Mopsify: Gamified Spatial Crowdsourcing for Content Creation in Location-based Games

Nancy Fazal
School of Computing
University of Easter Finland
Joensuu, Finland
fazal@cs.uef.fi

Pasi Fränti
School of Computing
University of Eastern Finland
Joensuu, Finland
franti@cs.uef.fi

***Abstract*— Location-based games require players to step outdoors to interact with real-world objects. The gameplay depends on the player's current physical location, and it is crucial to have the content available everywhere. Global scalability of the content is a huge challenge, as many games find it difficult to scale worldwide. Even players of the successful games like Pokémon Go complain about the lack of locations in certain regions. Different approaches have been studied for content creation including Web crawling, Open Street Map data, and social media data. Crowdsourcing has been successfully used but only with established games with rich community support. In this paper, we present *Mopsify*, a location-based game prototype which combines the power of crowdsourcing, gamification, and Open Street Map data for content creation. The content generated as part of the *Mopsify* gameplay shows the potential of this approach. We tested it in 15 locations in three games in Joensuu City. Only 4 of the locations had issues with accessibility, as they happened to be inside other buildings, which were closed already by the time gameplay happened. The other 11 were classified as good for their place name, location from OSM, and photo captured by the player. The players gave positive feedback and were interested in enriching the content by using smaller, interesting objects in the gameplay instead of restricting them to only visible landmarks.**

Keywords: Location-based games; Spatial Crowdsourcing; Gamification; Open Street Map; Content Creation.

I. INTRODUCTION

Location-Based Games (LBGs) have been around since 2000 and are a subgenre of pervasive games. The common feature of these games is that they use the player's physical location to generate a gameplay. The first commercial game was *Botfighters*, in which players take control of a robot to destroy other robots [1]. *Shadow Cities* was another early game created by a Finnish company Grey Area. The game uses the player's physical GPS location on an in-game map to battle other players.

LBGs saw immense popularity when Niantic launched Pokémon Go. The game is free-to-play and has over 100 million downloads and about 14 million reviews on the Google Play Store. It received mixed reviews such as appreciation for the concept but criticism for the technical problems, causing public annoyance and contributing to accidents. Despite all the critics and challenges, Pokémon Go in-app purchase revenue surpassed 645.59 million dollars worldwide in 2022. The success of Pokémon Go made it evident that LBGs offer exciting commercial potential [2]. Since then, several companies have attempted to recreate the phenomena with their games and have achieved various levels of success [3].

One challenging factor for LBGs is content creation as it requires visiting outdoors, collecting game content, and attaching it to real-world locations [4]. Even a simple treasure hunt game would require many locations worldwide. As a result, many games hand over the content creation responsibility to the game administrators or the players themselves followed by a review mechanism.

Pokémon Go uses a collaboratively built database of locations spread worldwide. The players, however, still complain about the lack of locations in many places, despite community support and success. Other games such as *Hidden Lion* [5]; *See It* [6]; *Museum Scrabble* [7] and *O-Munaciedd* [8] have been built around a specific location and cannot be easily transferred to other places as they rely on specific stories and knowledge. Manual content creation around the globe is a hard problem, and as a result, many LBGs find it difficult to survive over long periods.

According to Laato et al. [11], the literature has shown that games using crowdsourcing procedures lead to geographic bias and so far, mainly web-based crowdsourcing has been used for content creation. With the advancement of mobile technologies, traditional web-based crowdsourcing such as *Amazon Mechanical Turks* (AMT), *Crowd4U*, and *Upwork* has now extended to mobile and spatial crowdsourcing such as *Uber*, *Waze*, *Open Street Map* (OSM), *GigWalk*, *Field Agent* and *TaskRabbit* [12].

The major contrast between web-based and spatial crowdsourcing is that the latter requires volunteers to move in the real world to solve tasks using their mobile devices [13]. Typical spatial crowdsourcing tasks include capturing photos, traffic checks, store audits, groceries, and location-aware surveys [14]. The major issue with crowdsourcing is to keep the interest of participants alive [15].

Martella et al. [16] present gamification as a practical solution by leveraging user's intrinsic motivations. Morschheuser et al. [17] investigate how gamification elements in crowdsourcing tasks can increase the motivation and participation of the crowdsources. Their empirical literature review revealed that gamification is an effective approach for improved crowdsourcing participation. Gamification boosts the intrinsic motivation of contributors to participate in an activity [12].

Bowser et al. [18] report the experiences in evaluating *Biotracker*, a gamified location-based mobile application for

citizen science. Their findings suggest that people who use *Biotracker* are more motivated by the gamification element in the form of "*competing with peers*" and "*earning badges*". Some users' feedback on *Biotracker* exhibited that the gamification makes it fun and less tedious to participate in citizen science.

Laato and Tregel [11] state that submissions in Niantic require the players to make decisions on what to submit, writing the proper name and description, placement in the real world, and capturing a proper photo for it. The submission is then followed by a review mechanism. During the review, players also have some influence when they rate the submissions and can mutually decide to either accept or reject it or even move it from its original location. The process increases the work of players and reviewers. It further allows only players who have reached a certain level in the gameplay to make submissions and reviews.

In this paper, we present *Mopsify*, a location-based game prototype that combines the power of gamified spatial crowdsourcing and OSM data for content creation in LBGs. The data from OSM is highly reliable for its location accuracy and place names, which would eventually lessen the burden of contributors and reviewers. Capturing photos as part of the gameplay reduces the chance of attaching copyrighted, promotional, or vandalized photos. *Mopsify* aims to evoke intrinsic motivations in players to step out on an adventure of randomly generated real-world locations and show off their photography skills.

The remainder of the paper is structured as follows: Section II presents the content creation approaches in LBGs. In Section III, we present Mopsify, a LBG prototype to accelerate and overcome the limitations of existing content creation processes. In Section IV, we discuss the games played, players experience and quality of the content generated. Finally, Section V presents the concluding remarks and future work.

II. CONTENT CREATION IN LOCATION-BASED GAMES

O-Mopsi [19] content creation has mostly been handled manually by game administrators and players which as a result limited its applicability within Finland and a few other European countries only. Various approaches such as Web Crawling [9], OSM [4], and Social Media Data [10] have been studied for content creation. Their results remained modest and only a fraction of the 6845 retrieved images from web crawling contained geotags. OSM provided a better approach, but the challenge was that the data itself lacked geotagged images. However, the data sometimes included external web links from which the desired content was found 21% of the time. OSM data, however, is greatly underrepresented in Asian countries and good results were limited to the urban or downtown areas only. The data from social media services has varying strengths for different aspects of the content. Flickr had the highest number of images, representative of the place. Yelp and Foursquare always had the correct location. The place names were accepted as it is except for Flickr where relevant place names had to be extracted using an external method called Tag-tag [20].

Pokémon Go relies on the web-based crowdsourcing alone and one must reach a certain level before they can make any contribution to the Niantic Wayfarer [2]. Pokémon GO requires the players to reach level 37+ and Ingress requires the level 10+. The nominations are later reviewed by mature players for their positional accuracy (using maps, street view, or human judgment), safety, photo representativeness, appropriate title, description, and possible duplicate. Niantic's acceptance criteria for submissions [23] [24] and O-Mopsi have similar design principles for the Point of Interest (POI) [21] classified as attractiveness, accessibility, location clarity, identifiability, and lifetime. In such a case, the content contributed by players is of varying quality and requires the proper inspection from game administrators or mature players.

The review mechanism is usually a time-consuming process and might take several weeks or months. Besides reviewing the photo quality, its title/description, category of a nomination, verifying its location accuracy is also extremely important. A reviewer can use satellite views and street views to help in determining its real-world location. In cases, where the nomination happens to be inside the park or under a tree, the reviewer must use their best judgment to decide where it could exist in the real world by looking at clues in the submitted photo background [24].

III. MOPSIFY

Mopsify is a single player location-based game prototype, which aims to combine the gamified spatial crowdsourcing and OSM data to support the content creation. Players can create new games in the area of their own choice containing a desired radius and the number of locations they want to visit. The randomly generated locations are extracted from the OSM database.

A. Motivation

Mopsify aims to simplify the content creation process by obtaining POIs automatically from OSM. Since OSM does not provide pictures itself, *Mopsify* players are encouraged to visit the selected locations and take photos as a part of its gameplay. OSM data is usually reliable for its positional accuracy and textual names, and therefore, reduces the work of both reviewers and contributors. OSM is a leading crowdsourced spatial database, published under the Open Database License. Due to its free and open availability, several games have utilized it without any legal restrictions [22]. Pokémon Go uses it for its in-game map.

Mopsify allows any player to act as a contributor. The location data from OSM removes the need for contributors to select POIs and write descriptions. Instead, they can fully focus on taking pictures and enjoy visiting random locations. Photos are very crucial elements in Pokémon Go as well as O-Mopsi and must therefore be checked if they represent the POI [23]. Mopsify prompts the players to take a photo of a place right away when they arrive at the POI, thus, reduces the possibility of uploading copyrighted edited or vandalized photos.

LBGs enforce a set of safety and security restrictions like omitting areas on a private property, company grounds, military areas as well as locations without pedestrian access like highways. Laato et al. [11] construct three tag groups for OSM data. The first group called *strict* corresponds to the Niantic's criteria. The second group called *relevant*, represents the locations with shops, relevant societal buildings, or leisure areas. The third group called *notable* includes tags for better coverage in suburban and rural areas. Mopsify, however, only uses the randomly generated POIs with the only exception of excluding *hospitals*, *weighbridges*, *atm*, *nightclubs*, *fire stations*, *banks*, *prisons*, *crematoriums*, *graveyards*, *waste disposals*, *recycling*, *toilets*, *wastebaskets* and *parking*.

B. Gameplay

The gameplay (see Fig. 1) begins once a player has successfully logged in using their existing account or entered as a guest. A player is then shown brief instructions before starting the game. Next, the player can specify the game name, the number of locations they want to visit, and the desired radius from their automatically identified location on the map. For the given player preferences, random locations are generated from the OSM database. A player can shuffle the locations as many times as needed and can then freely choose the location wanted to visit first. Once selected, the location is highlighted on the map. A player can now go to the location and his/her arrival is notified by playing a brief *ta-da* sound once he/she reaches within a 20m proximity to the selected location.

The player is now prompted to capture a photo of the location and submit it when ready. She can move around to find a suitable location and angle to take the best possible photo. Once the photo is submitted to the database, the visited location is removed from the map. A player then chooses another unvisited location and continues her tour unless has visited all the locations. Once the game is finished, the player is shown all the locations and images captured. She is then asked to give feedback on how well each of the visited locations meets the five design principles [21] by rating them on a scale from 1 (lowest) to 5 (highest). In addition, she can submit general comments on the gameplay if interested. Having such information from the player would eventually help to construct better OSM data retrieval queries as per the player's preferences.

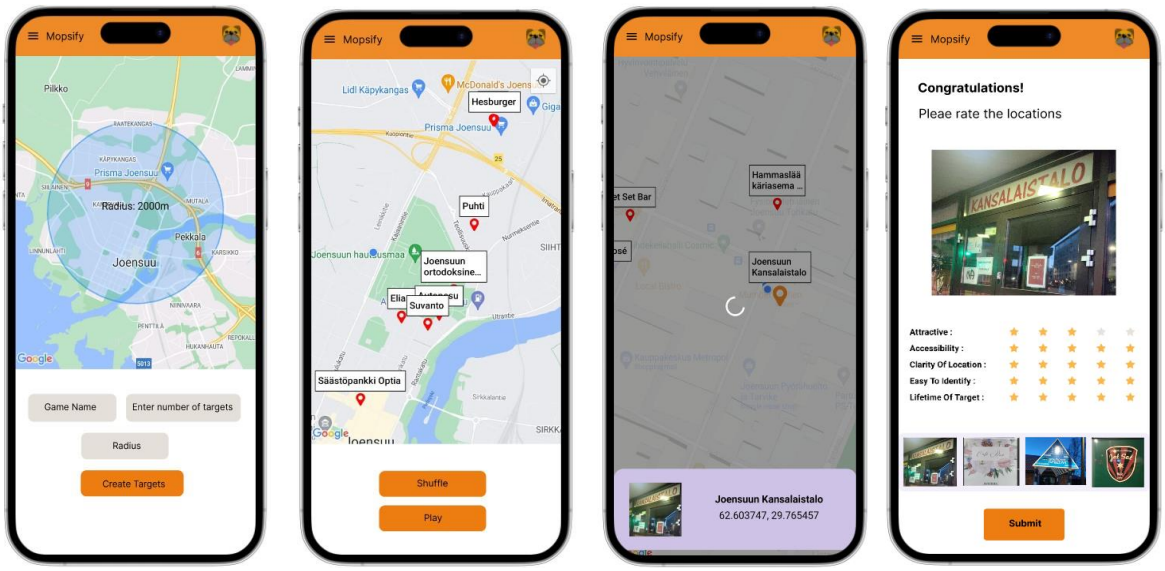

Figure 1. Mopsify gameplay.

IV. EXPERIMENTS

Three small games within the city of Joensuu, Finland, were played for data collection purposes. The games are named *Kanervala*, *Keskusta*, and *Kaislakatu*. The estimated game length varied from 2 to 3 km with an average number of 5 locations to visit. The content generated was examined for its quality by the authors, who are local experts. Besides the images captured, other location details such as POI type, original location, photo taken location, image EXIF data, device, network information, and accuracy are also recorded. Feedback from each location using the five design principles is additionally stored for analysis purposes.

Two female players who are residents of Joensuu played the games and provided the content shown in Tables I, II, and III. One player had good experience of playing LBGs, whereas the other had never played any such game before. Both players are software developers by profession. They gave good feedback on the gameplay, mentioning that they discovered places which they have often passed by but never noticed. One player talked about coming across a pizza shop called *Pizza Ella* which is about 53 meters from their workplace, and they were not aware of its existence.

The player showed excitement about this finding and ended up buying a pizza from there. The other player, however, complained about coming across places such as *schools* to take photos as they were CCTV monitored. Parents were picking up their kids by that time and the player hesitated about capturing a photo.

A player also reported that the game notified of her arrival at the location, she could not see herself. In such cases, the player just took a random photo to let the gameplay proceed. It happened with the restaurant *Amica* which the player could not find and ended up taking a photo of another restaurant nearby, *Kreeta*, to be able to continue the gameplay. A similar case was identified with *Punainen Risti – lajittelukeskus* and restaurant *Elisa* for which the player took a wrong photo of Hyvinvointi- ja kauneushoitola (a beauty salon). Outdated locations were also reported. The dentist shop *Hammaslääkäriasema Otso* is permanently closed even if still present in the OSM database. As a result, the player struggled to find it and ended up taking the wrong photo of Pihlajalinna (medical center) to let the game proceed. The content was later reviewed by the authors who concluded that such cases were mostly inside buildings that were closed at the time of gameplay. These cases are highlighted in red in Tables I, II and III.

In general, for places with good accessibility, both players provided positive comments on how they learned a bit more about their surroundings and taking photos was an enjoyable activity for them. Playing the game did not feel tedious but rather made their evening walks adventurous. Players also showed interest in having small objects in the gameplay such as *statues*, *benches*, *fountains*, *trees*, and *bird towers*.

TABLE I. CONTENT GENERATED FOR THE GAME "KANERVALA"

POI					
Name	Elias	Muistelupaikka	Heinosen Leipomo Oy	ABC Kanervala	Joensuun vapaaseurakunta
Type	restaurant	place of worship	cafe	fuel	place of worship
Design Principles Feedback (*Attractive*, *Accessibility*, *Clarity of Location*, *Easy to identify*, *Lifetime*)					
	(0,0,0,0,0)	(5,3,3,3,5)	(2,5,5,5,5)	(1,5,5,5,5)	(5,5,5,5,5)

TABLE II. CONTENT GENERATED FOR THE GAME "KESKUSTA"

POI					
Name	Joensuu Kansalaistalo	Amica	Hammaslääkäriasema Otso	Jet Set Bar	Café Rosé
Type	Community centre	restaurant	dentist	pub	cafe
Design Principles Feedback (*Attractive*, *Accessibility*, *Clarity of Location*, *Easy to identify*, *Lifetime*)					
	(3,5,5,5,5)	(0,0,0,0,0)	(0,0,0,0,0)	(4,5,5,5,5)	(5,5,5,5,5)

TABLE III. CONTENT GENERATED FOR THE GAME "KAISLAKATU"

POI					
Name	Joen Eläinlääkäriasema	Kanervalan koulu	Punainen Risti - lajittelukeskus	Joensuun Nuorisoverstas ry	Pizza Ella
Type	veterinary	school	social centre	social centre	fast food
Design Principles Feedback (*Attractive*, *Accessibility*, *Clarity of Location*, *Easy to identify*, *Lifetime*)					
	(3,5,5,5,5)	(1,1,5,5,5)	(0,0,0,0,0)	(1,5,5,5,5)	(5,5,5,5,5)

V. CONCLUSION

Mopsify is a location-based game prototype for content creation in location-based games. It combines gamified spatial crowdsourcing with Open Street Map data to ease the work of both contributors and reviewers. The OSM data is highly reliable for its positional accuracy and place names. We made a small-scale experiment of the app in Joensuu, Finland with three games. The results were promising and support the potential of this approach. The games length ranged from 2 to 3 km with 5 locations in each. In total, 15 locations were visited. Four of the locations were either not accessible or had been closed permanently. The content generated was reviewed by the authors and they found that 11 valid locations had correct place name, and location from OSM. Their images captured by players were also representative. Players mostly expressed positive feedback and showed interest in having *statues*, *benches*, and other interesting small objects in the gameplay. Places such as schools, fuel stations, community centers and veterinary were reportedly less attractive for the players.

In future, we aim to extend the gameplay as per players feedback, do extensive testing, and work on handling the accessibility issues. OSM data has been reportedly biased in rural areas, thus finding ways to overcome this constraint should also be addressed as part of the *Mopsify* gameplay. The data generated from *Mopsify* can be used in any location-based game and sight-seeing applications.

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