

Anarchy or Order on the Streets: Review Based Characterization of Location Based Mobile Games

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ABSTRACT

Location based mobile games have traditionally relied on implicit codes of conduct, legal ordinances, common social norms, or community emergent rules. However, these games are becoming increasingly popular and enforcing these implicit or explicit restrictions has become difficult. In this paper, we present a critical and systematic review of both commercial and non-commercial location based mobile games. We list selected characteristics of the games and highlight their connection to the affordances and restrictions on urban game arenas. We also demonstrate the feasibility of our characterization by applying it to two recent location based mobile games, *Pokemon GO* [53] and *Street Art Gangs* [4].

Author Keywords

Location based mobile games; game design; pervasive games

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

All games impose a certain level of restriction to gameplay. Especially multiplayer games require a consistent set of rules and mechanics to ensure well-balanced and enjoyable gameplay. Restrictions on gameplay can be as light as a suggested storyline, to which the players can either adapt or choose to ignore; or there can be very strict rules, where the players are actively monitored and banned for e.g. cheating or exploiting game mechanics. In this paper, we focus on rules and restrictions outside conventional gameplay. We discuss *pervasive games* where the physical world overlaps with the boundaries of gameplay i.e. the *magic circle* [29]. Orchestrators of pervasive games have actively attempted to steer clear of imposing too many rules or regulations, and many guidelines for setting up pervasive games aim at

minimizing rules and suggesting that players simply ‘play fair’ [50]. However, the recent success of commercial games like *Ingress* [30] and *Pokemon GO* [53] have shown that better-defined restrictions need to be applied when masses engage in gameplay.

Our focus is on a specific type of pervasive games, so-called location based mobile games (LBMGs). Substantial changes have taken place in pervasive games and LBMGs from the beginning of the century until today. Previously, orchestration, e.g. organizing and up keeping the game events, was considered inseparable from pervasive gameplay. It was further viewed as a part of the social complexity of pervasive games, and even considered beneficial for mixed reality experiences [17, 36, 73]. However, the level of orchestration per player has decreased when moving from the early *first generation* pervasive games to the *second generation*, making it possible to host games on global scale. In second generation games, it is no longer a requirement to have human intervention on the streets or do manual updates on game servers. Much of this has been automated in a way that orchestration per player is significantly lower. Specialist hardware has become largely unnecessary, as games can be deployed on smart phones and tablets. Some commercial games, such as *Pokemon GO*, are continuous and ongoing, because the games no longer need to be orchestrated events, which further adds to the player’s (Figure 1) freedom on choosing when and where to play [39, 53].



Figure 1. Players on city streets. LBMGs combine true mobility of computing to the infrastructure and social possibilities of hybrid cities [66].

In this paper, we conduct a systematic review on location based mobile games, with a focus on understanding the types

of applied affordances and restrictions. We identify the main features in LBMGs and further define the scope of the restrictions applied in games in relation to current theories and concepts [19, 21, 34, 42, 66, 67]. We conclude with discussion on our findings and further demonstrate the feasibility of our characterization by applying it to two recent location based mobile games, commercial *Pokemon GO* [53] and noncommercial academic *Street Art Gangs* [4].

BACKGROUND

On the Importance of Rules

A rule is not merely a suggestion on how to play the game. The rules of a game are there to be obeyed and they truly define the game: rules frame what is possible in the game, yet limit possibilities. In traditional video games, rules rarely need to be explicitly stated, as they are already built into the game mechanics and enforced on the player. Conversely, guidelines for pervasive games often suggest trying to avoid rules: the game is designed to facilitate play, much like a toy would. Toys do not usually have instructions or rules on how to use them correctly. They rely on users (for example children) to find imaginative ways of engaging and playing with them, and developing their own sets of rules when needed [2, 37].

The relationship between the rules of video games and pervasive games is somewhat reminiscent of the relationship between the rules of video games and traditional games such as board games: just like traditional games, pervasive games are played in the physical world [18, 28, 50, 51]. The physical world as an environment imposes certain laws and restrictions derived from everyday life in a society, and other basic rules such as the 24-hour daily rhythm, or the inability of human beings to fly unassisted, apply. Other restrictions emerge from the play itself. The idea of minimal rules of play in pervasive games stems from *ludology*, i.e. the notion that people are playful by nature, and everyday life already has elements and hints of this playfulness. Therefore, an orchestrated event that takes place in everyday life will intrinsically display play-like or game-like qualities [37, 50].

The question of how this relates to contemporary pervasive games, however, remains open. Can a LBMG developer rely on the player community refining their own set of rules and regulations while still following social norms, established laws, and staying safe? Furthermore, the intensity of the game can make players endure outdoors conditions they would not usually tolerate [4, 72], and the distraction to reality can lead to potentially dangerous situations [49, 63].

Why to Implement a Restriction and Why Not?

Emergence happens when player actions result in unpredicted second order of events, but the game itself stays rational and acceptable [69]. The rationale behind designing emergent game systems is that these systems empower the players, and give them a higher level of freedom of expression than a more restricted game system would. In pervasive games, there will always be a degree of emergence due to the freedom of players to interact with their

environment, even in unpredictable ways [36, 50]. Location based mobile games have traditionally been very allowing for game emergence [38]. *Geocaching* is perhaps one of the most well-known examples. Player interaction and game narrative are both emergent and the only fixed items are location coordinates and the physical caches. However, even *Geocaching* has restrictions. The visibility of personal information amongst the geocacheers is restricted, as participants use game IDs. Furthermore, volunteers review the suggested new caches [18, 55]. These so-called *community emergent rules* or *restrictions* have taken a while to become established. While such rules may or may not emerge serendipitously from gameplay or the community, they are always an integral part of the game and cannot be ignored when designing a game.

For a player, the experience of successful play is composed of the ability to create a strategic path that complements the actions of other players and respects the rules of the game [37]. Therefore, successful gameplay requires a balance between player interaction, player control, and rules. In the context of human computer interaction, the player control could also be called player affordance. As discussed previously, this balance can emerge naturally after some time, i.e. players themselves can attempt to balance an unbalanced set of rules. However, relying on these self-emerging rules may lead to a situation where a majority of the player base has already given up and quit the game. Hence, it is important for a game developer or designer to implement a concise set of rules thoughtfully and clearly. However, implementing restrictions on gameplay requires resources, both during development and after deployment. Furthermore, updates may be needed to account for unforeseen exploitation by players. The lack of resources is particularly relevant in research based games, as researchers should be able to concentrate on observing the game instead of supervising it.

Generally, there is an asymmetrical tie between the rules of a game and the actual realized game: It is impossible to predict the outcome of the game only by knowing the rules [37]. This is especially true for pervasive games. Even though there are guidelines for developing and running a successful pervasive game [10, 17, 36, 37, 39, 55], there are no guidelines specifically targeting the affordances and restrictions of LBMGs. The requirements, especially the technical ones, have been mapped [57] and ethical considerations especially on the use of player location in gameplay have been addressed [48], but no thorough assessment of the specifics of various types of LBMGs have been made. In this paper, we address this knowledge gap by first conducting a survey of modern LBMGs and then introducing a characterization of games and the affordances and restrictions in game space and play. Although phrase rules is a very common way to describe limitations in gameplay, we instead use restrictions, as those relate to both limiting or controlling as well as the act of limiting and controlling.

METHOD

We conducted a two-step review of non-commercial and commercial LBMGs. First, an initial mapping study identified the range of LBMGs. Then, a systematic review focused on selected 30 games shown in Table 1.

A Mapping Study of LBMGs

An initial review of known non-commercial and commercial LBMGs was conducted within a three-week period 5th – 26th

August 2016. The information of LBMGs and their affordances and restrictions was retrieved from academic publications as well as commercial application repositories such as Google Play store and Apple App Store. The keywords used in the search were “location based mobile game” and “location-aware game”.

Game	Year	Description of the game	Affordances and Restrictions	Developer motivation	Source
<i>Geocacheing</i>	2000 **	Single player, noncompetitive, unlimited timespan, high attendance, undefined timespan, global	High freedom of movement, locations physically fixed, non-linear emergent stories, ethical guidelines to lessen environmental impact, entwines with daily life	Noncommercial	[23, 55]
<i>Botfighters</i>	2001 **	Multiplayer, competitive, long timespan, global (across few countries)	High freedom of movement, nonlinear paths, locations used are the players' physical location, entwines with daily life	Commercial (Research)	[65]
<i>URAAAY</i>	2003 **	Collaborative, noncompetitive, long timespan (two weeks), high attendance, local	Low freedom of movement, linear path, linear story, self-reported positioning	Commercial (Research)	[13]
<i>Mogi</i>	2003 **	Multiplayer, competitive, long timespan, high attendance, local	High freedom of movement, wide area around locations, possible to see other players' location data, entwines with daily life	Commercial	[43]
<i>Pacmanhattan</i>	2004 **	Multiplayer, competitive, players have different roles, low attendance, short timespan (10 min-1 h), local	Low freedom of movement, nonlinear paths, but restricted area, self-reported positioning, possible to see other players' location data	Noncommercial (Student work)	[56]
<i>Treasure</i>	2005 *	Collaborative, competitive, short timespan, low attendance, local	High freedom of movement, fixed locations on an unilinear path, possible to see other players' location data	Noncommercial (Research)	[6]
<i>Prosopopeia</i>	2005 **	Multiplayer, competitive, low attendance, long timespan, local	High freedom of movement, strong storyline forced linear paths, entwines with daily life	Noncommercial (Research)	[35]
<i>Hitchers</i>	2006 *	Multiplayer, competitive, long timespan, high attendance (47), global (across six countries)	High freedom of movement, nonlinear paths, players can change the locations, entwines with daily life	Noncommercial (Research)	[20]
<i>Feeding Yoshi</i>	2006 *	Multiplayer, collaborative, low attendance, long timespan (7 days), local	High freedom of movement, wide area around locations, possible to see other players' location data, entwines with daily life	Noncommercial (Research)	[10]
<i>MobiMissions</i>	2006 **	Multiplayer, photo-blogging game, competitive, low attendance, long timespan (5 weeks), local	High freedom of movement, nonlinear paths, players can change the locations, non-linear emergent stories, no direct contact facilitated for players, game-time outside school hours, entwines with daily life	Noncommercial (Research)	[26]
<i>RexExplorer</i>	2007 **	Single player or team play, noncompetitive, low attendance, short timespan, local	Nonlinear story, self-reported positioning used in some parts	Noncommercial (Engage visitors to a site)	[8]
<i>Momentum (Prosopopeia 2)</i>	2008 *	Multiplayer, competitive, low attendance, long timespan (36 days), local	High freedom of movement, strong storyline forced linear paths, some physically fixed locations, entwines with daily life	Noncommercial (Research)	[36]
<i>EyeSpy</i>	2009 *	Multiplayer, storytelling and photo-blogging game, competitive, low attendance, long timespan (2 weeks), local	High freedom of movement, nonlinear paths, players create the locations, entwines with daily life	Noncommercial (Research)	[11]
<i>Parallel Kingdom</i>	2009 **	Multiplayer (Massively Multiplayer Online Role Playing Game), competitive, high attendance, undefined timespan, global	High freedom of movement, nonlinear paths, locations are linked to the players' locations, entwines with daily life	Commercial	[58, 59]

Game	Year	Description of the game	Affordances and Restrictions	Developer motivation	Source
<i>PanOULU conqueror</i>	2009**	Multiplayer, competitive, high attendance (96 players), long timespan (weeks), local	Fixed locations (Wi-Fi hotspots), no fixed paths, entwines with daily life	Noncommercial (Research)	[71]
<i>Blowtooth</i>	2010*	Single player, noncompetitive, low attendance, short timespan, local	Moving locations (bluetooth on devices), no fixed paths	Noncommercial (Research)	[40, 44]
<i>Frequency 1550</i>	2011*	Collaborative, low attendance, competitive, co-located gameplay, short timespan (one day), local	Linear path at some assignments, otherwise content tied to areas and locations, high story content and necessary assignments	Noncommercial (Education)	[3]
<i>Itography Item Hunt</i>	2011**	Multiplayer, competitive, leaderboard, players explore close by areas and collect items, based on Foursquare, high attendance, undefined timespan, global	High freedom of movement, fixed coordinates for locations, no paths, entwines with daily life	Commercial	[32, 33]
<i>FreshUP</i>	2011**	Collaborative, low attendance, competitive, co-located gameplay, long timespan (2-4 weeks), local	High freedom of movement, fixed coordinates for tasks, no paths, entwines with daily life	Noncommercial (Education, research)	[74]
<i>Zombies, run!</i>	2012**	Single player, noncompetitive, high attendance, undefined timespan, global	High freedom of movement, GPS mode is not necessary, linear story, entwines with daily life	Commercial	[64]
<i>Ingress</i>	2012**	Multiplayer, competitive, regional leaderboard, high attendance, undefined timespan, global	High freedom of movement, fixed coordinates for locations, no paths, entwines with daily life	Commercial	[30]
<i>Free All Monsters</i>	2011* 2015*	Multiplayer, collaborative, competitive, high attendance, relies on player authored content, undefined timespan, global	High freedom of movement, nonlinear paths, players create locations (“monsters”) and routes, entwines with daily life	Commercial (Research)	[45, 46]
<i>YourWayYourMission</i>	2013*	Collaborative, small attendance (23), competitive, co-located gameplay, long timespan (7 days), local	High freedom of movement, nonlinear paths, players create locations (“missions”) and routes, entwines with daily life	Noncommercial (Research)	[16]
<i>GPS Tycoon</i>	2014**	Multiplayer, competitive, leaderboard, players buy and explore close by areas on a map, high attendance, undefined timespan, global	High freedom of movement, in game possibility for faking player location, in came warning on playing while driving, entwines with daily life	Commercial	[25]
<i>Street Art Gangs</i>	2015**	Multiplayer, competitive, players can attack each other, leaderboard, players know each other, low attendance, long timespan, local	High freedom of movement, fixed coordinates for locations, no paths, intense gameplay, entwines with daily life	Noncommercial (Research)	[4]
<i>School Scene Investigators</i>	2015*	Collaborative, low attendance, augmented reality, co-located gameplay, short timespan, local	High freedom of movement, somewhat linear story, QR code locations	Noncommercial (Education, research)	[14]
<i>Gossip at palace</i>	2015*	Single player or collaborative, noncompetitive, low attendance, short timespan, local	High freedom of movement, somewhat linear story, QR code locations	Noncommercial (Engage visitors to a site)	[62]
<i>Landlord – Real Estate Tycoon</i>	2015**	Multiplayer, competitive, market for popular locations, based on Foursquare, high attendance, undefined timespan, global	High freedom of movement, players can see each other’s real first names, fixed locations, no paths, entwines with daily life	Commercial	[60]
<i>SoundPackman</i>	2016*	Single player or collaborative teamplay, noncompetitive, sound is central game element in avoiding ghosts and finding berries, short timespan, global	dynamically created but fixed coordinates for locations (“berries”), no linear paths, intense gameplay	Noncommercial (Research)	[15]
<i>Pokemon GO</i>	2016**	Multiplayer, competitive, high attendance, player names used, undefined timespan, global	High freedom of movement, fixed coordinates for locations, in came warning on driving and playing, no paths, entwines with daily life	Commercial	[53]

* The year of a paper publication

** The year the game was published or piloted

Table 1. Characteristics of the reviewed LBMGs.

Characteristic		N		N		N
Player investment	<i>Low investment</i>	17			<i>High investment</i>	13
Number of players	<i>Few players</i>	17			<i>Unlimited number of players</i>	13
Commerciality	<i>Noncommercial</i>	20			<i>Commercial</i>	10
Timespan	<i>Short timespan</i>	8	<i>Long timespan</i>	13	<i>Undefined timespan</i>	9
Use situation	<i>Edge of the magic circle</i>	9			<i>Daily-life</i>	21
Competitiveness	<i>Noncompetitive</i>	7			<i>Competitive</i>	23
Gameplay type	<i>Single-player</i>	4	<i>Multiplayer</i>	18	<i>Player vs. player</i>	8

Table 2. LBMG characteristics and their frequency in reviewed games.

A search in Google Scholar returned 463 publications, while Google web search returned millions of hits, of which we included only web pages updated in 2015-2016. Furthermore, we inspected games referred in a review and a book on pervasive games [51, 39]. As a rule, the publications chosen for closer inspection had to describe a specific game. The games themselves had to fulfill two conditions: 1) they had to be played on a mobile phone or handheld device, and 2) they had to utilize player location in the game mechanics.

Some games, especially commercial ones, have not been evaluated academically or the results of such evaluations have not been published. To review such games, we installed and played the available commercial games. In these cases, the year of publication and the time of accessing a commercial game can differ notably. We focused our review on games played in urban outdoor settings, but also included some games played in vast indoor areas such as *Blowtooth* [39] played in an airport terminal and *FreshUp* played on a campus [74].

Systematic Review of LBMGs

26 games were selected from the mapping study for the thorough review as they fulfilled our conditions. We then conducted a second systematic review on 9th-13th September 2016. We used the same search and selection criteria as in the initial study. As a result, the selection of games included in the thorough review expanded to 30. Although the list of games is not exhaustive, we believe it provides an adequate basis for our analysis.

The level of pre-game and on-game orchestration distinguishes first- and second-generation LBMGs [39]. Some first-generation games deployed earlier this century were included in the analysis despite their requirement for special hardware. This was done in order to have a reference point in evolution of current pervasive games. We considered carefully whether to include games that utilized self-reported positioning and eventually decided to include *Uncle Roy All around You (URAY)* [13] and *PacManhattan*

[56], as these games present a specific case on the freedom of movement for the player.

CHARACTERISTICS OF LBMG GAMES AND GAM PLAY

In our review (Table 2), we first identified three overall themes for each game: description, affordances and restrictions, and developer motivation. In-depth inspection of revealed seven recurrent game characteristics that can affect the amount of required restrictions: 1) *player investment*, 2) *number of players*, 3) *commerciality of the game*, 4) *timespan*, 5) *use situation*, 6) *competitiveness*, and 7) *gameplay type*. We further identified three dimensions of affordances and restrictions that were either enforced or suggested to players: *on freedom of movement*, *on player interaction*, and *on interaction with the environment or the game*.

Game characteristics

Player investment can be either financial or time effort. The investment in game increases over time, so many games with unlimited or very long timespans, or games based on a leveling system, will have to take this in consideration. Furthermore, although we characterize games with research or educational motivation for developers as having low player investment, the incentive the players get from participating, whether it is learning or a reward, can affect player investment even when a game has a short duration.

Number of players: A coarse characterization is that in pervasive games, there exists a linear correlation between the number of players and the need for more extensive and intricate restrictions. To draw an analogy to more traditional video games, a game of solitaire requires far fewer rules than, say, a massively multiplayer online role-playing game such as *World of Warcraft*. Similarly, a pervasive game with a large number of concurrent users such as *Pokemon GO* [53] will require more rules and restrictions to gameplay than a game such as *YourWayYourMission* [16], which imposes far fewer limitations. Many current LBMGs designed to be expandable like *SoundPackman*, *Ingress* or *Landlord – Real Estate Tycoon* are or can be played globally, which allows

having a nearly unlimited number of players. We believe that this characteristic is somewhat related to user acceptance and a direct consequence of the number of downloads. However, for academic games the *number of players* is a more suitable characteristic than the number of downloads.

Commerciality: Legal and ethical issues differ between research prototypes and commercial games. Furthermore, the level of sophistication level can vary. Where research prototypes can be unpolished yet still be able to serve their purpose, commercial products need to be polished in order to satisfy their users. Some commercial games are purely commercial, although there are games where the authors express both academic and commercial interests as their motivation, such games we categorized commercial (Table 2). It is notable though that the commerciality of a game is not a Boolean variable.

Timespan: Games mature over time, and emergent rules become guidelines. An example of this is *Geocaching*. Further, games that have long or unlimited timespans have more time to develop issues that affect the gameplay. These games must present a more sophisticated user experience and require a lower level of orchestration in order to remain viable. Games with undefined timespan also tend to be quite slow paced, despite having competitive elements (e.g. *Landlord Real Estate Tycoon* or *GPS tycoon* [60, 25]).

Use situation: LBMGs entwined with daily life have to apply further restrictions in addition to local laws and rules of conduct. The actual use situation in location-based games is more complex than mere safety issues while playing amongst traffic, for example. Generally, pervasive games are characterized as ongoing and a part of the daily life [44]. This is not though true for those LBMGs that are played as a short tournament and therefore situate closer to edge of the magic circle, where the separation between game and everyday life is more defined.

Competitiveness: The goal of a game can be winning by e.g. beating or outmaneuvering others. However, LBMGs can have other forms of rewards such as increased fitness or learning. A game can be classified as competitive if it involves direct or mediated confrontation or competition between players, even if this is implemented simply as a leaderboard in a single player game. This feature relates closely to *game type* described in the following and further to the characteristics of the game space on *Player-player Interaction* introduced in the following section.

Gameplay type: This characteristic directly affects the level of interactivity amongst players, hence it is presented here as a separate characteristic from *Competitiveness*, despite their close relation.

The set of characteristics listed in Table 2 are used to create an overview of the LBMGs. This overview provides a better understanding of the underlying links between game characteristics and the three categories for affordances and restrictions i.e. the characteristics of gameplay. We illustrate

these links in Figures 2-4 with simple visualizations of the range of limitations set for a player by a particular dimension of affordances and restrictions. Typical ways to implement the dimension and example games are shown below the range.

Characteristics of LBMG gameplay

The game characteristics affect the characterization of the affordances and game mechanics and therefore game-play. Game characteristics are somewhat set based on the purpose and context of a game. The characteristics of game mechanics and play are subject to design and development. In the following, we go through the characteristics of LBMG gameplay as well as introduce relevant theories.

Affordances and Restrictions on Freedom of Movement

Mobile devices offer limited modalities for interaction in mobile gaming hence interaction with physical environment has high relevance [57]. However, mobile devices, wireless connectivity and positioning have shaped the perception of physical environment, which in turn has led to the reconfiguration of the urban space. It is no longer considered stable, but in constant flux as it is created and shaped by people passing through [42]. The shaping of space can be described through the concept of embodiment, where the space is shaped especially via the mobile device mediated sensory mapping of people and space. Implication is the transformation of space into place. According to Farman [21], “*Implication locates our situated nature and our sense of proprioception with others and with objects in a space*”. The complexity of thus formed place can result in displacement [21], which has certainly been observed in pervasive games [12, 4]. In LBMGs displacement can be enhanced by the inaccuracies and latencies in connections, cognitive attention, and positioning. The characteristics of modern space and both the resulting implication and displacement give dimensions to the players’ freedom of movement. The freedom of movement is one of the most obvious non-rules in location-based games (Figure 2), possibly because previous research has shown that players prefer autonomous orienteering instead of preconceived paths [7].



Figure 2. Levels of freedom of movement in LBMGs.

The freedom of movement was the most transparently reported feature in the reviewed games. Location based games oftentimes feature predefined targets or significant locations, which the players are allowed to reach in any given order. The game can also take place in a restricted area, e.g.

a town or a building. This is often not an implemented rule, but a necessity especially with many research based LBMGs, where restricting the observable area saves resources and removes the requirement to rely on an outside source for global positioning data [20]. We consider players having close to full freedom of movement if there are random explorable locations in a game, but also if players are allowed to shift their non-physical entity (e.g. avatar) or change their location inside game area. Few location-based games have preconceived paths for movement, which typically take place in museums or historical sites. These types of games can be considered similar to interactive storytelling.

It was noticeable that in many of the reviewed games, a strong storyline defined the paths players are allowed to take. The closer a game is to interactive storytelling, the more restricted the allowed paths become. For instance, in location based live action role-playing games (LARPs) such as *Momentum* and *Prosopopeia*, player paths are more restricted [35, 36]. Conversely, in a game like *Hitchers* that only has a hint of a backstory, players can freely drop to any location inside an undefined game area. In the commercial game *Parallel Kingdom* [59], a role-playing game saturated with fictional story content, players can move freely inside a small area on the game map and travel without having to move physically, but widening the game area requires moving on the physical streets, as well. *Zombies Run* [64] has a strong backstory, yet players are free to choose where and when they run.

Affordances and Restrictions on Player-player Interaction

Player-player interaction can take many forms in LBMGs, such as observing other players’ location data, observing other players game stats, psychological battle, or bullying. We drew influence from the social interdependence theory [19, 34] to characterize a game as *individualistic* when individuals have no effect on others, *cooperative* when individual actions promote the goals and actions of others or *competitive* when individual actions obstruct the goals and actions of others [54]. However, we regard this dimension also a feature of the game space, as the affordances for interaction are offered by the game itself. Uncompetitive single player games do not often have to implement heavy restrictions or rules, as the need is typically created by the interaction with other people/players. Such games are isolated experiences where players’ achievements are hidden from other players. Once a game has a real-time leaderboard, the game becomes competitive. In many location-based games where direct observation of fellow players is not possible or is prevented, the players find a way by using indirect means of observing other players such as real-time leaderboards or public logs [4, 55, 43]. On the streets, the possibility for players to be able to keep an eye on each other and especially competing players can prevent rule breaks.

In games having multiple types of player-player interactions (Figure 3) are available, we observe an interesting transition from co-located (or co-located collaborative) games and games that have player-player interference e.g. in-game

battle (Figure 2). We suggest that multiple modalities of interaction afford greater freedom for interacting with other players [54].

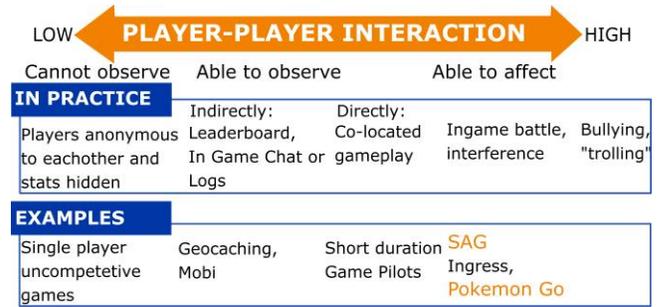


Figure 3. Levels of player-player interaction in LBMGs.

Affordances and Restrictions on Interaction with the Environment or the Game Space

In characterizing interaction with the environment or the game space, we drew inspiration on De Souza e Silva’s definition of hybrid spaces [67]. Hybrid reality games utilize city infrastructure and are by definition social (Figure 4). This is especially true for games that have urban outdoor spaces as game arenas, as these spaces are full of opportunities and obstacles, which can even prove dangerous. As we have seen with *Pokemon GO* and other pervasive games, player behavior may even require the attention of local authorities [71, 55, 63].

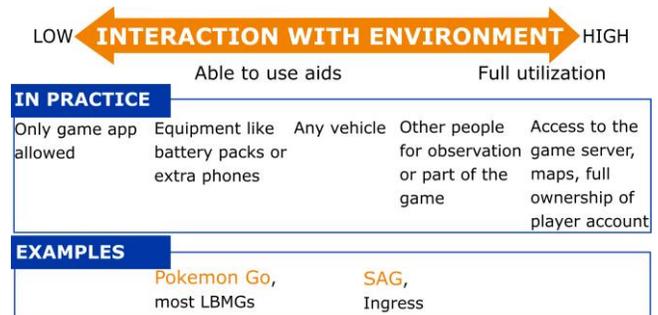


Figure 4. Levels of interaction with the environment including the game itself.

Players have the lowest amount of freedom in interacting with their environment when they can only play the game via a dedicated game application or an online interface. This kind of setup brings the game closer to a well-defined magic circle [29, 49], which is familiar from traditional videogames. The highest amount of freedom in *Interaction with the environment*, we consider to be the ability to not just utilize any tools or privileges the players have but a total ownership of their player accounts and ability to access the game server. Even if there currently are no games designed to give players this kind of freedom or let alone allow it, it is important when considering the potential of LBMGs to recognize the extremes.

DISCUSSION

There is a need for guidelines for applying restrictions on LBMGs. Often, the game developer’s solution to abuse is to

rely on the community to observe and report unwanted behavior [30, 31]. This approach has also been adopted by small LBMGs originating from academic research [4]. What we noticed and what we are communicating in this paper is that characterizing LBMGs is not as simple as dividing the games into commercial and noncommercial academic games. Furthermore, due to variations in LBMGs the affordances and restrictions designed into the game should relate to game characteristics and the motivation of the game developers. In the following, we show the viability of our characterization by two examples: a well-known commercial LBMG *Pokemon GO* [53] and research based *Street Art Gangs (SAG)* [4], where the research data is available to us.

Example 1: Pokemon Go

Pokemon GO (Figure 5) can be characterized as commercial, global and having very high attendance, low orchestration per player and undefined timespan. Its game play involves both exploration and battle [53]. Players collect experience, items, and fantastic creatures known as Pokemon from physical world locations. Pokemon are collected (or captured) using expendable items known as Pokeballs, which the player ‘throws’ at a creature once it appears on their mobile phone screen. After capture, Pokemon can be trained and made to fight in battle arenas known as Gyms. The game is distributed globally and has been installed from Google Play Store on estimate 50-100 million times. The game received a wide audience and enjoyed instant popularity after its launch in July 2016. *Pokemon GO*’s game characteristics are presented in Figure 5.

Pokemon GO players have high freedom of movement (Table 1). The game has fixed coordinates for Pokemon and other relevant locations, but there are no preconceived linear paths. Furthermore, in some locations players can use various devices (available as in-app purchase) to attract Pokemon to a location of their own choosing. The in-game battle system adds an element of interference between players, but the players do not need to be co-located in order to battle.

After the global launch, a new restriction was implemented in an early update. It disabled the use of external applications for visualizing the locations of hidden Pokemon on a map. Furthermore, the intensity of gameplay has already resulted in instances of people injuring themselves while playing [63]. Therefore, another restriction, an interruption to the game-play in a form of a pop-up notification, was implemented to make it more difficult to play while driving.

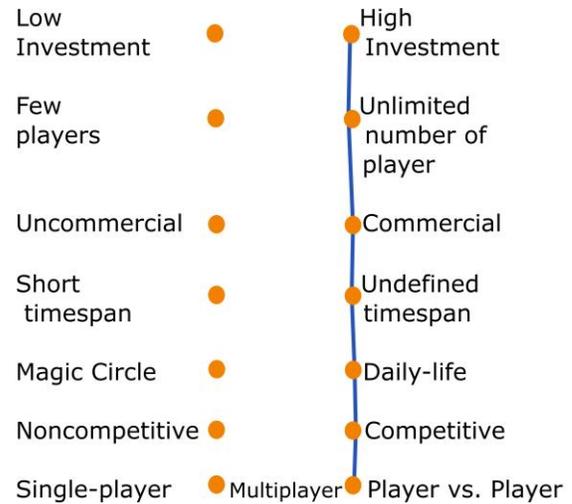


Figure 5. Approximate characterization of Pokemon GO. The blue line visualizes the game characteristics found in Table 2.

Currently, Niantic, responsible for such games as *Pokemon GO* and *Ingress*, is still fighting the disadvantages of hosting their games to a big audience by having to monitor the use of third party software used to cheat in the game. Further, instead of a simple ban of a player account, the punishment is built into the game in a subtler way, which means making the game more frustrating or harder to play for the cheating player and negating the some of the advantage they gain from cheating [7]. This shows that more sophisticated means of restricting LBMG gameplay are not only needed but are already in use.

Example 2: Street Art Gangs

SAG [4] is a research prototype that can be characterized as uncommercial and local with small attendance, some required orchestration and long timespan. It is a game where teams of players play for a restricted amount of time and compete for the ownership of the town, or points. In *SAG*, recruited players *conquered* locations by using their mobile device to ‘spray paint’ a virtual *tag* on buildings or landmarks, for example. Players were also able to *interrupt* competing players while they were attempting to conquer a location, which can be considered as an in-game battle system. The game uses fixed location coordinates, but there are no preconceived paths of movement for the players. The game area was restricted to 0.11-0.26 km² and game hours were limited to daytime. As such, players had plenty of opportunities to observe each other during the game and report any abuse.

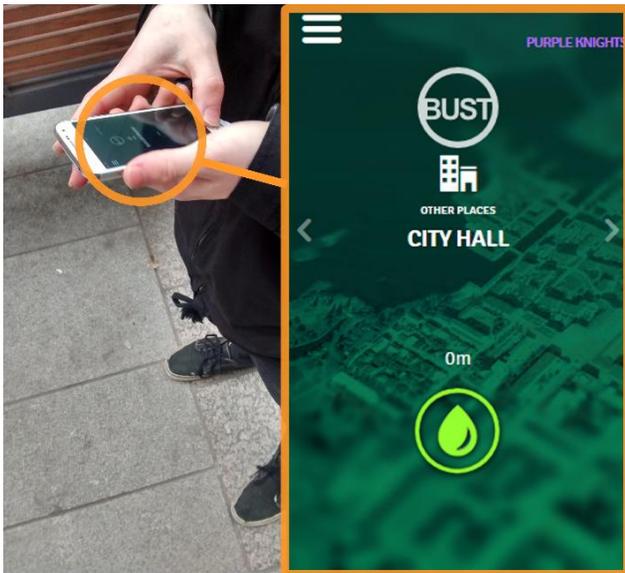


Figure 6. SAG player on the city streets.

Participating players (Figure 6) knew they were taking part in a study.

Unlike *Pokemon GO*, SAG’s characteristics are mostly at the left side of our characterization of LBMGs (Figure 7). They clearly affect the affordances and restriction in gameplay, e.g. the players were allowed to use any vehicle, motorized or otherwise. This was done to encourage community emergent rules. Researchers imposed one rule on their young players during orientation: “Do not neglect schoolwork or other responsibilities during the gameplay”. Authors reported that participants recruited their friends from time to time to observe competing players at the streets. Players also utilized the game app’s leaderboard to see how they were doing in comparison to competing teams, even when they were outside the actual game area.

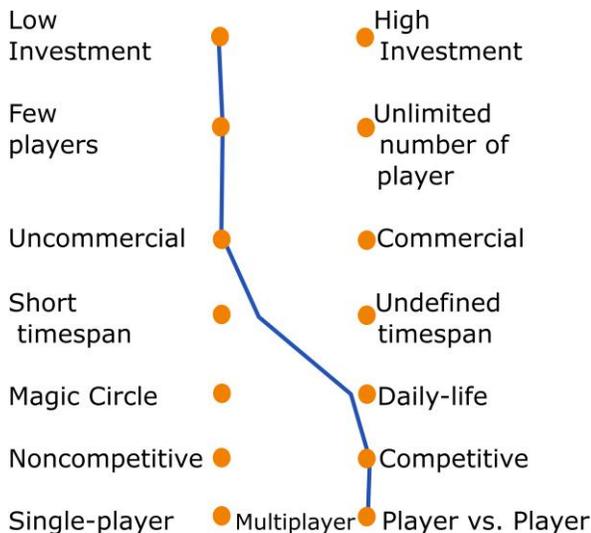


Figure 7. Approximate characterization of Street Art Gangs. The blue line visualizes the game characteristics found in Table 2.

LBMGs Expanding What Is Considered Traditional Gaming

Pervasive games are by definition games that aim at expanding the boundaries of traditional gaming. The three expansions defined by Montola are spatial, temporal and social [51]. De Souza e Silva’s characteristics for hybrid reality games (urban pervasive games) are mobility, sociability and spatiality [67]. She replaced Montola’s *temporal* with *mobility*, a shift that reflects the divide between the old and the more recent location based or pervasive games, i.e. the true mobility provided by the advances in mobile and ubiquitous technologies. These resemble our characterization although the temporal expansion is mentioned as a game characteristic (Timespan) and the spatial and social expansion are presented in our three characteristics of the game space. The expansion of the game space is intrinsic to pervasive games hence we extended our characterization of the restrictions outside the boundaries of what can currently be found in games. Therefore, our study helped us to recognize some ideas for future development of provocative LBMGs. We noticed that there does not appear to be LBMGs, where the players are allowed, without punishment, to utilize their environment for gameplay. The highest possible level of freedom of movement is still unattained as well. This opens an opportunity for designing games where the core game mechanics are developed around the idea of tinkering with player stats or location spoofing. We note that games with self-reported player locations [13] have already done this, but these games have not utilized both positioning with a smart phone and being able to self-report a location, shifting between the two. When it comes to player-player interaction, games allowing psychological battle between players are also scarce in LBMGs, albeit there is witty insult fighting or roasting in other medias. Of course, there are ethical considerations when such games are played in the city streets, therefore also a requirement for designing specific restrictions for gameplay. Further, our research revealed that while there are beneficial location based educational games and exergames, the full potential of LBMGs in societal and mobility training [1, 47, 70] has been largely unexplored. The upside of utilizing busy urban settings for games is that they can help people discover and see their city in new ways, they can encourage new social interactions to occur, and they can result in e.g. health benefits as players become more physically active [1, 47, 70].

Limitations and Future Work

The game characteristics discussed in this paper are derived from the reviewed games. This can be considered both as a weakness in the review methodology and as a strength due to the extensive selection of games. Further, many reviewed reports and papers do not directly mention the restrictions or rules of gameplay; hence, the records of implemented affordances and restrictions are not complete, but the wide scope of games complements this.

Noncommercial academic prototypes have different requirements and ethical considerations to commercial

LBMGs. The presented affordance and restriction categories should be refined to better account for these differences, with special focus on “interaction with the environment”. This is likely to reveal new aspects of so-called *hybrid reality games* [67], where communication and interaction via and with city infrastructure is a defining quality. Some of the hypothesized factors affecting the required number of implemented rules were left out of this inspection due to insufficient material, for example regarding the role of a player motivation or player type (e.g. socializers vs. grievers) [5, 9]. For instance, would the dominant player type in a specific game have an effect on how much rules are needed for players to stay in the game. This does though provide an interesting target for future research. Social motivation is important in LBMGs [9, 41] and one could speculate that the recruitment of players for experimental LBMGs favors the socializer. Furthermore, as the number of players increase, does the number of social players diminish in relation to other player types with other motivation for playing. Will this increase cheating and further add to the amount of implemented restrictions on gameplay?

We also considered using the story content or simplicity of the game mechanics as defining characteristics. However, *Timespan* and *Game type* cover these characteristics. Complex, narrative heavy games can also be multiplayer games. Games with strong backstory like *Zombies Run* [64] or educational games located in museums can have quite simple game mechanics. The narrative seems to affect most at the point where a game moves from simple interactive storytelling to location based LARP. It is not always that straightforward however illustrated by the example of *Geocaching* [23], a game with simple game mechanics can encourage emergence of narrative. One could also argue that the ratio between the number of locations used in the game per player should be a LBMG characteristic. However, the number of used locations can be dynamic or player defined, and often is not reported at all. The *Number of players* included in the characterization has causality with both the amount of locations and the scale of the game area.

The characterization presented in this paper could benefit from a more thorough validation, which would in turn provide a scale between values in the characterization (Figure 5. Figure 7.) and make it possible to develop a more precise metrics for characterization.

CONCLUSION

Implementing and applying restrictions and rules can be considered as a specific form of orchestration. However, as games have evolved and the level of overall orchestration in LBMGs has diminished, the effort on orchestration has shifted from keeping the game up and running to monitoring the players to preventing them from breaking the rules, thus the number of implemented restrictions has increased. This has happened both as the old games like *Geocaching* have aged and as the new commercially viable games like *Pokemon GO* have appeared.

We conducted a systematic review of a wide range of LBMGs to analyze the characteristics and the rules and restriction of 30 games. We further created characterization of the games and affordances and restriction in gameplay. The purpose was to entwine the LBMGs characteristics closely into the design process and aid in understanding the close association between the characteristics and the player affordances in LBMGs. Hopefully, this will benefit the design process of future games and guide on the road to maturity for the current games.

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