Identifying patterns and affordances in location-based games: The practices of Niantic

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Abstract. *Niantic is a global company pioneering in the immersive gaming industry, with this feature driven by location-based game mechanics. This paper identifies and analyzes affordances and game patterns related to players' locations in Niantic's games—Peridot, Monster Hunter Now, Pikmin Bloom, Pokémon GO, and Ingress—to uncover LBG patterns and perceived affordances. The analysis shows that Search-and-Find and Change-of-Distance are the most stimulated mechanics. The impact of these game dynamics necessitates careful implementation in urban environments for healthy and safe gameplay. Affordances in LBGs frequently use real-world locations, and procedural content generation could enhance user experiences without location-based distortions.*

Keywords *Location-based games, LBG, affordance, LBG Patterns.*

1. Introduction

Location-based games (LBGs) have become increasingly popular in recent years. Using the Global Positioning System (GPS) and incorporating augmented reality allows LBG players to experience unique adventures that integrate real-world elements into the digital gaming universe. Numerous companies have been active in this field. For instance, Niantic, Northern Forge Studios, Groundspeak, Six to Start, FourThirtyThree, Square Enix, and Black Bird Interactive displayed game cases in the LBG area [Laato et al. 2019, Laato et al. 2020].

LBGs distinguish themselves by using the player's position in the real world to affect gameplay. These games may demand intense physical activity from players and encourage location sharing with other players. Laato et al. [Laato et al. 2020] exemplify that players can engage in specific activities based on their locations, thus fostering real-world exploration and social interaction.

Sukiyama and Silva [Sukiyama e e Silva 2019] elaborate in their research that games may possess elements capable of influencing human behavior. The range of possible action in a gaming environment, where there is understanding and interaction, is referred to as an affordance.

In LBGs, this affordance can be represented by virtual aesthetic elements on the smartphone screen or spatial coordinates. For example, an image of a compass in a

game, displaying magnetic needles and direction marks, indicates that when accessing that point some activity related to orientation and cartography will appear. The affordance relationship with the game mechanics is crucial for introducing new content or creating progression in the game. In this interface between game mechanics and design elements, authoring tools or automatic content generation tools can be inserted. For LBG game designers it is highly beneficial and productive to use automated content generation tools that produce, for example, the game's missions, content, and affordances on a dynamic scale according to the player's location as seen in the game Bus Runner [Baldwin et al. 2017]. Producing the appropriate affordances for this type of location-based game design context is still an open problem [Bomström et al. 2020]. A literature review from Silva [da Silva et al. 2024] identified a lack of utilization of procedural content generation tools in academia within the LBG domain.

Seeking to identify affordance actions that are used within the industry, this article evaluated Niantic's games, which currently have five LBGs in their portfolio[1]: Peridot, Monster Hunter Now, Pikmin Bloom, Pokémon GO, and Ingress. Niantic was responsible for presenting the first immersive experience to most users on the market, creating expertise and a portfolio to rival companies like Apple, Meta and Google in the market [Sullivan 2022]. The objective is to analyze the design elements and observe the relationships with location-based game mechanics and their perceveid affordances, thereby assessing the state of the art in the use of affordance in LBGs.

This article will be organized into the following sections: Background, where you will find theories and content related to LBG and affodance; Methodology, which explains the procedure, the origin of the process, materials used and also connects the bibliography with the study; Results, where research questions are answered and results are reported; finally, the Final Considerations, where state of affairs, insights, limitations found and future work are placed

2. Background

In this section, the theoretical content for analyzing LBG and affordance will be highlighted, as it is necessary to understand their qualities and nuances.

2.1. Location based game

Regarding LBGs, Laato et al. [Laato et al. 2019] defined them as games where gameplay involves the player's location or a physical location of an object, and where the game experience can be localized or mixed with the real world. This mechanic, which promotes integration between physical and virtual spaces, encourages players to explore places through a virtual narrative.

For years, location-based games (LBGs) have been used in artistic activities. Leorke [Leorke 2019] notes that detailed ethnographic accounts of LBGs are rare in academic literature, attributing this scarcity to the small-scale, bricoleur approach to their projects. Most early applications were confined to a single city and had a short duration. Games such as Shadow Cities, Life is Crime, and Ingress were the first commercial successes in the game industry.

[1]https://nianticlabs.com/products?hl=en

The global popularity of LBG surged with the release of Pokémon GO in 2016 by Niantic. The game allowed players to hunt and capture Pokémon in their cities, incorporating elements of the real world. Smartphones, functioning as an advanced Pokédex, expanded the Pokémon narrative into augmented reality. The integration between physical and virtual spaces created an immersive experience, offering a realistic simulation of a Pokémon trainer's journey.

2.2. Affordance

Hassanin et al. [Hassanin et al. 2021] succinctly define affordance as a set of possible actions that the environment allows an actor to perform. In games, affordance refers to the perceptual cues provided by the game's design that suggest possible actions or interactions from players [Sukiyama e e Silva 2019].

Players' emotional reactions must be taken into account during the initial phase of game design. Designers prioritize factors such as player engagement, enjoyment, excitement, and satisfaction when crafting the gaming experience [Aslam e Brown 2020].

Game designers use affordances to guide players without the need for explicit instructions, typically resulting in a more immersive and intuitive game. Lucas and Bruno [Freitas e da Silva 2020] mention that narratives can even be told and complemented through the design elements of the scenery. These affordances in the game's environment fall within the realm known as Environmental Storytelling.

Cardona-Rivera and Young [Cardona-Rivera e Young 2013] cite cognitivist theory in game design, the idea is that designers should prioritize what players perceive they can do over what they can actually do. He defines that real affordances are the real possibilities for action within the game. Perceived affordances are what players believe they can do, influenced by their experiences and expectations. Finally, feedback consists of perceptual information provided by the system to align perceived affordances with real ones, thus guiding the player's actions.

De la Fuente et al. [de la Fuente et al. 2015] describes the term affordance as utility function or actionable possibilities of an object. Sukiyama and e Silva [Sukiyama e e Silva 2019] mention in their article that each component of an environment has its action to perform and an ability to perceive. For example, a pencil in an office has a high possibility of being used in a writing action. Meanwhile, a pencil in a hairdressing salon may also have a ability to hold the hair. Functions in a scene refer to the roles each element of an environment plays, such as identifying whether a space is a classroom, office, or recreation room, by examining the arrangement, form, color, and sounds of the components within the context.

Davis [Davis 2023] elicits a relationship between mechanism and conditions of affordances, where mechanisms address how technologies are accessible, while conditions address variation between subjects and circumstances. The author explains that the mechanism of actionable possibilities (request or demand) is related to the perception condition. The relation with the artifact response (encourage or discouragement) and the relationship with the dexterity condition, finally, the neutral intensity (Allow) which relates to the cultural condition and Institutional Legitimacy. Perception refers to what a person knows about technology's functions; dexterity over the ability and capacity to

operate a technology; and Cultural and institutional legitimacy refers to the degree of support (or lack of support) in the development of a technology operations.

The relationship that this affordance has with the game mechanic is a crucial point of analysis. In this interface, automatic content insertion is possible. In the article by Sarkar et al. [Sarkar et al. 2020], the proper use of functions for level creation with affordances along with procedural content generation tools allows for obtaining new game scenarios.

3. Methodology

Compiling the understanding of previous works, the present exploratory study is an observation, comprehension, and analysis of design elements and their relationship with LBG mechanism patterns. This work analyzed the available LBG portfolio from Niantic intending to check affordances in LBG mechanics used in the industry. From this objective, two research questions are generated: QP1 - What are the LBG patterns adopted in the analyzed games? and QP2: What are the affordance functions found and their relationship with LBG patterns and the level of virtuality of affordance in the analyzed games?

Following methodologies similar to Aslam and Brown [Aslam e Brown 2020], Sukiyama and e Silva [Sukiyama e e Silva 2019], Perani and Duarte [Perani e Duarte 2017], Valente et al. [Valente et al. 2017], and Silva [Silva et al. 2022], we defined a literature study phase that was concluded with the definition of a list of LBG Patterns and affordance locality classification to be analyzed. With these filters ready, the indexing of functions was initiated, followed by an exploratory analysis of Niantic games, through the download and execution of each game (playtest) in search of filtering the dynamics of each game, extracting the perceived affordance, and identifying the locality link of this element. Finally, this identified function was validated through documentation offered by the company.

3.1. Literature Review

3.1.1. LBG Patterns

Observing the works involving the classification of LBG Patterns over the years by Lehmann [Lehmann 2012], Ferreira et al. [Ferreira et al. 2017], and Ferreira et al. [Ferreira et al. 2019], we will use the following coding in the following tables: (P1) Search-and-Find where the player searches for a point, (P2) Follow-the-Path where the player follows a path, (P3) Chase-and-Catch where an player seeks a moving object, and (P4) Change-of-Distance player walks any distance.

3.1.2. Virtuality of affordance in LBG

Jachna [Jachna 2021] describes in his book that Locational Affordance is the relationship of opportunities and possibilities that a location offers about actions and activities. Woodill [Woodill 2014] states that Geospatial data (which is a type of locational affordance) is recognized as capable of integrating various types of information

comprehensively, even explaining past and present activities in locations. LBGs using Locational Affordance are capable of blending physical and digital worlds in the game.

The presence of affordance in a Location-Based Game (LBG) environment can originate from three sources: Virtual Objects (VO), Virtual Objects with Real coordinates (VOR), and Real Objects (RO). VO are limited to the software scenario and lack locational context, such as an affordance appearing in the middle of a lake without cartographic consideration. VOR are virtual objects linked to real points of interest but do not influence the game flow based on location, serving only logistical purposes. For instance, a task at a generic location within 300 meters. RO are real objects where location impacts the game, using locational affordance to generate context or narrative, like collecting GPS coordinates or temperature data from a region. An example of an RO is a mission requiring players to visit a real-world gas station to update game status. This classification highlights the varying roles of virtual and real objects in shaping LBG environments.

3.2. Materials and Methods

The tests were conducted on two devices. The first device was the Motorola Edge 20 Pro (MEP) with Android version 13 and no active accessibility features. The second device was the Poco F5 (POCO) with Android version 13, also without any active accessibility features. In both devices, only the GPS was turned on for gameplay.

3.3. Sample

In this research, an analysis of five LBG games from Niantic was conducted. In both devices, MEP and POCO, the game versions respectively were: Pokémon Go - 0.309.0; Monster Hunter Now - 74.1; Peridot - 1.16.0; Pikmin Bloom - 92.0; and Ingress - 2.139.1.

3.4. Analysis Procedure

To analyze affordances, Aslam and Brown [Aslam e Brown 2020] provides the guide in which the playtest is a way to identify and analyze these elements. Also observing the methodologies found in the articles of Silva et al. [Silva et al. 2022] and Valente et al. [Valente et al. 2017], we modularized the research into two stages: an exploratory analysis and a documentary analysis. For the first stage, the games were downloaded and executed. Then, the exploration of each game began by listing the utility functions of affordances that required or linked displacement as a means to achieve some objective in the game. Next, with the list of these activities, we proceeded to analyze the documentation provided by Niantic[2] for each of the games. The listed behavior was observed and validated, and the concept was checked for correctness.

These stages were independently carried out by two researchers, compared, and validated in their lists in a peer review format at the end of each stage. The flow of the research is illustrated in Figure 1, where Step 1 involves evaluating the game, Step 2 evaluates the results of the exploration by the other evaluator, Step 3 conducts the literature search for each identified action, Step 4 evaluates the results of the documentary search by the other researcher, and finally, Step 5 is the merging of the identified function list.

[2]https://niantic.helpshift.com

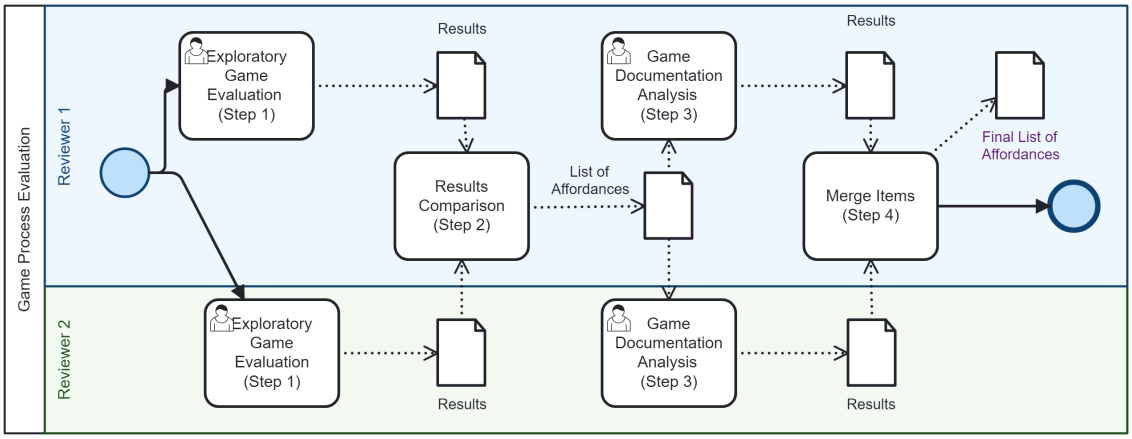

Figura 1. Research steps. Source: Authors. Images: Camunda Modeler.

4. Results

In this section, the research questions were addressed. The outcome illustrates Step 5 in the flow depicted in Figure 1. The tables where the raw results are displayed are on the Zenodo website[3]. When the article references the data table collected in a game, it means that it is referring to a Spreadsheet in the file whose title is the name of the respective game.

4.1. QP1: What are the LBG patterns adopted in the analyzed games?

In Table 1, we identified that in the game Monster Hunter Now, actions related to LBG mechanics predominantly exhibit patterns P1 and P4. In Pokémon GO, the same pattern as Monster Hunter is followed, with variations combining P1 and P4 for the same action. However, it presents a Follow-the-Path mechanic for route actions, as seen in Table 1. For the game Peridot, there is a predominance of the Search-and-Find mechanic, with only one action using Change-of-Distance. Pikmin Bloom predominantly exhibits P4, with one action classified as P1 and one as a combination of P1 and P4. Lastly, in Ingress Prime, there is a predominance of P1, with only 4 out of 18 actions classified as P4.

Tabela 1. Overall result of the LBG Patterns analysis. Source: Authors.

Game	Search-and-Find (P1)	Follow-the-Path (P2)	Chase-and-Catch (P3)	Change-of-Distance (P4)
Monter Hunter Now	X	-	-	X
Pokémon Go	X	X	-	X
Peridot	X	-	-	X
Pikmin Bloom	X	-	-	X
Ingress	X	-	-	X

[3]https://doi.org/10.5281/zenodo.11193152

4.2. QP2: What are the affordance functions found and their relationship with LBG patterns and the level of affordance virtuality in the analyzed games?

The obtained results highlight the influence of space on player immersion with the presence of a particular identified action. Additionally, the relevance of elements present in the scenario is emphasized, as they are central actions in the game dynamics, and it is described how each case is understood in relation to interaction possibilities and their relationship with LBG mechanics patterns. The results tables below are identified in the columns as follows: Column 1 - affordance function described as an action, with an affordance linked to the game's MDA, Column 2 - LBG Patterns, and Column 3 - level of affordance virtuality (LAV).

Looking at these results, we do not perceive a predominance of just one LBG Pattern, but rather two spectrums: Search-and-Find and Change-of-Distance. It's worth noting the almost total absence of the Follow-the-Path pattern, with only one occurrence of P2 found in Pokémon GO, stemming from a feature created less than a year ago. Additionally, the Chase-and-Catch pattern is absent. Understanding these two types of underutilized patterns and considering the wide range of player profiles and all the issues involved in playing the game with attention and safety [Laato et al. 2019], these mechanics would strain the player with extreme physical demands and could compel them to follow certain paths instead of exercising caution and attention. For instance, P3 could prompt the player to search for an object while restricting another variable such as time or specificity (only that object can be collected under certain conditions of evolution). On the other hand, not enforcing route following (P2) could lead to a lack of player physical safety, and they might comply if the route is rigid, for example.

Another analysis we need to perform is to determine which layer creates the appearance of this affordance to initiate the link with the mechanic. LBG has this intrinsic characteristic of blending reality with virtuality, depending on the theme, even being able to merge both into an immersive narrative. In the game Monster Hunter, there are affordances with the game's theme that link to points of interest in reality. Some actions link to randomly created virtual objects (for example, marking a monster to hunt later), and others are implied by the player, such as a reward mechanic for displacement, which is the automatic collection of items by the Palico, which does not require physical displacement of the search-and-find type.

In the game Pokémon GO, there is a presence of VO and VOR affordances. In particular, there are RO affordances for two actions: scanning PokéStops and weather changes. For the first one, it involves "scanning"reality, where a point of interest is identified and updated. Typically, other software like Campfire is used as a data generation source by users. For example, a PokéStop can be added there. This association is made thematically. As for the second point, it involves weather changes. In this case, Pokémon "adapted"to the weather are more likely to appear for the player. In Peridot, this sharing of photographs/videos to Campfire is explicit. Only one mechanic is related to a virtual affordance, which is the retrieval of dots, which can appear randomly or be linked to a map point.

The Figure 2 are from the game Pokémon Go. In Figure 2 (a), at the top right, we highlight green, red, and blue circles that become affordances that represent in the game weather, navigation (route), and radar (association introduced by the game's storyline),

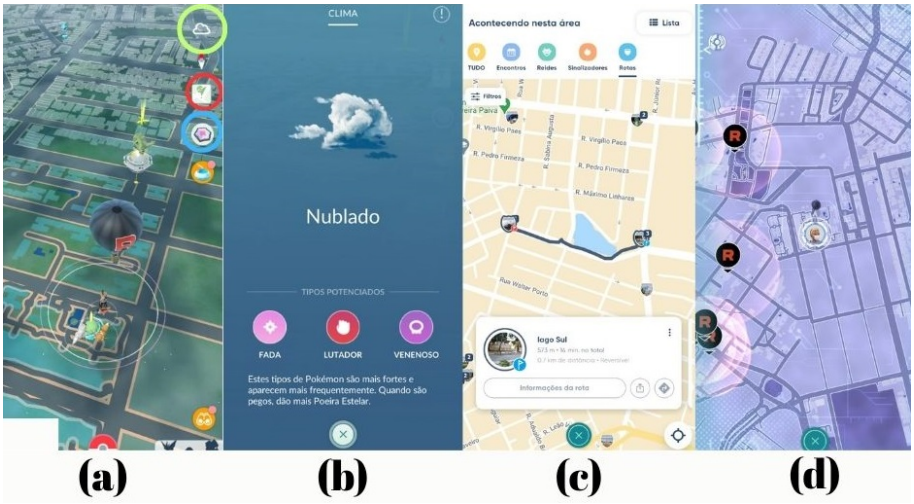

Figura 2. (a) Main screen with green, red, and blue circles marking affordances resulting in screens (b), (c), and (d). (b) Route display, (c) Weather display, (d) Event radar. Source: Authors

respectively.

Still analyzing Figure 2 (a), there are design elements that capture the player's attention. In addition to the virtual interaction with the Pokémon that randomly appear on the map (OV), there are Team Rocket balloons (OV), which, clicking on them, causes a confrontation with them, and a pokéstop that has a color indication, informing which faction of the game maintains the POI, in this case, is located in a water tank (OR).

In Figure 2 (c) where points on a route are presented, similar to highway signs, these points are not necessarily linked to a point of interest (RO), but to a position in the map (VOR).

Pikmin Bloom has a reasonable variation of VO and VOR affordances but no RO. Lastly, Ingress predominantly presents affordances related to real points, except for three: in the creation of Kinetic Capsules, listing metric data on the map, zooming on the map, and finally, the activity of decoding Shaper Glyphs.

In Figure 3, the weighted average frequency of P1 is 6 and P4 is 5. Showing that in general between games there is a variation similar to both patterns. A fact to highlight is only one appearance of the P2 pattern in Pokémon Go and in the record of P3. The P1 and P4 patterns vary between games.

In Figure 4, the weighted average frequency of VO is 4,2, VOR is 7 and RO is 0,6. Showing that in general between games there is a variation similar to both patterns. There is little intervention of locational affordances within the games analyzed. This is an opening point for researching how to correctly adapt these qualities in games.

5. Final Considerations

In this section, reflections on the research will be concluded, and the utility in future work will be addressed.

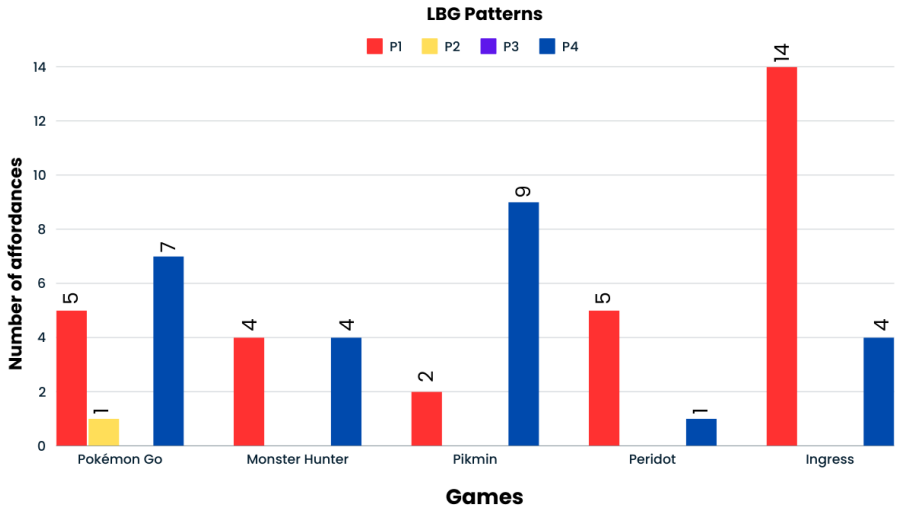

Figura 3. In this bar chart, the Y dimension indicates the frequency of appearance of LBG patterns and dimension X the games analyzed separated into groups. Source: Authors

5.1. State of Affairs e Insights

This article analyzed and observed behaviors in Niantic's LBG games, portraying the state of the art of a company in the sector. As one of the future works, other portfolios from other companies will be analyzed to identify continuities or innovations.

Regarding the analysis methodology, there were no major discrepancies in the identification of actionable possibilities affordances by the two evaluators, but in the classification of LBG Patterns and identification of virtuality, a more comprehensive dialogue involving other researchers was necessary for filter selection. The most complicated game to list for was Ingress, which has layers of content for understanding.

Knowing these frequencies and particularities of LBG mechanics in Niantic's game design, one can infer practices that are reused, providing points for future analysis to check if their observed use by players, for example, can generate different dynamics in the game or increase engagement. There are also data on practices that are not widely used, possibly due to the issue of using the game in urban environments, and mechanics such as Follow-the-Path or Chase-and-Catch need to be carefully evaluated for their implementation in contexts that allow for healthy gameplay; they may be included in game design.

In the part that interfaces the player with the system, facilitating understanding and also stimulating the player's ludic experience to ensure that the physical aspect of locomotion is plausible to achieve the game's objectives, the affordances in these LBGs generally use a location as support. A wall figure, a bench, a water tank, and many other points of interest in reality are suitable for anchoring at a VOR level. The story may even qualify by filtering these points and allowing or not allowing manipulations performed by users in Campfire, for example, depending on the restrictions and purposes.

For affordances that use VO, it is easy to highlight it as an element of easy use in the game context since the restriction is limited to a location, open, without fixed ties to real points of interest. It is easy to conceive in these actions a possible entry for the

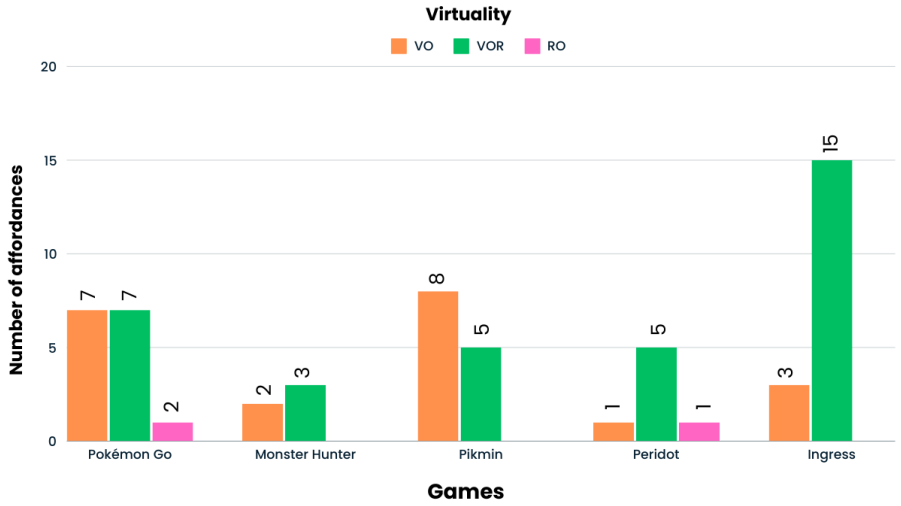

Figura 4. In this bar chart, the Y dimension indicates the frequency of appearance of virtuality of affordance in LBG and dimension X the games analyzed separated into groups. Source: Authors

use of procedural content generation (PCG) tools or algorithms. Automation with PCG is the standardized way for a user in any location to have an affordance generated without distortions.

Observing Figure 2 (a) from Pokémon Go, we see examples of affordances inside the green, red, and blue circles representing weather, navigation (route), and radar (association introduced by the game's storyline), respectively. Each of them targeting a different context and dynamic. The player perceives the information and the possibilities of taking an action that are related to locomotion or that affect this context.

Finally, the use of RO by actions generally indicates some sharing of real data, as a form of proof. An example of usage was done in Pokémon GO with the PokéStop scanner and the sharing of points of interest in Peridot. There is the use of augmented reality in some games, where the scenario used is the one present in the player's reality, but in this case, they did not enter our filters as LBG Patterns mechanics were not identified in them.

5.2. Limitations and Future Work

Limiting the analysis to games from Niantic may lead to a loss of generalizability of the research results, but as it is a globally successful company in the market, the results have variations and innovations approved by the public, as these games have already gone through alpha and beta phases.

Regarding the analysis of games carried out in other studies, there is a lack of methodology in these articles where the data cannot be replicated. And a crucial factor for reproduction that this article brings is the game's version number.

Despite attempting to use a peer review methodology, some patterns and affordances may not have been correctly identified. In future work, expanding the list of games and increasing the number of evaluators will allow for greater generalizability and academic utilization of the results. And there is still an explicit dependence on the developer documentation.

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