affects how he perceives competition strategy.

How can the presented competitive orientations then inform the use of competitive strategy in persuasive systems? Firstly, *anxiety-driven competition avoidance-oriented* individuals experience anxiety in competitive situations. Thus, we can presume that these individuals will not benefit from system features that utilize the competition strategy, on the contrary, such features might even generate counterproductive outcomes. Second, users with *lack of interest towards competition* are not likely to benefit from the use of competition strategy. These users do not care about winning or losing and are therefore not likely to use the competition feature. Thus, it would make sense to show these users some other feature to increase system persuasiveness. Third, *hypercompetitive* individuals are motivated by competition and thus, competition strategy should be used in persuasive systems to leverage on their strong drive to compete and win. Finally, a third group of individuals who will not benefit from system features utilizing the competition strategy are individuals with the *self-developmental competitive orientation*. Individuals with this competitive orientation are concerned about self-improvement, not about how their potential rivals are doing. However, as stated in 2.3.1, while an individual might have a dominant competitive orientation, the different orientations can co-exist in an individual. Thus, the division of individuals, e.g., into four different user groups to form a basis for personalization of competition feature and its contents is not so clear-cut.

Chapter 2.3.1 presenting the study setting outlined the criteria for a self-competition feature. Self-competition was defined as a type of competition that allows the individual to compete against himself to beat his own personal best performance. By providing a self-competition feature, the system can offer users with self-developmental competitive orientation a way to challenge themselves and make the experience intrinsically

motivating. Thus, this study suggests that for users with the self-developmental competitive orientation, the competition strategy should be replaced with self-competition strategy. Relevant to note is that one of the important conditions for enabling competition is the possibility to measure the performance (Hurych, 2007). This prerequisite should be incorporated in the implementation of the self-competition strategy. Table 6 summarizes the findings regarding competitive orientation and the use of competition strategy.

Table 6. Competitive orientations and the use of competition strategy.

Competitive orientation	Description	Implications in regard to competition strategy
Hypercompetitive orientation	Strongly outcome-oriented, focus on winning over others.	Competition strategy should be used to leverage on the individual's strong drive to compete and win
Self-developmental competitive orientation	Focus on self-improvement, not concerned with rivals.	Competition strategy should be replaced with self-competition strategy
Anxiety-driven competition avoidance orientation	Tendency to avoid competition for the fear of failure.	Competition strategy should be discarded
Lack of interest in competition orientation	General disinterest towards competitive situations.	Competition strategy should be discarded

4.1.2 Personalization of competition strategy

Personalization is suggested by previous literature to have an impact on persuasive strategy preference, intervention engagement and effectiveness (D'Addario et al., 2020; Sporrel et al., 2021; Shameli et al., 2017; Tikka & Oinas-Kukkonen, 2019; Schroé et al, 2022; Oyebode, 2021). Thus, to maximize the persuasive power of the competition strategy, and that way to increase the system effectiveness, the competition strategy should be personalized.

Personalization can have a varying levels and depths as explained in 2.1.3. The level or personalization describes weather the personalization is taking place at the software feature level or at the system contents level. Feature level personalization means that not all users have the feature employed in their applications. Contents level personalization, in turn, means that all users have the same feature, just the contents of the feature is personalized. The depth of personalization describes the characteristics of the personalization in terms of how individualized it truly is. Low-level personalization means actually the same as tailoring, i.e., targeting at a given user segment. High-level personalization in turn, means that the system really offers individualized content for its users. Table 7 below presents the different personalization strategies in terms of their depth and level.

Table 7. Personalization strategies according to the depth and level of personalization. (based on Oinas-Kukkonen et al., 2022).

		Depth	
		Low	**High**
Level	**Feature**	Low-level personalization, i.e. tailoring of features. Different user segments might have different sets of features employed in their applications.	High-level personalization of features. Depending on their personal characteristics, different users might have different sets of features employed in their applications.
	Contents	Low-level personalization, i.e. tailoring of the contents of the feature. All users have the same set of features, but the contents of the features might vary with different user groups.	Strong personalization of the contents of the feature. All users have the same set of features, but the contents of the features might vary according to the personal characteristics of the user.

The previous chapter 4.2.1 discussed the ways in which competitive orientations can inform the use of competitive strategy in persuasive systems. Taking into account the different personalization strategies presented above in Table 7, in the context of competition strategy, the following personalization strategies presented in Table 8 can be adopted.

Table 8. Personalization strategies in the context of competition strategy.

		Depth	
		Low-level	**High-level**
Level	**Feature**	Competition feature is only employed in the applications of those user groups which are determined to benefit from the feature. E.g., the feature is only employed for Canadians since they are a nation characterized with a high level of individualism and competitiveness (Fülöp, 2009).	Competition feature is only employed in the applications of those users who are recognized as being hypercompetitive since hypercompetitive individuals are motivated by competition. --- Users who are recognized as having a self-developmental competitive orientation receive a feature that utilizes self-competition strategy.
	Contents	All users have the competition feature, but the contents of the feature is tailored based on user demographics, such as age, gender and level of activity. E.g., the user is competing only against those rivals whose physical fitness is similar to that of the user.	Detailed information about the user is utilized to personalize the contents of the competition feature to match the specific needs of the user to gain optimal motivational effect. The competition components, e.g. type of competition, rivals and competition price should be personalized to achieve optimal motivational effect.

Feature level personalization means that not all users are offered the same set of features. Some users receive the competition feature, and some receive the suggested self-competition feature. If the feature level personalization is done at low level, the use of

competition strategy is determined according to user groups. For example, competition feature would be employed only in the applications of Canadian users since it has been found that Canadians are likely to be competitive, and thus benefit from the use of competition feature (Fülöp, 2009). High-level personalization, in turn, would mean that users' competitive orientation determines the use of competition and self-competition features. There might also be users who do not benefit from either of the features. Regarding the contents level, previous research has shown that individuals have varying preferences for feature implementation (Nibbeling et al., 2021). This should be considered in the design of the competition feature. Competition type, goal, participant composition, price etc. are examples of factors that should be optimized to match user needs to achieve optimal motivational effect. This can be done either at the low level, i.e., group level, or at high level, i.e., relying on the personal characteristics of the users.

4.1.3 Summary

This study argues that competitive orientation is linked to how competition strategy is perceived by an individual. The claim inherent in this argument is that competitive orientation of the user should be considered in the design and personalization of a persuasive system promoting PA, in particular, in the design of competition strategy, to maximize system persuasiveness. The warrant, i.e., the assumption underlying the argument is that systems should be designed as persuasive as possible. The argument proposed is grounded in the theories presented in this study. Research on competition by various fields has found that there are numerous factors that affect how an individual experiences competition, and what the outcomes of competition are, as presented in 2.3. There is no theory to unambiguously explain and predict competitive behaviour, but some factors have been suggested to determine it more than others. Competitiveness as a personality trait is one of them. State of the art research on competitiveness suggests that competitiveness is a multidimensional construct that can distinguish four different competitive orientations: hypercompetitive orientation, self-developmental competitive orientation, anxiety-driven competition avoidance and lack of interest toward competition. Thus, this study proposes that to some extent individual's competitive orientation explains how competition strategy is perceived and experienced by the user. Moreover, this study proposes, that competitive orientation of the user should be considered in the personalization of the competition strategy as presented in Table 8. Furthermore, this study suggests that competition and self-competition features should be personalized to match the user needs for optimal motivational effect. Figure 2 below depicts the relationships of the key concepts of this study. Mobile applications promoting PA have different ways of implementing the competition and self-competition strategies. There are four main competitive orientations that should inform the design and personalization of the competition / self-competition strategy which, in turn, has an effect on the perceived persuasiveness, effectiveness and engagement of the whole system.

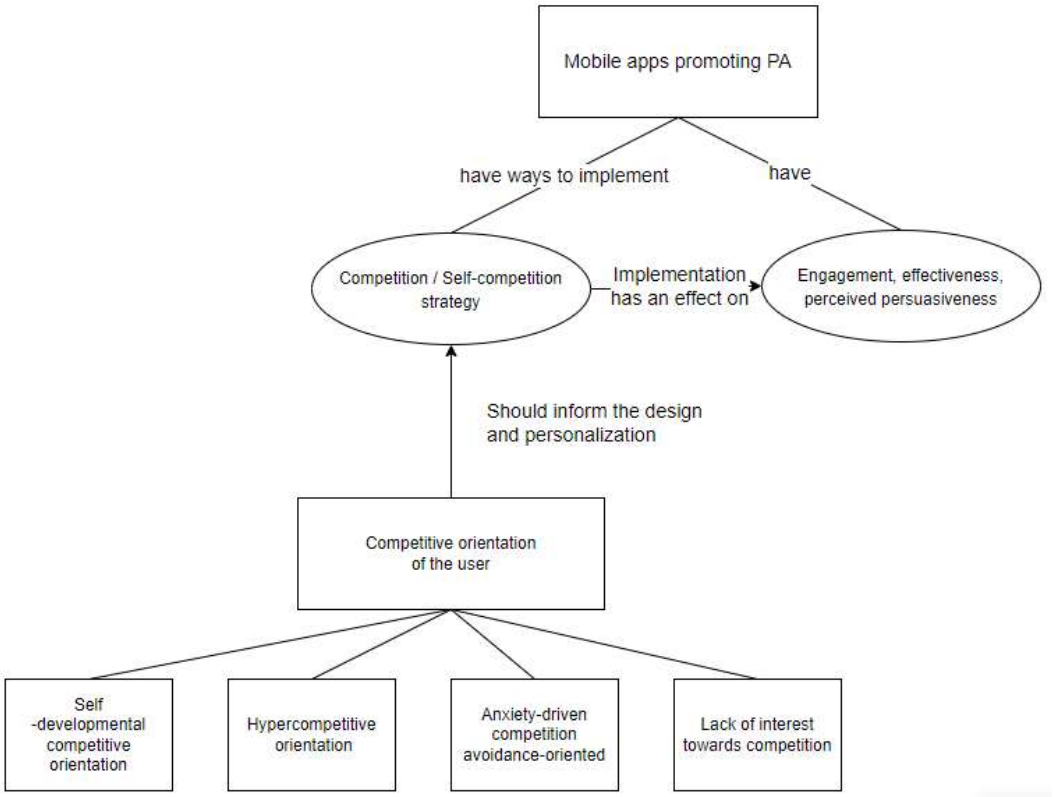


Figure 2. Relationships of the key concepts of this study.

4.2 Empirical findings

This chapter presents the findings of empirical data, i.e., the data extracted from the reviewed applications. 4.2.1 presents the ways in which the competition feature was implemented in the reviewed applications. 4.2.2 presents findings related to self-competition. 4.2.3 presents findings related to personalization.

Four applications matched the selection criteria provided in 3.2.2 and were reviewed. Table 9 provides a list of the reviewed applications. The number of downloads and rating refer to the information provided by Google Play. Date of data extraction refers to the date that the information about the number of downloads and rating were recorded from Google Play Store.

Table 9. Reviewed applications.

App name	No. of downloads	Rating	Date of data extraction
Samsung Health	1B+	4.0	24.11.2022
Fitbit	50M+	4.0	24.11.2022
Strava	50M+	4.4	2.12.2022
Relive	10M+	4.6	8.12.2022

4.2.1 Competition strategy implementation in the reviewed applications

The competition features of the reviewed applications had a lot of similar characteristics. All applications call their competition feature "Challenges". They all allow the user to create custom competitions where the competition components can be adjusted. In all applications the competition feature includes a leaderboard that shows the user how he ranks against other competition participants. In all applications, the competition feature also includes a competition message board that allows the competition participants to post messages throughout the competition. Finally, in all applications the competition feature allows the user to earn virtual rewards, such as trophies or badges. (Strava, 2022; Samsung, 2021; Fitbit, n.d.; Relive, 2022)

As stated before, all applications enable the user to create custom competitions. The customisable components of the competition included for example, the number of participants, the objective of the competition (steps, distance, etc.), and the duration of the competition. There are options for the user to invite friends to join the competition or to allow anyone using the application to join.

Strava, Samsung Health and Relive include competitions that are hosted by the application provider. They allow users to participate in competitions with even hundreds of thousands of participants from all over the world. For example, Samsung Health Global Challenges allow users from all around the world to enter a competition of monthly step count to compete over who takes the most steps in a month. Achieving goals in the challenge can earn users special digital badges. Strava Challenges, in turn, sometimes include even physical prizes that can be won by the challenge participants.

The leaderboard of the competition feature was used in all applications to show users how they rank against other competition participants. Figure 3 shows three different leaderboard implementations. The leaderboard typically includes the names and profile pictures of the participants along with their rankings and current scores.

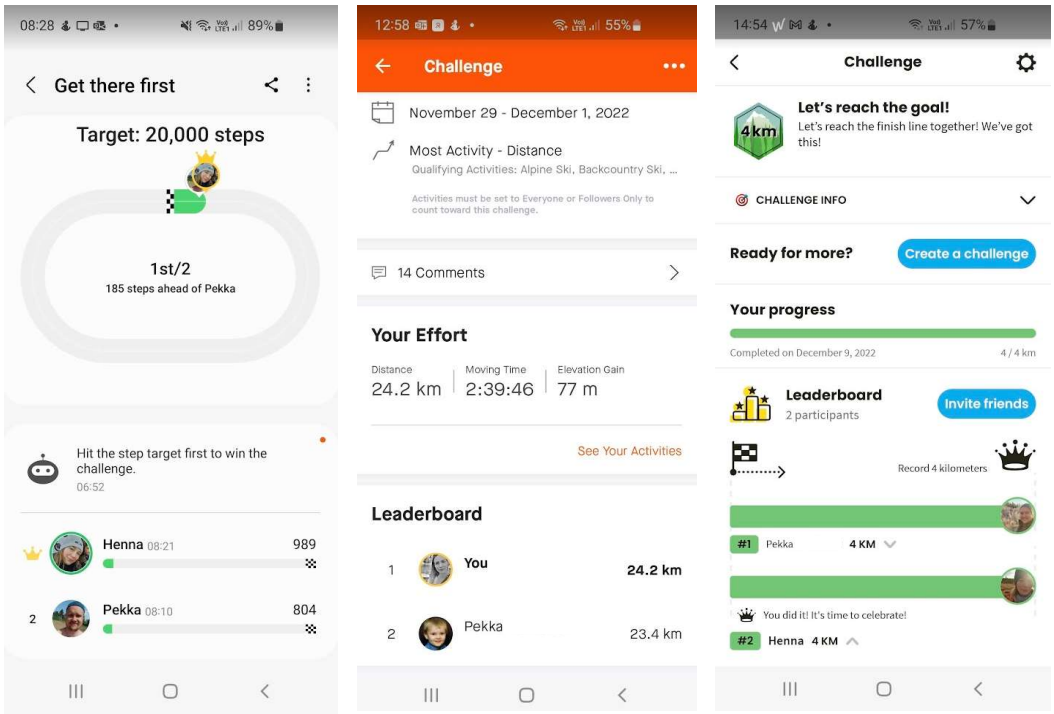


Figure 3. Leaderboards in Samsung Health (left), Strava (middle) and Relive (right).

Virtual rewards, such as trophies or badges, were used to reward the users for winning a competition. In Fitbit, for example, a user can earn a trophy by coming in first place in a challenge. Some implementations, e.g., the competition feature of Relive, include a pre-determined competition goal (e.g., reach 4 kms), and a reward, which is issued to all participants achieving the goal. Figure 4 below presents three different applications with their rewards.

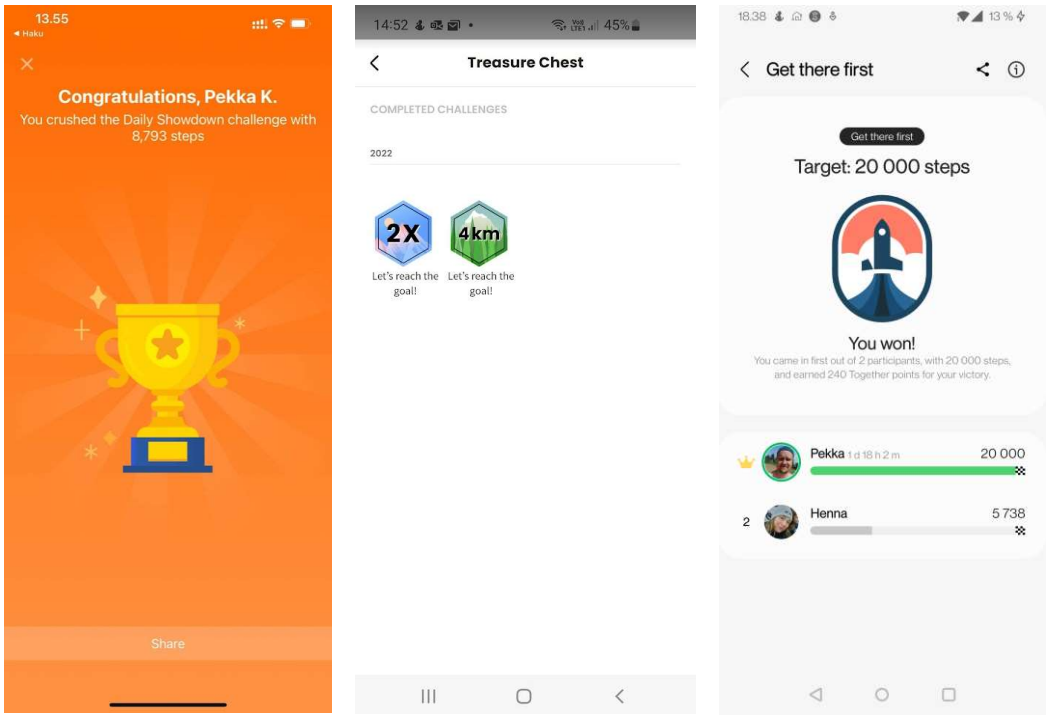


Figure 4. Virtual competition rewards in Fitbit (left), Relive (middle) and Samsung Health (right).

Overall, the competition features of the reviewed applications were composed of very similar elements. There were small differences, such as Relive competition message board also allowing to post photos in addition to text, and Fitbit custom challenges allowing your friends to invite their friends to join the created competition. Table 10 presents an overview of the competition feature implementation in the reviewed applications. The table presents the main components that could be discovered in the applications.

Table 10. Competition feature implementations in the reviewed applications.

Feature component	Samsung Health	Strava	Fitbit	Relive
Leaderboard	Yes	Yes	Yes	Yes
Custom competitions	User can create competitions on who reaches the set step goal first or who gets the most steps in a pre-defined time period. User can choose who to invite to the competition.	User can choose the sports included in the competition, and which participants to allow enter the competition	User can create competitions with up to 100 participants. The competitions can be about steps, distance, or active minutes.	User can create custom competitions with varying goals. Goals can be for example single, multiple or team goals and they can concern distance, duration, elevation or number of activities.
Global competitions	Users from all around the world can enter a competition of monthly step count to compete over who takes the most steps	Strava challenges have a goal for the users to strive for. Each user accomplishing the challenge goal will receive a badge	No	Relive Challenges that are created and hosted by relive and can be joined by any user.
Badges/ Trophies	Only the winner of a competition gets a badge.	Each user accomplishing the competition goal will receive a badge. Badges awarded also from global challenges.	Trophies can be earned by coming in first place in a challenge.	Badge is issued to all competition participants achieving the competition goal.
Competition commenting	Yes	Yes	Yes, including photos and videos	Yes

4.2.2 Self-competition strategy implementation in the reviewed applications

None of the reviewed applications included a clear-cut self-competition feature where the user would be competing to beat his own personal best performance as suggested by the conceptual analysis in 4.1.1. However, there were elements that well qualify as components of self-competition strategy. For example, in Fitbit a user can create a competition which can be performed solo. When creating a solo competition, it is stated in the application that the goal is to reach "your personal best" result (Fig. 5, left). The effective personal best result is, however, not indicated in the created solo competition in any way, nor is it discoverable in other parts of the application. Thus, the solo competition of Fitbit does not fully qualify as self-competition strategy as presented in 3.1.2. Self-

competition strategy should provide the user a possibility to measure, track and compare his performance with his own previous results and to purposefully aim to achieve a new record.

Another potential component of self-competition can be found in Relive. In Relive the user gets prompted for achieving various personal records, such as the longest or furthest activity (Fig. 5, middle). This alone does not qualify as self-competition either, since the user is not being purposefully encouraged to strive for these results. However, indicating that a personal best record has been achieved, is a essential component of a self-competition feature.

Finally, Samsung Health has an excellent way of listing the personal best results of the user (Fig. 5, right). However, the application does not have a feature that would encourage the user to break these. Overall, these components, that highlight the users' own personal best results, or challenges the users to strive for achievements alone, can be viewed as the building blocks of a self-competition feature.

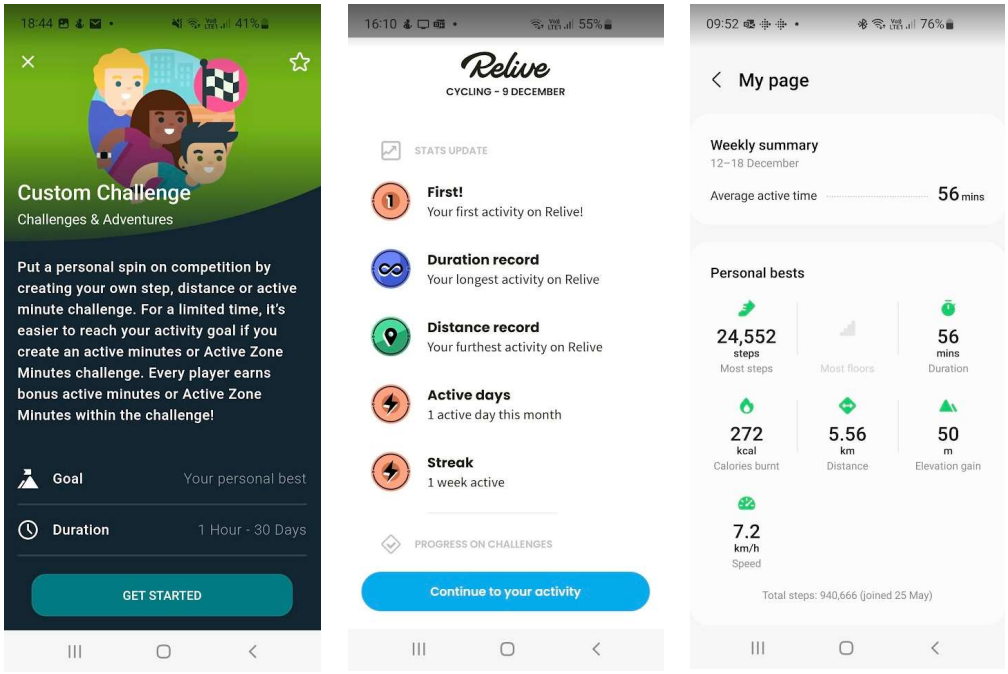


Figure 5. Solo competition in Fitbit (left), personal record prompt in Relive (middle) and personal best results in Samsung Health (right).

4.2.3 Personalization in the reviewed applications

Based on the examination of the applications and the information found on the websites of the application providers, it can be concluded that none of the applications include feature level personalization. Feature level personalization is personalization where the set of features offered to users are personalized to match a certain user group or the individual characteristics of the particular user. Furthermore, none of the reviewed applications used contents level personalization. All applications asked for some basic information about the user. These included things, such as name, age, gender and sports of interest. However, the empirical study indicates that the gathered information was not

used to personalize the competition feature contents in any way. Table 11 summarizes the findings related to personalization of the applications.

Table 11. Personalization in the revied applications.

		Depth	
		Low-level	**High-level**
Level	**Feature**	Low-level feature personalization was not used in any applications; competition feature was employed for all user groups.	High-level feature personalization was not used in any applications; competition feature was employed for all users.
	Contents	Low-level contents personalization was not used in any applications. Competition feature contents was the same regardless of the user group.	High-level personalization of the competition feature contents was not used in any of the reviewed applications.

Customization is defined as system modification by the user himself as explained in 2.1.3 and can be viewed as a form of personalization. In all applications, the competition feature allowed the user some customization by enabling the user to create custom competitions where, for example, the number of participants, the objective of the competition (steps, distance, etc.), and the duration of the competition were modifiable. The user could also choose whom to invite to participate.

4.3 Synthesis: Findings from empirical data and conceptual analysis

This chapter discusses the findings from empirical data and conceptual analysis together, to form an understanding about how the theoretical findings are portrayed in the reviewed applications. Chapter 4.3.1 discusses personalization of the competition strategy at the system level. Chapter 4.3.2 discusses personalization competition strategy at the feature contents level.

4.3.1 Personalization of the competition strategy at the system level

First, conceptual analysis reveals that competition feature could be personalized at the *feature level* either at low or high level as presented in Table 8. Personalizing at the low level would mean that application providers will try to find ways to distinguish user groups that will and will not benefit from the competition feature and deploy it accordingly. I.e., competition feature would be only employed in the applications of those user groups which are determined to benefit from the feature. None of the applications reviewed in the empirical study use this personalization strategy.

Regarding the high-level personalization at the feature level, conceptual analysis suggests that the competitive orientation of the individual should be considered to determine the deployment of the competition feature. I.e., users who experience competition as positive and motivation-enhancing, e.g., those who are hyper-competitive, would have the competition feature employed in their applications. Users who are recognized as having a self-developmental competitive orientation receive a feature that utilizes self-competition strategy. The empirical findings of this study indicate that the reviewed applications do not have any means to find out the competitive orientation of the user. As

described in 2.1.3, uncovering facts about the user for the basis of personalization can be done, e.g., by using different types of sensors, or by asking for the information directly from the user. When using the strategy of asking information directly from the users, competitive orientation could be defined by asking the user a set of questions relating to competitiveness, and users' behavioral and emotional reactions to winning and losing. However, no such questions were presented in any of the applications. Thus, it can be concluded that information about the user's orientation to competition is not obtained nor used in any of the reviewed applications. However, combining the data of the conceptual analysis and the empirical study, we can find ideas on how to implement a self-competition feature. According to conceptual analysis, a self-competition feature is a feature that allows the individual to compete to beat his own personal best performance. Empirical data, in turn, presented some elements of self-competition: for example, a possibility to measure and view data relating to one's performance records, and a possibility to compete solo to achieve a pre-determined goal. Combining the elements present in different applications, an example implementation of a self-competition feature can be outlined as follows: self-competition feature allows the user to create a competition with himself as the only participant. The competition is about the user trying to outperform his previous record in a given activity and performance measure (such as steps or distance). Table 12 presents the self-competition feature as suggested by this study with the principle, example requirement and example implementation.

Table 12. Self-competition feature.

	Principle	Example requirement	Example implementation
Self-competition	A system can motivate users to adopt a target attitude or behavior by leveraging on human beings' drive to compete against themselves.	The system should provide means for users to compete against themselves. User must be able to measure, track and compare his performance with his own previous results. The user's best performance must be indicated.	User can create a competition with himself as the only participant. The effective record of the given activity (e.g., number of steps in a week) is indicated in the beginning of the competition to encourage the user to purposefully aim to outperform his previous best performance.

4.3.2 Personalization of the competition strategy at the feature contents level

Conceptual analysis revealed that the *contents* of the competition feature should be personalized at low and/or high level. Low level personalization would mean that the contents of the competition feature is personalized to cater for different user groups. Empirical data findings show that all applications ask the user for some basic information, for example, relating to demographic factors and/or favorite activities. This data, however, was not used to personalize the contents of the competition feature. There are various ways in which the user data could be used to personalize the competition feature contents. For example, demographic data about the users could be used in dividing competition participants into different competition groups to allow optimal participant composition that, in turn, affects the competition dynamics as suggested in 2.2.5. Or, users

that have indicated that they have an interest for cycling, would have competition templates for organizing cycling competitions. High-level personalization, in turn, would mean that multiple factors contributing to user motivation are considered in personalizing the competition feature contents. In practice, this might mean that the competition components, e.g. type of competition, rivals and competition prize, are personalized to match the user needs. Empirical findings indicate, however, that none of the reviewed applications use this personalization strategy.

4.3.3 Summary of findings from empirical data and conceptual analysis

Based on the empirical findings, it is evident that the different ways of implementing the competition strategy do not support individual differences in competitive orientation. In the screening process of looking for applications to review, it became evident that there are numerous applications without any kind of competition feature (e.g., Google Fit and Sports Tracker). These applications cater for individuals who are not motivated by competition or self-competition. The applications that were reviewed and have a competition feature, offer it to all users despite the fact that there undoubtedly are users with such competitive orientations that they do not benefit from it. Users that are anxiety-driven competition avoidance-oriented, have a lack of interest towards competition, or self-developmental competitive orientation, are not likely to benefit from the competition feature. Furthermore, individuals with self-developmental competitive orientation would benefit from self-competition feature. However, none of the applications offer such a feature. Furthermore, competition and self-competition feature contents should be personalized to match the user needs. Empirical findings indicate, however, that this personalization strategy was not used by any of the applications.

5. Discussion and implications

Chapter 5.1.1 will present the main findings of this study by providing answers to the research questions. Chapters 5.1.2 and 5.1.3 present the empirical and theoretical implications correspondingly.

5.1.1 Main findings

This study included a main research question and three sub-questions. The first sub-question was: What are the different ways competition strategy has been implemented in mobile apps promoting PA? The empirical research of this study reviewed four applications that included a competition feature. The implementations of these features were quite alike. In all the reviewed applications the competition feature included a leaderboard, a message board and virtual rewards. All reviewed applications allow the user to create custom competitions but also include competitions that are hosted by the application provider. Some minor difference could be observed: e.g., one application competition feature included physical rewards, and another included predetermined competition goals.

The second sub-question was: To what extent has the competition strategy been personalized in mobile apps promoting PA? Empirical evidence of this study showed that the competition strategy has not been personalized in mobile apps promoting PA. The lack of personalization in the reviewed applications corresponds to the difficulty of implementing personalization reported by previous study. High-level personalization requires machine learning or other techniques, or elaborate questionnaires directed at users. Furthermore, the system would need to constantly keep learning and adapting to the user, since over time, users' goals, needs, wants and preferences might change. This notion is further supported by competition research that has found that the competitiveness of individuals changes over life-course (Jurišević, 2020). (Oinas-Kukkonen et al., 2022.)

The third sub-question was: How do the different ways of implementing the competition strategy support individual differences in competitive orientation? Conceptual analysis showed that there are four main competitive orientation that should be considered in the personalization and implementation of the competition strategy. Furthermore, conceptual analysis showed that the system can be personalized at feature level or at contents level. Empirical evidence indicates that feature level personalization was not used in the reviewed applications to serve the different competitive orientations of the users. The competitive orientations of the users were not considered in any way and the competition feature was offered to all users. Moreover, none of the applications utilized self-competition strategy to serve the self-developmental competitive oriented users. Thus, the potential motivational benefits to be gained from serving different competitive orientations were left unharvested by the reviewed applications. This is in line with the findings of previous study which has concluded that much can still be done in the area of personalization to enhance system persuasiveness. Empirical evidence found that contents level personalization was not used in the reviewed applications. However, the reviewed applications offered users possibilities for customization, which serves as a way for the users to fulfil their needs regarding at least some of the feature components.

The main research question of this study was: How and to what extent can and should competition strategy be personalized to consider the different competitive orientations of

individuals? Conceptual analysis of this study suggests that the competitive orientation of a user is one of the factors explaining the perceived persuasiveness of competition strategy. Users who are hyper-competitive, should have the competition feature employed in their applications. Users who are recognized as having a self-developmental competitive orientation should receive a feature that utilizes self-competition strategy. Users who are not motivated by competition against others or against themselves should have neither competition nor self-competition feature employed in their applications. Conceptual analysis also revealed that contents level personalization should be used to serve the different preferences users have regarding competition feature implementations. Competition type, goal, participant composition, prize etc. are examples of factors that could be optimized to match user needs and increase the motivational effect of the system.

5.1.2 Theoretical implications

Aldenaini et al. (2020) have suggested that there is a need to extend the PSD model to include some emerging novel persuasive strategies. This study suggests that the PSD model should be extended to include a feature of self-competition to motivate users with self-developmental competitive orientation. The principle of the self-competition strategy states that a system should motivate users by leveraging on human beings' drive to compete against themselves.

This study suggests that competitive orientation moderates the perceived persuasiveness of the competition strategy, and the perceived persuasiveness of the self-competition strategy. Competition strategy can be personalized at the feature level or at the contents level to enhance the motivational effect of the system.

5.1.3 Practical implications

System designers should recognize the need to personalize the competition feature at the system level as well as at the contents level. Self-competition should be viewed as one of the potential persuasive strategies for system content and functionality. Competition and self-competition features should be deployed to different users according to their competitive orientations. Offering the right set of features to each user will enable optimizing the use of the limited space in the application menu and ultimately lead to increased persuasiveness of the system. To overcome the obstacles of implementing personalization described in 5.1.1, the users could be given a possibility to choose for themselves, if they would like to compete against other users, against oneself, or if they would prefer not to compete at all.

System designers should recognize the need to personalize the competition also at the contents level. People differ in their preferences regarding feature implementations. Competition type, goal, participant composition, prize are components of competition feature that should be personalized to match the user needs.

Also end-users can benefit from this study. This study provides an explanation to why different people experience the competition strategy differently. By understanding and acknowledging the potential effect that the competition strategy has on their behavior, individuals are able choose an application that best suits their competitive orientation, and thus supports them in their behavior change. E.g., users who recognize themselves as being self-developmental, should try to look for an application that has a self-competition feature.

6. Conclusions

This chapter presents the research contribution (6.1), limitations of this study (6.2) and recommendations for further study (6.3).

6.1 Research contribution

This study was set forth to explore the contrasting evidence of competition strategy being reported by previous studies both as motivating and demotivating. The conceptual analysis of this study revealed that the user's competitive orientation affects his responsiveness to competition strategy. The findings indicate that there are individuals with such competitive orientations that they will not benefit from the use of competition strategy. For users who are anxiety-driven competition avoidance-oriented or have a lack of interest towards competition, the use of competition strategy should be avoided. There are also individuals, who are motivated by competition. Hypercompetitive individuals are driven by competition and should have the competition strategy employed. Users with self-developmental competitive orientation should have a self-competition strategy employed. Self-competition strategy is a new persuasive strategy suggested by this study to leverage on human beings' drive to compete against themselves.

Furthermore, this study exposed the limitations of non-personalized approaches to the competition strategy and presented design opportunities that will appeal to users with different competitive orientations. This study described the principle of a new persuasive feature *self-competition* and described its example requirement and implementation. The empirical research of this study found that the competition strategy implementations in the reviewed applications are quite similar and that the applications lack personalization in terms of the competition strategy.

6.2 Limitations of the study

This study has some limitations. First, regarding the empirical data gathering of this study, only four applications were reviewed. Furthermore, the applications were hand-picked using the criteria presented in 3.2.2. Thus, the sample of applications is not objective. The empirical findings cannot be generalized due to sampling method and sample size. Even though this study did not find any applications promoting PA that would have used a self-competition strategy, it does not mean that there might not be one (or many) available. Second, no systematic literature search was performed, so important literature could have been overlooked in forming the background of this study. For example, more extensive look into the gamification literature could offer valuable information that should be taken into account in this study. Finally, the results of this study may not generalize to other behaviour domains outside physical activity and therefore the study results should be applied with caution in other domains. In light of these limitations, the results of this study should be treated with caution.

6.3 Recommendation for further study

Although this study showed many interesting findings, it also opens up many new areas for further research.

First, this study used conceptual analysis to explain the relationship between competitive orientation and competition strategy. Conceptual analysis of this study suggests that the competitive orientation of a user is one of the factors explaining the perceived persuasiveness of competition strategy by the user. However, this study has not established a statistically significant causal relationship between the two concepts, neither does it tell anything about the strength of the relationship. Thus, a quantitative study is needed to confirm the relationship between perceived persuasiveness of competition and self-competition strategies and the user's competitive orientation. Multidimensional competitive orientation inventory (MCOI) could be used to assess the competitive orientation of the user (Orosz et al., 2018). Perceived persuasiveness could be measured by using the validated scale for assessing perceived persuasiveness as presented in Orji et al. (2017).

Second, chapter 3.1.1 described social comparison, rewards and praise, which are persuasive strategies similar to competition and self-competition strategies. Further study should investigate if the competitive orientation of a user also affects the perceived persuasiveness of these closely related strategies. This study could use the same measures of MCOI and perceived persuasiveness described above (Orosz et al., 2018; Orji et al, 2017).

Third, individual experience and outcomes of competition depend not only on the competitive orientation of the individual but also on other factors, such as characteristics of competitive situation as presented in 2.3.2. Further study should examine to what extent the competitive orientation of the user moderates the perceived persuasiveness of the competition and self-competition strategies, and what is the role of other factors, such as competition participant composition. Further study could also explore to how the characteristics of the competitive situation could be taken into account in the competition strategy implementation in order to maximize the effectiveness of the competition strategy.

Finally, this study was done in the domain of physical activity. Further study should investigate if the study results apply in other domains as well. For example, personalization and/or self-competition might be more widely used in other application domains, such as education and learning.

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