Camt-Run: Gamified Fun Run Events for Promoting Physical Activity

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Abstract—This work proposes the design and implementation of a method for the gamification application of running events in order to promote physical activity and it also proposes personalized gameful techniques or the gamification User Type Hexad framework. The application transforms the standard Fun Run event, which is normally included as a side event, and creates an event called "The gaming Fun Run" attached to marathon events and designed for people who are interested in either gamified applications or their health, allowing them to play and run at the same time. The application was used during the running event called "The Run Fest" to celebrate the 15th anniversary of the opening of Chiang Mai University's College of Arts, Media, and Technology. To evaluate the approach, we gathered both quantitative and qualitative data after finishing the event. Based on the results, we can conclude that the 701 participants, including 339 males and 362 females, were pleased and motivated to engage in physical activities. In addition, it can be concluded that running newcomers, 380 people, or 54.20% of all participants, were attracted to attend the running event and were able to complete the route, indicating that it was a successful promotion that enhances physical activity and health among newcomers in running through the application of gamification. Moreover, the approach demonstrated that the preference for gamified running events can recruit both experienced and new runners to join the running event.

Keywords—gamification, Fun Run, physical activity, competitive game

1 Introduction

The World Health Organization (WHO) has been concerned regarding the prevalence of overweight among teenagers for the last ten years. Such a population is grouped as a nutritional risk group due to insufficient eating habits and inadequate physical exercise habits. It is challenging to estimate and measure the effects of overweight and obesity and the widespread chronic illnesses connected with them [1]. Based on Bussiek et al., a survey found that around 110 million kids and young people in their twenties were considered overweight [2]. Long-term impacts of poor eating habits will result in obesity and a surge of lacking micronutrients, as well as the

emergence of chronic illnesses that, if ignored, will have long-term effects in adulthood [3]. 92 percent of teenagers aged thirteen to seventeen in America said they always went online once a day. Besides, 88 percent said they use a mobile phone, a desktop computer, or a laptop computer on a regular basis. It can be concluded that the use of electronic resources seems to be on the increase, particularly among teenagers [4]. Furthermore, on weekdays, one-third of present-day western employees spend much time at work [5]. As a result, daily workplace habits, such as how long a person gets to sit at work, what a person has for meals, and what a person drinks on their coffee break, should have a similar, if not more, consequence on workers' health than their personal ways of life. Unfortunately, because of the increased competition and specialization of occupations, nowadays' workplaces can significantly result in the various behavioral threats of chronic illnesses, such as type 2 diabetes and hypertension [6]. Therefore, it is a difficult task to promote a healthy way of living. Due to enticement, self-control difficulties, and poor routines, individuals usually fail to convert their health plans and wills into actions without additional personalized assistance [7]. Fortunately, the fourth industrial advancement may reduce the restrictions of typical health encouragement projects and provide a possibility for a significant breakthrough in the field of job-related health, thanks to modern developments in big data, sensor technologies [8], and the internet. Of these technical innovations, one particularly intriguing approach is the use of mobile gamification technologies to assist people in self-managing their iilnesses and/or adopting better ways of living [9].

In Thailand, an increasing number of running events have been held each year in various locations because Thai people have been interested in and concerned about their well-being. [41] stated that of all the running events held in 2018, 15 million runners had participated in those running events, while in 2016 there were a total of 12 million runners participating in such events.

In conclusion, while numerous studies have been conducted on the use of gamification in fitness apps to motivate people to exercise, none of them have used gamified mobile applications in a running event. The proposed studies for developing a mobile application based on the gamification approach include:

1. Determining a suitable design and implementing the innovative approach, gamification, in an application specific for running event;
2. Promoting physical activity and encouraging running event for former and new runners to participate.

Thereby, this research presents the design and implementation of a method for the gamification concept of the application specific for running events attract people who are interested in either the gamified application or their health. In addition, we tested and promoted our approach on the event of “The Run Fest” celebrating the 15th anniversary of the opening of Chiang Mai University's College of Arts, Media, and Technology, Chiang Mai University to verify the results of the application usage. Finally, our approach can assist the organizers of running events, game designers and researchers in the making of a feasibility study regarding the Gamified running events.

Regarding other sections in this study, we focus on related works, the design and development of gamified mobile application, results of the study, discussion, limitations, conclusion and future work.

2 Related works

2.1 Gamification in mobile application

The COVID-19 epidemic has brought important challenges to each and every teaching method in the world. Indeed, during this difficult and crucial period, the epidemic has afflicted more than 94 percent of the student population, demonstrating the severity of the widespread effect on education [34]. Furthermore, during the global epidemic period, there have been communication difficulties among pupils as well as between pupils and professors. Instructors had difficulty encouraging students in their lessons, and pupils' social relationships were weakened. Understandably, the relationship between instructor and student was often distant and one-sided. Providing an interactive teaching atmosphere, on the other hand, is critical for assist-ing pupils in structuring their education via action rather than passive involvement [35]. It is totally true that a learning environment can, in fact, enhance students' motivation for education, especially during this difficult time. According to [36], school administrators contribute to building an online educational environment in schools by assisting teachers with topics such as creating an online educational environment, using suitable technology devices, technological lectures, and using e-books as well as e-exams. Distant education and online learning technologies were hailed as education's saviors [34]. To make such online learning successful in enhancing students' performance, the following paper provided a Learning Styles approach in teaching students in an e-learning form. [37] indicated that Learning Styles can help in increasing the knowledge and engagement of students during the process of learning. Several methods that tailor the learning process to learners' needs and expectations yield greater academic achievement or have a favorable influence on the academic results [37]. In addition, mobile devices contribute to motivating students in learning. Children can learn and play while using mobile devices at the same time as they would engage easily with a touchscreen [38, 39]. Such technology provides an interactive interaction that is similar to a child's developmental knowledge construction.

2.2 Gamification in physical activity

It is recognized that gamification has become a method for motivating behavior change in a variety of areas, such as healthcare and health-related environments in recent decades. Gamification is increasingly used since it has been showed to increase individuals' engagement and it also enables them to be more in control of their health-related behaviors [34]. Agarwal et al. (2021), attempted to prove whether gamification with social support, with and without a loss-framed financial incentive, could truly promote physical activity among obese and overweight veterans. A gamified

mobile application was provided to all participants for tracking their step counts. The finding of the study revealed that when coupled with loss-framed financial incentives, gamification with social support was able to moderately encourage physical activity in veterans who are obese or overweight. Without incentives, gamification had no impact on physical activity [32]. Using financial incentives with gamification to promote physical activity in veterans may result in unsatisfactory outcomes because they may focus solely or mostly on financial incentives rather than their well-being. So, the developers who design what to use with gamification should consider what other promising approaches can considerably improve in encouraging physical activity. In addition, a gamified mobile application has been discussed and employed in the research of Cho at al. (2021) as well. They implemented gamification elements in mobile application trackers to test whether or not they had the potential in promoting physical activity. By doing so, they suggested gamification concepts, such as, social-based, reward-based, and goal-based gamification implemented in the mobile application trackers. The results demonstrated that gamification characteristics in the mobile application could be used to provide users with a sense of competence, ownership, and connectedness, as well as to improve long-term involvement and physical activity performance outcomes. Moreover, it made people desire social recognition and status in competitive social environments [33]. Nonetheless, implementing such gamification concepts in the mobile application trackers might not be adequate in keeping people engaged in physical activity. More gamification features are required to allow individuals to enjoy themselves while still engaging in physical exercise. To make it more exciting, the developers may consider implementing gamification on other platforms or technological devices [43]. In addition, [40] developed and gamified two fitness apps, one with social value and another with emotional value, in order to increase the user's engagement in physical activity. Following the usage of the fitness tracking application, the results revealed that both applications could promote the physical activity of the user. However, the one with social value demonstrates better performance in enhancing physical activity. Despite that, the app with social value should be applied in a competition event to enhance the app's performance in motivating the user to continue doing the physical activity.

Hence, to fill a gap in research, such gamified mobile application has not been applied in any running event. For this reason, we propose the design and development of a gamified mobile application which includes the popular Pokémon Go's basic game mechanics as well as personalized gameful techniques or the gamification User Type Hexad framework, which is to be used in the Fun Run event. We can make our application more fun and engaging by including Pokémon Go's core game mechanics, which keeps people engaged in physical activities and allow them to have fun during a marathon event. We also propose the development of a game based on personalized gameful techniques.

3 Proposed study and research questions

As we mentioned before in the introduction, this study aims to research and develop an application based on the gamification approach for running events. The proposed study contains the following steps:

1. Determining a suitable design and implementing the innovative approach, gamification, in an application specific for running event;
2. Promoting physical activity and encouraging running event participation among experienced and new runners.

To verify the effectiveness of our approach, we examined the effect of the application on the event of the 15th anniversary of the opening of Chiang Mai University's College of Arts, Media, and Technology. Moreover, the experiment aimed at verifying the following research questions:

- RQ1: What is the suitable design and implementation for the Gamified mobile application specific for the running event?
- RQ2: Can Gamified mobile application recruit and promote physical activity among experienced runners and new runners encouraging them to participate in the running event?

In order to verify the research question, we developed the application “Camt run” and used it during the event of “The Run Fest” celebrating the 15th anniversary of the opening of Chiang Mai University's College of Arts, Media, and Technology, Chiang Mai University. The gamified Fun Run events have been held to provide opportunities for people to share and exchange knowledge of creative art and digital technology. The mobile gamification Camt Run Fest is the highlight of these events because it has been designed with new functions, an interesting game plot, and a design to attract a large number of people who are interested in participating in or experiencing the innovation of games. Apart from attracting people to experience the game’s innovation, The Camt Run Fest also promotes health in new generations of people by raising their awareness on health issues and using gamification to make it more interesting and easier for them to take care of their health and have fun at the same time.

4 Designing the gamified Fun Run events

In order to design the gamified Fun Run event, we employed the framework of mobile gamification [17, 18] adapted from the MDA framework [19]. The overview of the design process of the gamified Fun Run events is showed in Figure 1. We describe the process step-by-step in the following section.

Fig. 1. The overview of the gamified Fun Run events design process

4.1 Determining objectives for promoting physical activity

With the intention of creating the software efficiently, we used the theory of a knowledge professional co-creation-based approach [20], which incorporates knowledge professionals who are promoted by a gamification application deployed in a field-based context. The framework's fundamental outline is to make sure that health promotion experts, runners, designers of games, and software engineers collaborate to comprehend and manage the constraints of the target users so that the users can take part in the application and obtain exercise benefits. It is important to correspond to the framework as we have to comprehend the viewpoint of each knowledge professional who operates the application, with aspects including the way of behaving, age, incentive, enjoyment factor, knowledge domain, and so on. For the requirements of the software, various aspects of knowledge professionals are considered, which might affect which game features should be included in the design of the game. The initial goal of the Camt Run app is to make it suitable for those who would like to exercise without the encouragement to workout; the second goal is to facilitate health promotion by influencing player habits so that it can promote a health-conscious mindset, similar to Pokémon Go [20].

4.2 Defining the core game flow and mechanics

This method comprises software needs from the earlier procedure that are relevant to mapping basic game mechanics to user interactions. Regarding defining basic game mechanics, the likelihood of the knowledge professionals' conception being mapped to user actions is noted. We started coming up with ideas to develop the idea of the game flow diagram after the software need was defined.

There are five stages in the Camt Run's game flow diagram. The essential idea of our main concept is to increase the involvement for the activity of running in the area of the faculty and the natural environment surrounding Chiang Mai University by incorporating game mechanics to explore new monsters along the running route, the method which has been proven to be successful in Pokémon Go's basic game mechanics encouraging physical movement [21]. It is to be mentioned that the players joining the gamified Fun Run event had a distance of 5 kilometers to run. The example of the core game flow and mechanics is shown in Figure 2. We described each step in the following sections:

Start the route. Before starting to play the game, we developed an activity flow for players to check the prior information of statistics, and adjust the game's settings, including an avatar, display name, and so on.

Route planning to tower map. Following the creation of a gaming account, when the player is on the route, a player symbol will be presented on a small map depending on the GPS position of the player. The featured map presents the "Tower," which helps guide the players when they start running throughout the location. The geolocation map, developed by Mapbox Vision's real-data geo-location of Chiang Mai University, is a real-time 3D map renderer that contains precise information on latitude and longitude as well as a heightmap.

Run to the tower area. We developed a gaming mechanism in this activity flow that requires the player to run to every checkpoint to catch the monster. The monster can only be found in the place of "Tower". In doing so, we wanted the players to explore and experience the various places in Chiang Mai University, such as woods, buildings, and the picturesque lake.

Capturing the monster. The participants can collect the monster's egg in their inventory only when they run around the place of the “Tower”. They can collect it by clicking on their mobile phone screen. Monster collecting is divided into two groups, which are aesthetic and taxonomic [22]. The difficulty level of collecting the monsters will be based on the type of the monsters, such as rare, super rare, and legendary. Aesthetic collecting is described as the collection of items that are not restricted in quantity and are based on personal preferences. The participants in this study will be required to grab all levels of monsters, including rare and super rare, as well as score and time. We created a legendary monster for taxonomic collecting, which increases the participant's interest in capturing both kinds of collection. There are thirty species for these three groups of monsters. The monsters are shown in Figure 3.

Finishing the route. The participant may stop running the route at the checkpoint when trying to capture the monster and checking the "Tower". At the end, the finish screen will appear and the system evaluates the route's score, time, and ranking.

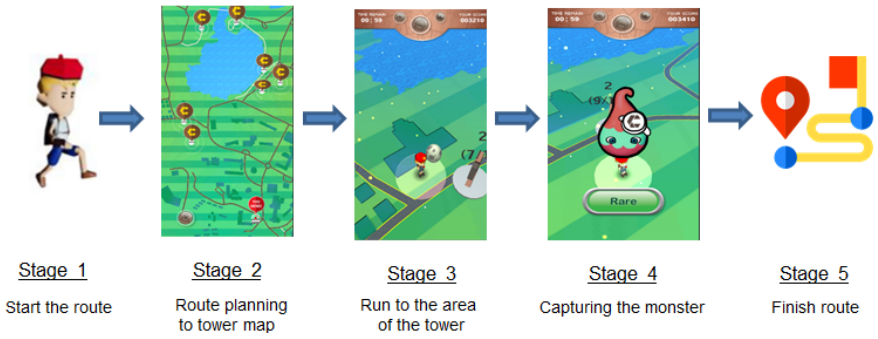

Fig. 2. Example of the core game flow and mechanics of the gamified Fun Run

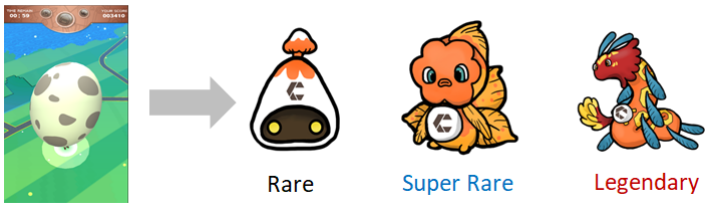

Fig. 3. Players collect the eggs of random types of monsters

4.3 Defining the game elements

Based on the flow diagram that we previously described, this approach is critical for gamifying the system since it allows us to choose appropriate game elements. Nevertheless, designing a first-design prototype with all the components of the game fitting within the game mechanics procedure is challenging. We planned to include several game components [23] in the initial loop of the spiral, including prizes, a leaderboard, a scoring system, and advancement levels. Furthermore, studies conducted by [24] and [25] looked at the effects of several game components and concluded that to increase the engagement of the user, the leaderboard and social interactions are the most suitable factors for that purpose. According to the study recommendations, we suggested that the leaderboard and social interactions are implemented first. Therefore, we separated the game components to be developed into two categories: required game elements and optional game elements (choice). The following game components were selected for inclusion in the Camt Run App according to their importance: The main game components have to be included in the basic mechanics system.

Leaderboard. It displays the top player and other players' names and scores. Leaderboards show the best performances of each player that are made available to others to enhance competition among the players [24], [26].

Score point. When the player performs an activity, he or she receives a score point. When players capture new monsters throughout their run, they earn points in this system. Bonus points are awarded depending on the amount of time left and the number and rarity of monsters caught by runners. To receive an actual badge award, all point values are evaluated for each profile of the player.

Map Progress Bar. Apart from displaying information during a run, we chose to include a map progress bar to update participants on their progress and encourage them to finish the route. Hence, the participants may keep track of how far they have to run or walk to complete the task.

Inventory system or collection. This is defined in a system, as a sense of possession achieved through the accumulation of items [27]. We offer an inventory procedure in our system that successfully eliminates the requirement to gather the number of monsters caught. If users still have the ability to pay for a monster or all types of monsters, including rare, super rare, and legendary, they should collect them in accordance with their types. Optional components are specified for pilot testing before a

decision is made on whether they should be included or excluded from the game mechanics process.

Choice. It refers to a user's capacity to make a decision from a variety of possible options [28]. We designed our game so that the users can create their own route planner allowing them to run to any Tower. Nevertheless, without a clear idea on which tower should be checked first, confusion among participants may occur. It is critical that every participant stays in the Flow Zone [29] without hesitating about the direction of running

Time pressure. It refers to a specific limitation that requires the player to finish a route in a specified period of time [30]. This game component challenges and stresses the participant to complete the route in a certain amount of time, or else the round will be lost.

Randomness. This is a lottery (a likelihood to win a big prize) component in the system, with unpredictable results every time you play [31]. We created a connection with the accumulation of game components to give the system a 10% and 0.1% likelihood of receiving super rare and legendary monsters respectively, and we also applied the randomization of scoring points after receiving super rare and legendary monsters. Consequently, even if players used the same technique, the final score for each play would be different.

Fig. 4. Example of implement game elements in gamified Fun Run

4.4 Defining of gamification user type Hexad

It is important to design personalized gameful techniques that fit each type of user, as the personalization of interactive approaches outperforms one-size-fits-all methods. Gameful techniques assist users in accomplishing their tasks, which frequently entail teaching them about certain issues, assisting them in changing their viewpoints or ways of acting, or involving them in particular subjects [32, 35]. The Gamification User Types Hexad framework [33] was developed by Marczewski which was founded on researches on human motivation, types of players, and practical design experience. Marczewski identified six user categories that vary in the degree of being driven by intrinsic or external factors as elements of motivation [33]. Philanthropists, the first user type, are driven by a sense of purpose. They are selfless and determined to offer

without asking for anything in return. Socialisers are driven by a sense of community. They seek to communicate with people and form social relationships. Autonomy motivates Free Spirits, or the freedom to express oneself and behave without external restraint. They enjoy creating and experimenting within a system. Next, Achievers are moved by competence. They want to advance in a system by accomplishing tasks or proving themselves by taking on challenging difficulties. Players are inspired by extrinsic benefits, with the intention of doing something to obtain a profit within a system, regardless of the kind of activity. The last type of user is Disruptors. They are influenced by the emergence of chance and prefer to disturb the system directly or indirectly in order to compel negative or positive transformations. They enjoy challenging the system's limits and pushing it farther. For the Camt Run App, we developed gaming systems to support and enhance all types of runners in running events based on these six user categories, as shown in Table 1.

Table 1. Description of user types provided in the gamified Fun Run

User types	Description
Philanthropists	Runners who are determined to help other runners who are lost on the route by giving directions to each checkpoint.
Socialisers	Runners who love to socialize and share information with other runners during competition.
Free Spirits	Runners who prefer to create their own route planner so that they can enjoy running and experience new spots in the university area.
Achievers	Runners who want to challenge themselves by trying to catch all levels of monsters, such as rare, super rare, and legendary, and finish the route in a specific amount of time.
Players	Runners who love to win a reward or lottery and compete with other players' scores displayed on the leaderboard.
Disruptors	Runners who tend to use many methods to get as many score points as they can when it comes to randomization of rewards.

4.5 Implementing the system architecture

This research proposes the implementation of the development of a system architecture applying the traditional Software Development Life Cycle model based on the spiral model. The application consists of frontend- and backend-based architecture. However, for the backend of the Fun Run event, we considered a distributed architecture for the massive real-time runner data exchange. We used three Linux servers as the operation system and developed the management system with the apache webserver PHP 5.6 and MySQL database. The geolocation data of the map was using Mapbox API (www.mapbox.com).The frontend of both the IOS and Android versions was developed by the Unity game engine with the data exchange between the client and the server using the JSON format. The detail of the system architecture is shown in Figure 5.

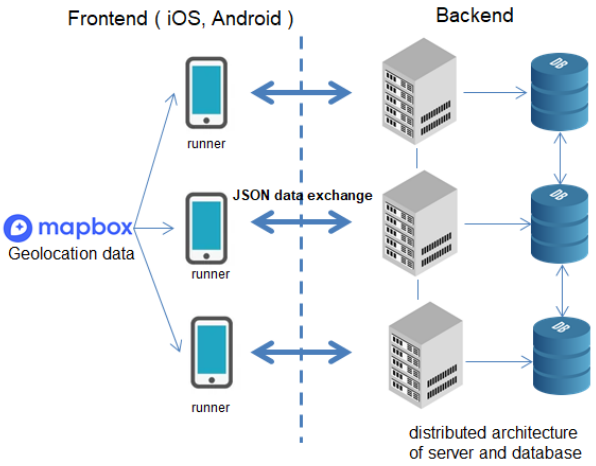

Fig. 5. Purposed system architecture of the gamified Fun Run

5 Research methodology

In this study we used the research and development method. According to [42] research and development (R&D) can use as the method to develop and produce a certain product and evaluate the effectiveness of the product. Moreover, the research and development can usually provide two objectives (1) to develop a product and (2) to evaluate the effectiveness of the product. In this study, we aimed to design and implement the concept of gamification in an application specific for running event. In order to evaluate the application, we gathered both quantitative (satisfaction questionnaire/ application usage) and qualitative data (open response question), which aimed to answer the research question.

5.1 Participants

We recruited the runners via social media platforms and the official Facebook page of the College of Art Media and. The total number of participants was 701 including 339 male and 362 female participants. Table 2 demonstrates the statistical data of participants in the running event. There were 701 participants in the running event, who were separated by age and gender. The majority of the participants who joined the event were males aged 15- 25, accounting for 156 people, while 169 females, aged 25–35, participated in the event. Regarding participants aged over 45, only 17 such people participated in the running event. Moreover, based on the participants' feedback on the question of "Have you ever participated or joined any running event?", it can be stated that 54.20 percent of the 380 respondents who attended the running event said they have never participated in any running event before.

Table 2. Demographics of the participants and statistical data

Group	Age	Sex		Percent
		M	***F***	
Gamified Fun Run (N=701)	15-25	156	122	39.65%
	25-35	120	169	41.22%
	35-45	55	62	16.69%
	> 45	8	9	2.42%
Total		339	362	100%
Have you ever participated or joined any running event?			Yes (n = 321) (45.79%)	No (n = 380) (54.20%)

5.2 Instruments

As we mentioned regarding the development process in section 4, we customized the application for the competition of the one-day event to celebrate the 15th anniversary of the opening of Chiang Mai University's College of Arts, Media, and Technology. The participants in the event could install both Android and iOS versions of the application directly from the Play Store and App Store respectively under the name "Camt Run".

5.3 Procedure

The participants were required to paid 300 baht (approximately USD 10) to join the gamified Fun Run competition event. The first, second, and third prize winners received 1500 baht, and another prizes were randomly awarded, including an IPAD, iPhone, Apple Watch, and a special prize for the best outfit throughout the competition. After finishing the competition event, participants were asked to take a questionnaire. Then, we analyzed the results for both qualitative and quantitative statistical data.

6 Results

6.1 Statistics and quantitative data

The total number of participants was 701 including 339 male and 362 female participants, while the total distance accomplished by all players was 1917.66 km and a total number of 23,425 monsters were captured. The dashboard of the data summary shown in a big screen LCD monitor at the start and endpoint of the competition is shown in Figure 6. We also collected a satisfaction questionnaire regarding our applications in order to improve the game design and for long-term studies. The demographics of the participants is showed in Table 2. We also evaluated the level of satisfaction by a short questionnaire with 5 Point Likert Scale, the results of which are shown in Table 3.

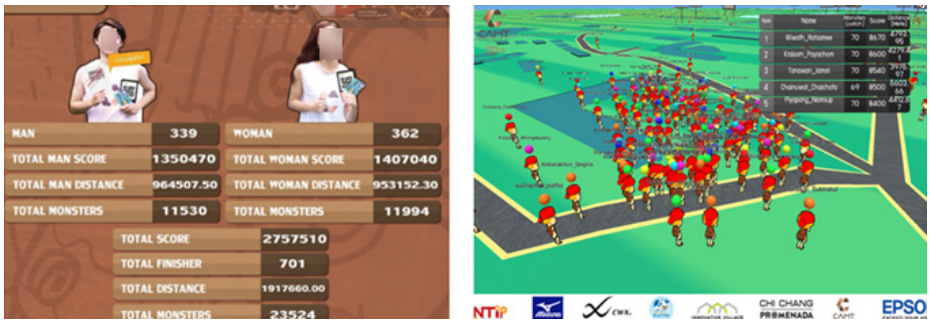

Fig. 6. The dashboard of the event data summary shown in a big screen LCD

However, based on the previous results the application proved to have positive effect only on the participants who have not reached the standard guideline for physical activity. Thus, we filtered the information of participants who have not reached which join our event. 190 from the total of 701 participants agreed to respond to the satisfaction questionnaire. The result was very convincing in terms of fun (4.42) and immersive experience (4.25) combining physical activity and game play. According to the results, we found that some participants felt that the game mechanics was not fresh (3.92) as it was very similar to the concept of Pokémon go and others had many issues (3.84) during the game such as the consumption of mobile phone battery, crash during competition, or inaccurate GPS signal on older mobile phones. We also collected these issues for optimizing the system in order to use it on a large scale. Based on short interviews, the participants felt very satisfied during their use of the application and they tended to use it to motivate them in physical activities.

Table 3. Results of the satisfaction questionnaire

	Survey question	Male(N)	Female(N)	Mean	S.D.
1	I thought it was fun	109	81	4.42	0.95
2	I felt immersive during playing the game	109	81	4.25	0.89
3	I found that the game mechanics was very interesting	109	81	3.92	1.14
4	I felt that the user interface was very easy to use	109	81	3.84	1.05

Fig. 7. The event of RUN FEST

The data regarding the application usage could be obtained from the server. We compared the physical activity outcomes of experienced and new runners. According to the data in Table 4 regarding experienced and new runners, the average of finish time (45.1 and 60.2), speed (7:15 and 8.56) and total score (7624 and 5284) showed that experienced runners perform better than new runners in every respect because experienced runners do physical activities more often. Surprisingly, we found that the average of total distance of new runners was longer than for experienced runners (5.52 and 4.51) because new runners felt engaged and enjoyed walking and running around the physical environment capturing the monsters. On the other hand, the experienced runners focused on winning the competition and keeping their scores as high as possible. These data showed that our approach has a potential benefit for the researchers, game designers and organizers responsible for designing running events for both groups.

Table 4. Application usage among experienced and new runners

	experience runners (N = 321)	**New runners (N = 380)**
Average of total distance (km)	4.51 km	5.52 km
Average of finish time (minutes)	45.1 minutes	60.2 minutes
Average of speed (Pace)	7:15 pace	8:56 pace
Average of total score	7624	5284

6.2 Qualitative data feedback of participants

The qualitative feedback information of participants was collected in a survey form after they finished the game. From 190 participants who answered the satisfaction questionnaire, 32 answered and filled out the open response question: “Do you have any suggestions for the Camt Run App?” The results of the open response question included both positive and negative responses as well as some suggestions for game improvement.

Positive feedback (4 responses). Among these responses, only one male and three females left positive comments on the question by stating that "It was so fun playing this game.” One of them also stated that “I hope this event will be held again next year."

Negative feedback (4 responses). Of four responses, two were about participants' complaints about the hot climate, and the other two complained about commotion happening in the event. Two male participants left comments saying that “It was a disorderly registration. The QR code was not really used in the registration,” and another participant stated that “The venue of the event was not spacious, and it was a chaotic registration. Nobody lined up properly.” Regarding the hot climate, two female respondents stated that "It would be better if the event were held in the early morning as it was really hot."

Suggestions for game improvement (24 responses). Since there were a lot of suggestions concerning many issues, we classified the suggestions into two topics: design and experience and technology.

Design and experience. The suggestions included improvements for more interesting and enjoyable experiences. One participant recommended that the map in the game should be more detailed, for example by adding more directions to the route. Another suggestion was to add more legendary monsters to the game to make it more engaging.

Technology. The problems were mostly concerned with the technology usage. Some of them involved hardware issues in certain mobile phones, occurring on both Android and iOS, which caused lags in the game play. Many participants experienced high battery consumption issues while playing the game. Some participants could not reconnect and enter the game play when they accidentally disconnected the internet. Another problem was inaccurate GPS. They found that the GPS missed the location of the players and did not follow them.

7 Findings and discussion

To promote physical activity and healthcare, we developed a gamified application and then collected the results of our findings. Hereupon, we propose two research questions so that we can obtain data and see the results.

(RQ1) Regarding the first research question, which is to determine a suitable design and implementation for the innovative approach, gamification, in an application for the running event, we attempted to combine many intriguing gamification elements and other interesting frameworks, such as Pokémon Go's core game mechanics and the gamification User Types Hexad framework or six user types, in developing our gamified mobile application for running events. The application successfully recruited a total number of 701 runners to participate in the event.

Based on our knowledge from the study, we suggested our approach for researchers, game designers or organizers who desire to apply our gamification concept to other running events, such as fun runs or mini marathons. However, we found that due to the high battery consumption, the running route should not exceed five kilometers in a gamified fun run, even if runners want to run a race for more than five kilometers. Thus, it would be better to warn runners to prepare a portable charger when participating in a running event. Additionally, climate should not be neglected either. A running event should be held early in the morning or at 5 AM to avoid hot weather.

(RQ2) The second research question is to recruit and promote physical activity among experienced and new runners to participate in the running event. According to Table 2, 3 and 4, they show that applying the gamification concept to promote physical activity and health for runners who have never attended any running events is successful. There were 321 former runners and 380 new runners who paid the registration fee to join the event. It means that our gamified mobile application can effectively attract and draw the interest of newcomers to running events, which accounts for 52.40% of all participants, and they even finished the running route. Moreover, our gamified mobile application also recruited experienced runners for the running event, accounting for 45.79% of all participants. Our qualitative data feedback also

supports the approach, as one participant said “I hope this event will be held again next year."

These results demonstrate a correlation between physical activity and gamification applications such that both factors can contribute to users’ entertainment and immersive experience and motivate them to engage in physical activity. This is in line with the research of [11] proving that implementing gamification in physical education can enhance and make students more engaged in healthy behaviors. Additionally, the results of our findings fit with the theory that applying gamification in health promotion can enable individuals to feel interested in and enjoy health-related behaviors while improving health outcomes [10]. Interestingly, to make the gamified application more interesting, we employed the Gamification User Types Hexad framework, six user types developed by Marczewski [33], in designing and developing our gamified application to support all types of users in the running events, because many users have their own preferences and personalities in terms of game experience. This is in line with the research of [32] that personalizing gameful techniques can enhance and assist users in achieving their tasks, as well as help in influencing their perspectives or behaviors, or immersing them in specific issues.

8 Conclusion, limitations, and challenges

This research aims at promoting physical activity through the application of gamification in order to create immersive game experience and encourage individuals to be aware of their healthcare. The research presents the techniques for designing and implementing the gamification concept of the application, the game flow diagrams, as well as the appropriate game elements. According to the first research question on the application of gamification in a running event, we attempted to combine many intriguing gamification elements and the gamification User Types Hexad framework or six user types, in developing our gamified mobile application for running events. The application successfully recruited a total number of 701 runners to participate in the event. Regarding the second research question to recruit both experienced and new runners, 701 participants, including 339 males and 362 females, were pleased and motivated to engage in physical activities. In addition, from Table 2, it can be concluded that newcomers of running events, 380 people, or 54.20% of all participants, were attracted to attend the running event and were able to complete the route, indicating that it was a successful promotion that enhances physical activity and health among newcomers through the application of gamification. Nonetheless, due to the lack of data on results for all user types in the Hexad framework, the results cannot confirm that our user type game design, based on Marczewski's [33] six types of users, can actually be of assistance in supporting individuals or making users more engaged in playing the game application based on their own preferences.

For limitations of this study, as our study was conducted only at Chiang Mai University, the map in our gamified mobile application can explore the area around Chiang Mai University only, which is not available or prevalent in other locations like the actual Pokémon Go game. So, in order to participate in the running event and play

our gaming application, the user needed to attend the Fun Run event. Furthermore, we were unable to collect data from all participants who attended the Fun Run event since some of them were middle-aged and did not know how to play the mobile application game or did not have a smartphone to do so.

Many challenges, including privacy issues and user experience, must be considered while developing a gamified mobile application for public areas. Normally, implementing gamification elements in developing a mobile application can increase engagement and interaction in public areas. Thus, considering how to improve such issues is crucially important.

9 Future works

Further research is needed to establish the feasibility of conducting a study on the results of developing a gamified application in accordance with personalizing gameful techniques testing new game systems to support users' mobile phones in terms of technology, and designing more new, riveting, and immersive game content.

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