Using Machine Learning to Understand the Motivations of Pokémon GO Players

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***Abstract*—Pokémon Go is the most popular augmented reality games in world which makes it a primary candidate for study. This paper uses clustering to assess the motivations of Pokémon go players to understand the state of the game and further assess what the game offers to audiences that gives it a unique place on the market. In turn we can see what features the game lacks expressing what facets of the game can be improved on. This of course has ramifications on the player experience as well as financially for the developers.**

Keywords—augmented reality, player motivation, clustering, Pokémon GO

I. Introduction

Pokémon GO (PG) was and still is one of the most popular augmented reality (AR) products in the public sphere since its release in 2016. Its combination of merging real world landmarks with one of the most popular media franchises of all time and the massive revenue it can generate have led to a boom in other franchises like Harry Potter joining in on the AR mobile game craze. Despite peak usage going down since its initial release, revenue has only been increasing (Iqbal, 2021). People play games for a variety of different reasons (Yee, 2006), so the additions made to the game over the years must have therefore captured the core audience to keep playing and spending on the game. Discovering the motivations of players is an essential way of improving the player experience which would then lead them to playing more.

This paper aims to capture a snapshot of the current state of PG in 2021 through the lens of understanding what motivates people who are still currently playing the game. We can achieve this through clustering players into groups by motivation and then assessing what differences the game has made to capture these group types. In turn, we could also potentially see what the game is missing to capture a larger audience. This of course could have implications for revenue on the publisher side while also creating a better player experience.

II. Literature Review

A. Augmented Reality

Milgram and Kishino (1994) devised a spectrum of mixed reality combining real and virtual environments. AR falls into the middle of this spectrum. AR can be defined as the merger of real and digital information in a real environment where virtual objects can be superimposed and interacted with in real time (Höllerer and Feiner, 2004). This stands in contrast to Virtual Reality (VR) in which entire virtual environments and virtual objects are fabricated and interacted with (Azuma, 1997). The advancements in mobile technology in the past two decades has given us significant computational improvements, camera enhancements, geo-location and sensory systems allowing games to be played almost anywhere (Chou and ChanLin, 2012). AR games are in position to make the most of these features, as reality can be virtually altered with ever-increasing fidelity and immersion. Immersion had previously been seen as a one-way effect of media causing passivity or numbness within the user (Read and Bohr, 2014). Shin (2019) counters this by redefining immersion as something that users are in fact fully engaged and intentional in their media/game (Shin and Shin, 2011), whilst also observing users making personal judgements on the quality of the product by looking at technical qualities as well as engaging features. It is these two tenets that define immersion, and they inform each other. The user's engagement and quality of the product overall drives immersion. It is essential for games to understand the motivations of their audience to maximise engagement, keep the player base up and thus remain economically profitable.

B. Player/User Motivation and Clustering

Uses and gratifications theory suggests that people take an active role in seeking out and choosing media that satiates their psychological needs. This theory can be used as the foundation at which we can assess player/user motivations for various types of media, including websites and online games (Luo and Remus, 2014; Wei and Lu, 2014). Bartle (2004) hypothesised the earliest motivational model regarding video games through the observation of Multi-User Dungeons. The model highlights four key playstyles/motivations. "Killers" aim to dominate other players; "Socialisers" are the opposite, preferring to create relationships with other players and role playing within the game. "Explorers" are motivated by pushing the limits of what the game has to offer both structurally and mechanically; "Achievers" are typically concerned with completing the goals set out by the game. Unfortunately, this model was not empirically tested by Bartle. Yee (2006) successfully adapted Bartle's initial research and managed to enhance the model using a forty-item questionnaire through the lens of "Massively Multiplayer Online Role-Playing Games (MMORPGs)". Yee's work identified ten motivations for playing MMORPGs which were then further categorised into three key motivational groups. These were "Achievement" (advancement, mechanics, competition), "Social" (socializing, relationship, teamwork), and "immersion" (discovery, role playing, customization, escapism). The results of this study implied that players do not exclusively belong to one group or the other but can be a combination of

the three. It is notable that Yee's research did not express anything novel to Bartle's original model instead simply refining it and providing empirical evidence. Frostling-Henningsson (2009) conducted similar research instead focussing on first-person shooter games and came to similar conclusions highlighting the social and immersive motivations as the key motivations for players of that genre. An issue with these studies is that they only cover one or two genres of game and not a holistic interpretation of the motivations of players. Demetrovics et al., (2011) aimed to resolve this by developing a unified questionnaire based on interviews with participants and literature reviews thus creating the "Motives for Online Gaming Questionnaire (MOGQ)". Confirmatory factor analysis was conducted to test the suitably of his questionnaire items and motivational factors. The MOGQ contains motivational factors like that of Bartle, Yee and Frostling-Henningsson including Skill Development, Escapism, Coping, Fantasy, Competition, Recreation and Social. The largest schism between this research and Yee's is the distinction between Coping and Escapism. The former potentially deals with problematic gaming that aims to reduce the stresses of life whereas the latter is simply about immersion into the virtual realm. The literature discussed here deals with traditional online video games meaning there is room for exploration in examining AR games and how the fusion of the real and digital can affect player motivation.

Clustering is defined as "the unsupervised classification of patterns (observations, data items, or feature vectors) into groups" (Jain et al., 1999). The various forms of clustering have been used for player behaviour analysis in games through user telemetry compiled within the games themselves and offer developers a deeper look into the actions of players. Player analysis is paramount to improving the player experience with telemetry supplying evidence of issues affecting the experience. This is exemplified in Drachen et al., (2009) and Drachen et al., (2014). Drachen et al's., 2009 research deals with player modelling behaviour using telemetry with the single player action game Tomb Raider: Underworld where k-means clustering is used to provide an early insight into player clustering. Emergent Self-organzing Maps were then applied to visualise the clusters, but this goes beyond the scope of the present study. Drachen et al's., 2014 study is more relevant to the present research due to its focus on multiplayer games. They compared various unsupervised clustering algorithms to produce behavioural clusters from the MMORPG "World of Warcraft". They concluded that k-means clusters before applying and archetypal analysis result in clusters that are most easy to interpret when compared to principal component analysis and non-negative matrix factorisation. The study notes the recency at which archetypal analysis has been developed to handle large datasets and further underlines its usability. The key commonalities between the two Drachen studies is the use of k-means as the main form of clustering. A central difference between Drachen et al., (2014) and the present study is the use of user telemetry and self-reported data. While self-reported data may result in issues with reliability due to bias and variance the telemetry of PG is not readily available, nor would it necessarily be useful when questioning the motives of players in contrast to studying actual player behaviour.

C. Pokémon GO

PG was released in 2016 and at the time of writing PG remains the most popular AR game in the world making it a prime target for study. Harnessing camera, location and sensory technology players set out in the real world capturing virtual creatures and 'training' them to compete against other players. The majority of PG literature focusses on its potential health benefits (Khamzina et al., 2020) as well as its impacts on social geography due to the games focus on locations and local landmarks (Colley et al., 2017; Oleksy and Wnuk, 2017).

Research has been conducted on PG and its motivational factors. Yang and Liu (2017) studied the motivations of PG players and how they may relate to physical and mental well-being. The motives identified for this paper echoed the motives discussed in the MOGQ with the added motive of exercise due to the mobile nature of PG. Positive associations were made between all motives apart from Escapism and Nostalgia. Yang and Liu did not make the distinction between Coping and Escapism Demetrovics et al., did but they cited the notion of immersing yourself in another world or ruminating in the past as having associations with poor mental health. While associations were made, causality between motives and well-being were not made suggesting a longitudinal or experimental designs are needed to resolve this. Lack of longitudinal data is a common theme among PG literature as is the research conducted by Zsila et al., (2018). Zsila et al., aimed to associate player motivations and impulsivity due to associations between problematic gaming and impulsivity (Liau et al., 2015), of which there were none. Furthermore, the motives presented in the study coincide with the research conducted by Yang and Liu and Demetrovics et al. Personality has been shown to influence motivation and game preference (Johnson and Gardner, 2010) making studies on PG and personality correlates relevant. An early study on PG and personality viewed the game through the lens of 'the Big Five' (Tabacchi et al., 2017). Tabacchi found that players were more introverted and closed whilst being highly conscientious. In contrast to this Mattheiss et al., (2017) found that players were highly conscientious and social. Reasons for this include cultural differences in the samples used as well as the time frame. Mattheiss et al., performed their research in two different timeframes where some players in the first study had stopped playing three months after the initial survey. Tabbachi et al., performed their study at a single point in time early in the games' release window expressing that the players in their sample were more likely to stop playing the game. Mattheiss et al., highlighted the need for more socially orientated and spontaneous game features to capture a greater player base and keep the present one, which further begs the question on whether the PG developers have successfully achieved this. While the present research is not longitudinal, PG has been constantly updated and changed since its initial 2016 launch leaving room for study of the current state of the game and its players and what the game may need in 2021 and onwards. Cultural differences in samples have been noted as a limitation of some research (Ghazali et al., 2018; Tabacchi et al., 2017), so by not limiting the sample to one country or university and opening the study up to players of potentially many different backgrounds

through the Internet we can ascertain a wider view of the player base.

III. Methodology

A. Data Collection and Sample

A 28-item survey (Appendix 1) was created based on the items found in Yee's questionnaire and Demetrovics et al's., MOGQ but were adapted to better suit the nature of PG. For instance, motivations like coping and exercising were taken in account following the research of Yang and Liu (2017) and Frostling-Henningsson (2009). Furthermore, the language in the questions were made more PG specific. For example, the question was regarding "Acquiring rare items" was spilt into two due to the presence and collection of both items and Pokémon are essential to gameplay but offer different uses. Basic demographic questions questioning gender and age were also included. Most questions were answered using likert-scales ranging from 1 (strongly disagree/most negative response) to 5 (strongly agree/most positive response). The survey was implemented online using Google Forms and later distributed on several PG focussed internet forums and communities, the most significant of which was r/pokemongo on the website reddit.com. An optional raffle was conducted offering four £10 AppStore/GooglePlay vouchers to gain more participants. Participants had the option to opt into the raffle by providing their email address with their survey. This of course raises security issues, but the emails were parsed out of the dataset and kept separately to keep the data anonymous. Emails were the only form of personal data taken and were used for the sole purpose of contacting raffle winners. The survey gained a total of 72 responses. 51 (70.8%) of the respondents were male making the other 21 (29.2%) female. There was an "Other" response which was not used. Regarding age 44.4% of participants fell into the 23-27 age range with the 18-22 age range being second at 29.2%.

B. Analysis Methods

The collected data was recoded into numerical variables in Microsoft Excel. This data was then analysed and later presented using R and R studio. Analysis was performed in two stages. Stage one involved assessing the correlation coefficients of the survey questions in order to assess their relationships to each other and check their validity as a means of assessing player motivations. The second step involves k-means clustering to group participants onto a motivational model, particularly Yee's model.

C. Correlation Coefficients

Correlation coefficients are used to present the degree of linear association between two variables, or in other words how strong the relationship between two variables are (Taylor, 1990). Due to the use of ordinal data in this study in the form of Likert items, Spearman's correlation was deemed most appropriate (de Winter et al., 2016). The formula for Spearman's coefficient is:

$$r_R = 1 - \frac{6\Sigma_i d_i^{\,2}}{n(n^2-1)} \tag{1}$$

n= number of data points of the two variables
di= difference in ranks of the "ith" element

D. Clustering

Clustering is defined as the process of taking raw data and grouping similar data similar objects together in a cluster; other data is separated into other clusters with other similar traits. *K*-means clustering is an iterative, unsupervised learning algorithm and is a popular method of clustering due to its simplicity on top of being a readily available package in most data analysis software (Na et al., 2010).

The *k*-means algorithm follows these steps and is (Kodinariya and Makwana, 2013):

$$W(S, \boldsymbol{C}) = \sum_{k=1}^{K} \sum_{i \in S_k} \| y_i - c_k \|^2 \tag{2}$$

1. Place *k* points in the space represented by the objects that are being clustered. These points represent initial group centroids.
2. Assign each object to the group that has the closest centroid.
3. When all objects have been assigned, recalculate the positions of the k centroids.
4. Repeat Step 2 and 3 until the centroids no longer move.

The central tenet of k-means clustering is to highlight *k* centroids for each cluster, in other words *k* is the number of clusters that are being made. This further begs the question on how to find the most suitable number for *k*.

The rule of thumb for finding *k* is defined as (Kodinariya and Makwana, 2013):

$$K = \sqrt{n} - 2 \tag{3}$$

Where *n* is the number of data objects.

The Elbow method is the oldest method for finding *k* and is a visual method (Ng, 2012). As the number of clusters increase the cost decreases and we want to decrease the cost until we reach a point with diminishing returns. In this sense the cost is the sum of the squared distance from the points of their respective centroids. The Elbow is a distinct bend we can see in a graph shown in Figure 1. However, a downside to this is that occasionally, the elbow is not visually distinct seen in Figure 3.

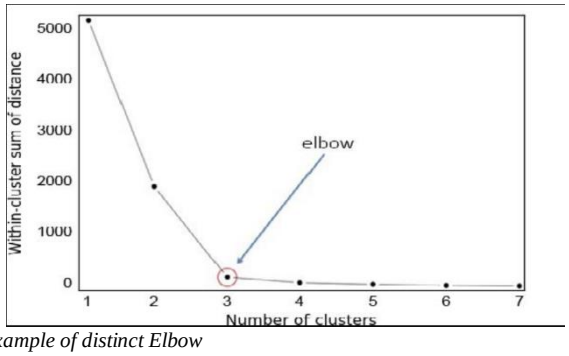

Fig. 1. Example of distinct Elbow

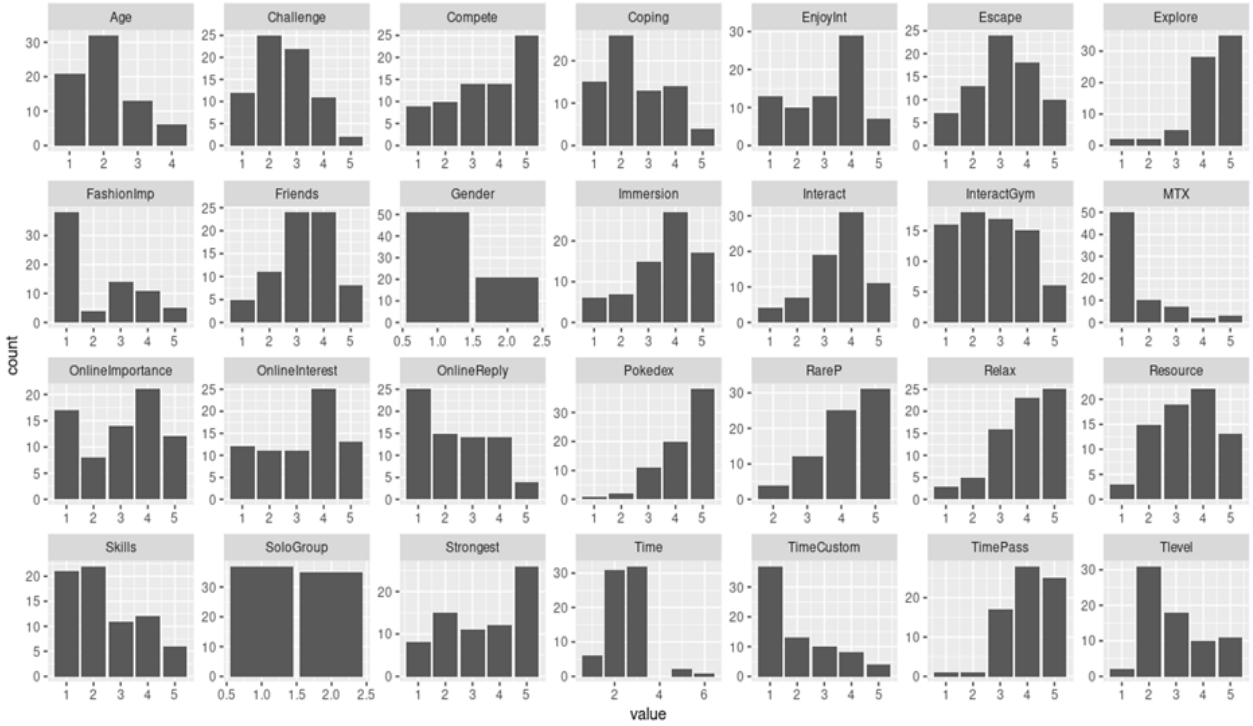

Figure 2: Responses for each variable

The Silhouette method is another popular method of finding *k* and is often used in conjunction with other methods to judge validity. The algorithm for the Silhouette method is (Kaufman and Rousseeuw, 1990):

$$s(i) = \frac{b(i) - a(i)}{\max(a(i), b(i))} \quad (4)$$

Where: *a* = the average distance between each point in a cluster

b = the average distance between all clusters

Values range from -1 to 1 where -1 means clusters are poorly assigned. 0 means clusters are likely to overlap. 1 means clusters are appropriately distinguished from each other.

IV. Results

A. Univariate Analysis

Figure 2 shows bar graphs of all the variables and the related questions appear in Appendix ***. The x-axis relates to the 5-point Likert-scale ranging from 1(strongly disagree/most negative response) to 5 (strongly agree/most positive response). The variables which relate to motivations of Competition and Power are Challenge and Skills which offer low levels of engagement; conversely Strongest and Compete show greater show much higher levels of interest from participants. Additionally, variables that cover the motivations of Achievement show an emphasis on collection. Pokedex, RareP and Resource relate to the completion motivation on Yee's model and show positive engagement. On the contrary, Tlevel had a mostly negative level of engagement with regards to the Achievement motivation.

Variables that refer to sociability include *EnjoyInt, Friends, Interact, InteractGym, OnlineImportance, OnlineInteract, OnlineReply* and *SoloGroup*. Aside from *OnlineReply* and *SoloGroup*, most of these variables show positive interaction. It is important to distinguish the two types of sociability present in these variables; someone deal with face-to-face interaction whereas others deal with online interaction. Evidently, the data expresses a link between the two that perhaps online sociability will lead to in person sociability. *OnlineReply* however shows that while people might be on these online message boards, they may not always reply to posts on them, instead using them for information in the lead up to "community days" which are conducted in person. *SoloGroup* questions whether the participant prefers to play on there own or as a group. Considering the amount of time players spend on the game (mostly 20-40 min according to *Time* variable) it is no surprise people don't usually organise something with their peers. The desire for group play may again stem from official "community days".

Immersive variables include *Coping, FashionImp, MTX, Escape, Relax, Explore, TimeCustom* and *TimePass*. Within this category include the role-playing side of immersion. *FashionImp, MTX* and *TimeCustom* deal with the ability to customise and buy outfits for your character, sometimes with real money. This facet of the game saw the

least amount of engagement from participants. Aspects that relate to the escapist side of immersion saw a much more mixed response. The variable in this field that had the most positive response was TimePass. This questioned the participant about whether they lose track of time when playing the game. The positive response to this variable hints that people play the game out of boredom.

B. Correlation Coefficients

Figure 3 contains a heatmap which visualises the correlation coefficients of the survey questions. The results express a strong positive correlation within the centre of the graph, where the questions regarding sociability reside. Other strong positive correlations feature at the bottom of the heatmap featuring the parts of the questionnaire that deals with escapism. A person who enjoys the act of socialising would logically be more predisposed to socialising more often. There are few strong negative correlations. The few of note include the *Pokedex* and *Challenge* variable. This is perhaps due to the simple nature of the Pokémon catching gameplay. The inverse of this would be the strong positive correlation between *Challenge* and *Compete* which deals with the player vs player element of the game which features a remarkably different style of gameplay.

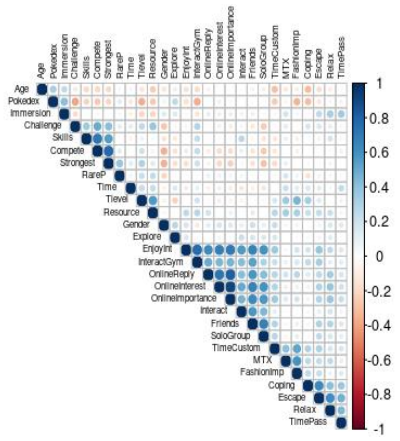

Figure 3: Correlation matrix of variables

C. Clustering

The first step in k-means clustering is to figure out what k is, in other words to find out the most appropriate number of clusters. There are two main methods of finding k, the first being the elbow method shown in Figure 4. Additionally, the silhouette method (Figure 5) was used to assess the validity of k. Evidently, they have different preferences for what k ought to be, 4 and 2 respectively. This may be due to the small sample size.

Figure 6 is a visualisation of the clusters where k = 2. The x-axis can be seen as a measurement of sociability, whereas the y-axis can be viewed as a measurement of role-play, escapism or indeed flow. The cluster towards the right is clearly defined by its link to sociability, the tightness of cluster reinforces the relationship between the variables in the cluster. The cluster on the left encompasses all the other variables. It is perhaps too large and unclear as to what this cluster represents.

Figure 7 is a visualisation of the clusters where k = 4. The clusters here are more clearly defined with the left-most cluster being clearly conveying the motivations that deal with action, competition, and strength. These players are more likely to take part in the Player vs Player aspect of them game. The cluster to the right remains the same. The top and bottom cluster is less easily definable. While the top cluster has common threads of Role-play and Escapism, the variables relating to the motivations of Achievement are also present (*Tlevel* and *Resource*). This is notable due to the *Pokedex* variable appearing on the bottom of the graph when one could assume these variables would appear closer together due to one of the core pillars of PG gameplay being to try and fill out the *Pokédex*. The bottom cluster generally seems to contain outlier variables that don't fit into the other clusters or share strong correlations with other variables. As aforementioned one would expect the *Pokedex* variable to be with other Achievement centric variables; the same could be said with the Immersion variable and other role-play/escapist motivations. This could be due to the low sample number. If we refer to the rule of thumb, $n = 72$ we get 4.2. We can then deduce that 4 is likely to be the true value of k.

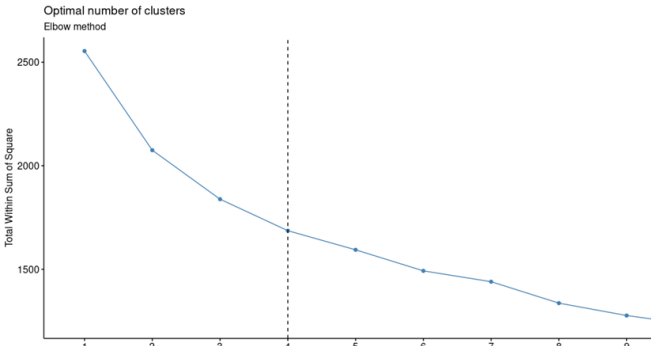

Figure 4: Elbow Method

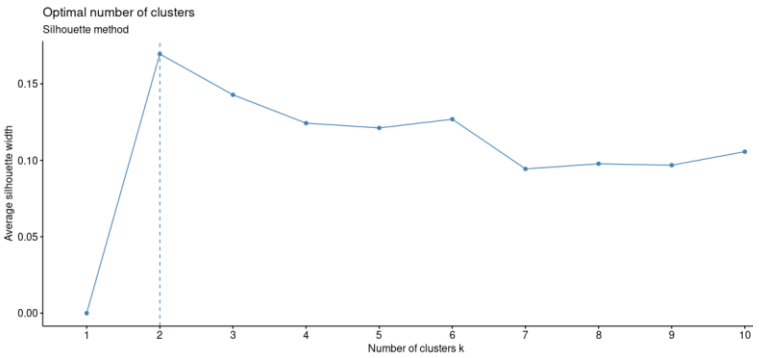

Figure 5: Silhouette Method

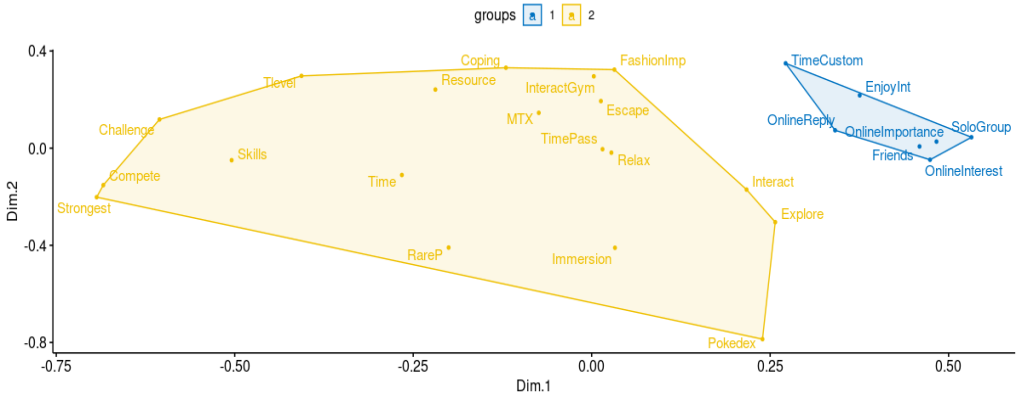

Figure 6: Cluster graph where k=2

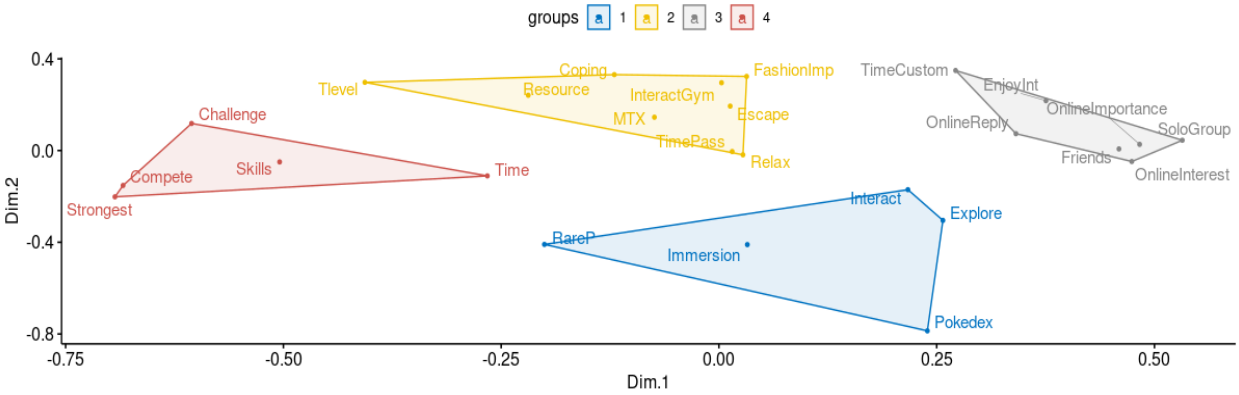

Figure 7: Cluster graph where k=4

V. DISCUSSION AND CONCLUSION

The present paper explores the motivations of PG players through the lens of Yee's motivational model and the MOGQ. The findings have unveiled players are typically motivated social interaction (online or in person) and competition with role-playing and escapism having smaller role in motivating people to play the game.

Previous literature also highlighted social factors as one of the primary motivations for gameplay. Both the online and face-to-face modes of interaction showed positive engagement as motivations for players in this study. Sociability usually enhances gaming experiences through sharing moments with others. The developers encourage this through their "community days" and events which utilise external websites and message boards to spread the news. The skew towards high sociability online in this study may be an issue due to the way the data was gathered. Due to being a self-selected sample on these forums, this sample was likely to already be interested in the online community which perhaps may not be totally representative of the rest of the player base which might play more casually. It may be better in the future to better vet participants or sample a larger more random portion of the player base.

The increase in competitiveness could be attributed to greater emphasis on player vs player mechanics that were missing from the game in its early years, in effect holding onto the players who may have stopped playing the game had these features not been implemented while also bringing in new players who desire such action in their games. These competitive features exacerbate interactions with other features. The drive to compete necessitates the drive for more resources and rarer and stronger Pokémon; of which can only be gained during raids or special "community days" thus increasing the likelihood of interaction with other players.

Escapism and Role-playing feature less as motivations. With regards to escapism, perhaps the merging of the real and virtual could be seen as a hinderance to the immersion for PG. Players often need to move and be wary of their surroundings people and cars; so much that the game offers reminders to players to mind themselves, pulling them out of the world. The role-playing side of immersion is not a major feature of PG anyway, though it could be said the desire to capture and strengthen Pokémon is both role-play and the main gameplay of PG; after all these features have been the seat of Poké gameplay since its inception. In essence though the self-expression facet of role-playing is not expansive enough on the gameplay or customisation side to be a key factor in anyone's desire to play PG. It could be argued however, that PG makes up for this in the other facets of its gameplay and feature set that have been discussed.

Like previous studies on PG, this study was also cross-sectional and focussed on the motivations of players'

now in 2021. Due to the ever-changing nature of the product may not offer an accurate portrayal of player motivations in the future. However, such a study could be performed again in the future to bolster the literature further. While the literature review mentioned the ability to open the study to anyone and everyone through the internet instead of viewing a sample from single location, the anonymity of the study prevents this from being true. It is not possible to see where the participants have come from and as such through pure coincidence may not be "worldwide". Reinforcing this, is the choice of forums where the survey was posted being primarily English speaking potentially limiting cultural diversity within the study.

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