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경영학석사학위논문

# A Study of Identity Fraud in MMORPG Game

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## Abstract

# A Study of Identity Fraud in MMORPG Game

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Massively Multiplayer Online Role Playing Game (MMORPG) has become a very popular business area to study as it represents new patterns of collaboration and social interaction in the virtual world. In this study, we empirically raise the issues of identity fraud in MMORPGs. In principle, the online game classification system controls the scope of users' activities with regard to the level of age appropriateness. However, the results from this study cast doubt on the effect of the current classification system in that distinctive behavior differences were not found to exist from one age group to another. Specifically, the econometric and

multivariate analyses show that the behaviors of the group whose ages are around 40 is very similar to those of the group whose ages are under 14.

**Keywords:** Virtual world, MMORPG, Online games, Identity fraud

**Student ID Number:** 2011-20537

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# CHAPTER 1 INTRODUCTION

Technical advancements in information technology provide a platform for various virtual worlds. These virtual worlds enable a number of remote users to interact mutually through avatars in online systems (Castronova, 2007). A virtual world is defined as “a synchronous, persistent network of people, represented by avatars, facilitated by networked computers.” (Bell, 2008). MMORPGs, as one of best examples of virtual worlds, are analyzed as a research topic as they provide new patterns of collaboration and social interaction (Assmann, 2010) (McKenna, Gardner and Myers, “Social Movements in World of Warcraft”, 2011) (Roquilly 2011) (Wall Street Journal, 2011).

MMORPG is a genre of online role-playing game in which a number of players interact with one another (Digi-Capital Global Games Investment Review, 2011). As in the majority of other role playing games, players are expected to choose a character in a fantasy world and control many of that character's actions, with the primary goal being to develop the chosen character. Almost every MMORPG features a character progression system in which players earn experience points for their actions and use those points to reach higher character "levels," which enables them to have more capabilities. Traditionally, combat with monsters and completing quests are the main methods to earn experience

points. The purchase of “items” is another way to progress in many MMORPGs, which is also best accomplished through combat. Players need to team up with others in order to progress quickly. Virtual items and currency should be obtained through play and have tangible value for players.

The MMORPG market in the U.S. has been growing rapidly. Since 2009, the revenue of MMORPGs has increased by 35% to \$2.6 billion in 2011 (ESRB). World of Warcraft, a popular MMORPG, has more than 10 million subscribers as of February 2012. According to Digi-Capital’s Investment report (<http://us.battle.net/wow/en/forum/?topicId=25712374700&sid=1>), the MMORPG is highly cash generative among a number of game genres. WoW customers pay \$12.99-14.99 in monthly fees. There are currently over 20 million paying MMORPG subscribers globally, with a strong presence in China and South Korea.

To enforce rating guidelines for online games, classification systems control user access in regard to age appropriateness following the content ratings provided by such organizations as the Entertainment Software Rating Board (ESRB). Ratings related to entertainment software are mostly categorized as Everyone, Teen (ages 13 and older), Mature (ages 17 and older), and Adults Only (ages 18 and older). The typical categorization criteria include the level of violence, gambling, sexual content and strong language (Wikipedia, <http://en.wikipedia.org/wiki/MMORPG>). The classification systems for MMORPG typically identify user age and

limit a user's playtime and their ability to purchase items according to age. In April 2011, the Chinese government issued a regulation requiring online operators to establish a "game fatigue system" that encourages players under 18 to play less than 3 hours a day (McKenna, Gardner and Myers, "Issues In The Study Of Virtual World Social Movements", 2011). In late 2011, the South Korean government also took steps to curb online game addiction by creating a "shutdown" law, which prevents players under 16 from playing online games between the hours of midnight and 6 a.m. The South Korean government is about to sign into law a "cooling off" system that will regulate the duration an individual can play during a 24-hour period (Kozinets, 2010) (Castronova, 2006). Online gamers in China will be required to register using their real name and identity card number to indicate if they are younger than 18. However, about 15% of under-18 players are estimated to have begun using a parent's ID number when signing up to avoid being affected by the new system (McKenna, Gardner and Myers, "Issues In The Study Of Virtual World Social Movements", 2011).

The authors' purpose of carrying out this study is to test the classification system for MMORPG in which the identities of users are managed online. The industry has seriously debated the issue of real identity in MMORPG (Forbes, 2012). In this article, tests for behavioral differences among age groups have been performed in an MMORPG with an analysis of micro-transactional

data which was received from one of a leading online game publisher. The MMORPG was open for everyone to play; however, there were restrictions on the purchase of items for players under the age of 14. The results would suggest the possibility of identity fraud. In particular, my cluster analysis shows that the age 40 group is classified together with the under 14 group.

With the exception of McKenna et al. and Kozinets (Kozinets, 2010), identity and social movements in MMORPG have received very little attention. McKenna et al. presented the multi-dimensional framework to identify virtual world social movements including the behaviors of gays and lesbians. In contrast, this study finds discrimination among the behaviors of age groups with the analysis of the data gathered from actual transactions.

The remainder of this article is organized as follows. Section 2 presents a literature review related with MMORPGs and identity fraud. Section 3 describes the data collection procedure, general summary statistics about online games, and predictable differences in behavior among different age groups. Section 4 estimates the cluster of age groups in an MMORPG using variables of user behavior. Section 5 interprets the results, and Section 6 concludes the analysis.

## CHAPTER 2 LITERATURE REVIEW

My study is related to a small amount of literature that discusses virtual worlds, MMORPGs, and identity fraud.

First, virtual worlds enable a large number of people to interact with one another in an online three-dimensional world. Virtual worlds supply new forms of social interaction, offering alternative spaces where social functions can be performed. More social movements are being organized through virtual worlds. Furthermore, the use of virtual worlds enables social movements to engage in collective action on a global scale (McKenna, Gardner and Myers, "Social Movements in World of Warcraft", 2011). Within these virtual worlds, individuals can take on an alternate persona or personae spontaneously (Barfield, 2006). Previous research has tried to define these virtual worlds (Gensollen, 2007) as a tool which "projects an identity into a generated three dimensional reality" or an "interactive computer simulation." Items (armor, space stations, condominiums for avatars, etc.) can be reduced to a series of bytes and can change the physical medium on which they depend without their value changing in any considerable way (Rheingold, 2000). Virtual worlds, as well, constitute a prosperous and competitive industry where game companies must deploy a certain number of resources to construct a sustainable and successful business

model. A community, within a virtual world, refers to a group of users connected online. It can form a strong network if users share an underlying bond based on key aspects such as personal interests or loyalty to the product (Shankar & Bayus, 2003) (Alemi, 2007).

Second, several researchers in the Internet solutions (IS) field have tried to analyze MMORPG. According to studies carried out by Alemi (Alemi, 2007), distinct categories can be identified as simple online games that are in a highly disparate category despite its label, with the MMORPG format being marked by the absence of a pre-scripted story line and avatars controlled by the users instead of being determined by the game developers in advance. Users are able to customize their avatars using elements designed and made available by the game developers. MMORPGs are analyzed to have characteristics which represent persistent worlds in which a number of users continue to evolve their character avatars. The avatar continues to exist when the users turn off the program software, if inscribed in lines of code. The world where these avatars evolve is constantly changing while other avatars are created, disappearing, and growing (Roquilly, 2011). MMORPG companies are expected to construct communities diverse enough to have enough motivation to participate in a virtual world when it hosts many different users (Katz & Shapiro, 1985). This mechanism of network externalities, identified by Leibenstein (1950) for the first time, constitutes an

extraordinary tool to secure competitiveness (Farrell & Saloner, 1985). Real-money trading (RMT) is identified as an economic activity where people exchange their property in the MMORPG such as currency, items, and even characters, for real currency. Two opposing attitudes of online game operators toward RMT stand out. One regards RMT as a natural act of players and seeks ways of bringing out its merits, such as accelerating personal trades between users and cutting down on costs for setting up a physical store. In contrast, other operators see RMT as the cause of problems and consequently prohibit it in their games (Itsuki, Takeuchi & Fujita, 2010).

Third, identity fraud can roughly be described as the unlawful changing of an individual's identity (Datenschutz und Datensicherheit - DuD, Volume 30, Number 9, pp 553-556). In literature in the field of psychology, the coping theory is referred to as a way to explain identity fraud. There are two different views of coping: the process view stressing the process of managing difficult circumstances versus the style or personality view focusing on an individual's personal style of managing and defending psychological integrity (Roquilly, 2011). Identity fraud can occur due to consumers' conventional behaviors as well as to computer-related threats (Federal Trade Commission, 2010). That is, it is likely that identity fraud happens both off- and online. Identity thieves can get an individual's identity by making use of conventional methods or advanced technological methods

(Fujun Lai, Dahui Li, Chang-Tseh Hsieh, 2012). Identity fraud in regard to MMORPGs can be categorized as an example of identity cloning among a couple of classifications in that the players are pretending to be others in the course of the game (V.M. Ramaswamy, 2006). Regarding the online purchase of contents, the possibility that online games place children at risk for identity theft in numerous ways is pointed out, as in almost all cases, children and teens are using a parent's credit card information ([http://articles.timesofindia.indiatimes.com/2011-09-01/gaming/29953270\\_1\\_identity-theft-gaming-data-breach](http://articles.timesofindia.indiatimes.com/2011-09-01/gaming/29953270_1_identity-theft-gaming-data-breach)).

## CHAPTER 3 DATA DESCRIPTION

The data set used in the analysis is a customer database of an MMORPG service provider in Korea. The MMORPG is the casual type game set in a fantasy universe where players control a character avatar within a game world to explore the landscape, fight various monsters, complete quests and interact with non-player characters or other players, as well as with other MMORPGs. The game which was examined for this study has several characteristics in regard to character avatar types and interfaces which are described as follows. The character avatars in the game are designed intentionally to be short and have ill-proportioned figures that are demonstrated as in the exemplary screenshot [Appendix 3] in order to attract younger players. In the same context, user interfaces used to control character avatars are designed in regard to ease of use, thus eliminating the need for a complex control panel.

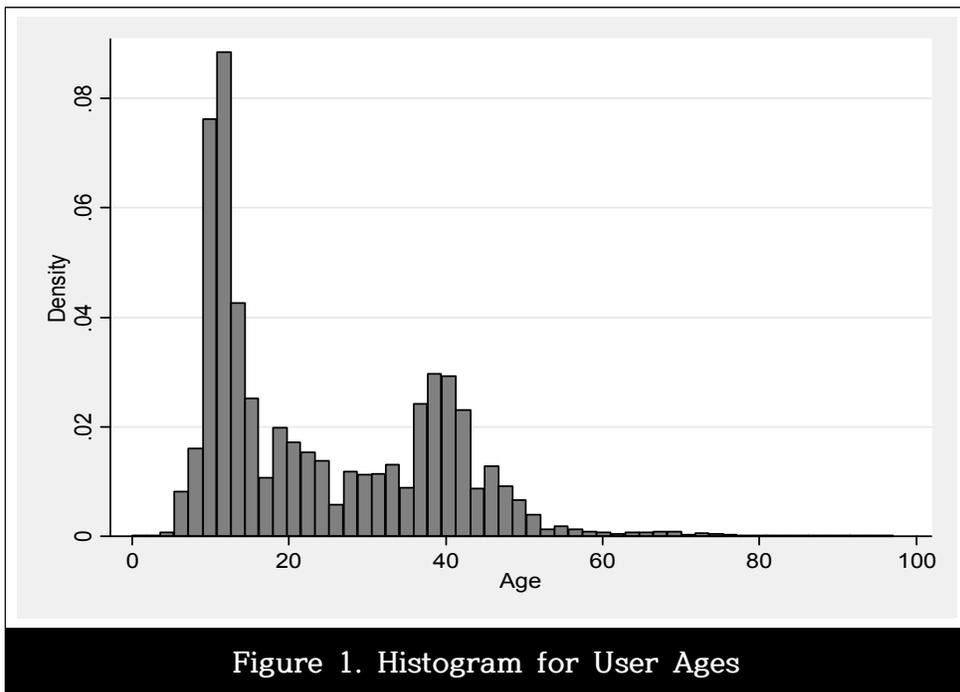
The database provides detailed information on the customer including: age, gender, play time, battle time, rest time, and the number of party members. My sample consists of 284,194 user data records from an MMORPG played from January 2011 to December 2011. Table 1 provides summary statistics for the user profile samples used in this analysis.

<b>Table 1. Descriptive Statistics for User Profile Samples</b>				
Variable	Mean	Std. Dev.	Min	Max
Age	23.86646	14.35311	0	97
Gender (Male=1, Female=2)	1.343924	0.4750168	1	2
Purchase	0.810939	6.643382	0	622
Play time	1.64E+08	2.38E+09	0	4.24E+11
Battle time	13015.21	59029.51	0	2296875
Rest time	53964.34	215662.6	0	8657258
Party member	206.0891	1377.067	0	78999

Notes: Number of users in sample: 284,194

Unit of play time, battle time and rest time is UNIX time.

### 3.1 Age Distribution



The content of Figure 1 motivated the authors to raise the issue of the possibility of identity fraud due to the abnormal distribution witnessed. The diagram of user ages shows a double hump pattern. According to Figure 1, the majority of players are classified into the around 10 age group, as was expected in light of the game's cute avatars and easy interfaces. However, the 2nd largest band of users represents players around 40 years of age, which can be interpreted as abnormal when taking the

decreasing pattern in the 20s and 30s age groups. Specifically the numbers of users from 36 to 45 are exceptionally larger than those of similar age groups. The whole set of 284,194 users who have played the online game at least once, rather than a sample of total users, was utilized for this study.

In a MMORPG where users under 14 have an incentive to fraud their identity, such users are likely to use the identity of someone which they may or may not know. Other users may try using the identity of someone else by making use of personal information acquired through the Internet. However, it is more likely that users under 14 will use a parent's identity. Interviews with game operators confirm the likelihood that juvenile users are likely to use a parent's identity.

### **3.2 Group Description**

To investigate the possibility of identity fraud, behavioral patterns among the age groups were analyzed. The analysis was begun by dividing users into age groups in order to compare the behaviors of juvenile users with other age groups. Members of the under 14 age group are assumed to have an incentive to falsify their identity because the age of 14 discriminates the authority of the user in several ways, namely in that users under

14 must gain parental approval. Moreover, other users would not be likely to team up with younger players with the expectation that older users would have more experience. When guilds and communities recruit new members, skilled players with high levels and more items are preferred. In particular, leaders of guilds and communities in their late teens or early 20s have reason to avoid including members in their teams who could be perceived as being too young.

Furthermore, based on the presence of the double hampered pattern, I divide the age groups into 4 groups: 14 and under, 15-35, 36-45, 46 and above. While members of the 14 and under age group are assumed to use their real identities, the 36-45 age group is classified as a discrete group. The authors hypothesize that the substantial number of members in this group are likely to be young people using a parent's identity. The behaviors of two remaining age groups (15-35 and 46 and older) will be compared with the two groups specified above. Table 2 shows the ratio of the divided age groups.

Table 2. Divided Age Groups				
Group	(Age)	Freq.	Percent	Cum.
1	(14 and under)	118,604	41.73	41.73
2	(15-35)	83,980	29.55	71.28
3	(36-45)	62,427	21.97	93.25
4	(46 and older)	19,183	6.75	100
	Total	284,194	100	

The youngest group accounts for 42% of total population while the group between 15 and 35 represents 30%. Although identity fraud is expected in the 36-45 age group, this age group nominally represents 22% of the population, while senior most group accounts for 7%.

### 3.3 Variable Description

The authors looked at the two sets of descriptive statistics for the behavioral variables among age groups using the following variables:

**Purchase** : The frequency to purchase items in cash

The age groups are likely to have access to different amounts of cash with which to purchase the game items.

**Play time** : The period during which users play on the game

It could be assumed that the users within an age group have similar life styles.

**Battle time/Rest time** : The ratio between battle time and rest time

This ratio demonstrates how willing users are to have battles while they are playing the game. If this ratio is low, the users are likely to spend more time exploring unknown areas or partake in non-battle activities. Meanwhile, users with a high ratio of Battle time/Rest time are likely to possess the know-how of growing their character avatars efficiently in that, by getting involved in the battle, the avatar will attain a high level most rapidly. Therefore, this measurement will represent how skilled the users are with the MMORPG.

**Party Member** : The number of members in the party

The more users the party has, the stronger the party becomes in battle in most cases. This measurement will show the alliance levels of users.

Table 3. Averages of Behavioral Variables of Age Groups				
Age_group	Purchase	Play time	Battle/rest time	Party member
1 N=118,604	0.2597636 (2.522457)	2.30E+07 (380,000,000)	0.1541549 (0.1234634)	75.11472 (436.915)
2 N=83,980	1.758371 (10.63229)	4.10E+08 (3,980,000,000)	0.1786187 (0.1359554)	442.5093 (2,186.638)
3 N=62,427	0.4963077 (4.38797)	9.76E+07 (1,600,000,000)	0.1570626 (0.115002)	130.6858 (1,022.82)
4 N=19,183	1.094928 (7.124026)	1.75E+08 (2,300,000,000)	0.1606805 (0.1251983)	226.2491 (1,485.753)
Total N=284,194	0.810939 (6.643382)	1.64E+08 (2,380,000,000)	0.1624632 (0.1260917)	206.0891 (1,377.067)

Notes: standard errors in parentheses

The descriptive statistics show that purchases by members of group 2 are far higher than those of any other group, with group 4, group 3 and the group 1 following. Such findings can be interpreted as follows: Members of group 2 understand how best to develop their character avatar and spend the largest

amount of money compared to time spent on the game. Interestingly, members of group 3 showed a lower frequency of purchase than members of group 2, while members of group 4 resemble those of group 1 in regard to their purchase patterns. One rational is that group 3 members have a higher frequency of purchase than those in since group 3 members are able to purchase items conveniently without any further authentication and registration of billing information. Moreover, users in this group have more purchasing power. If a user employs the identity of someone from another age group, those users will have a higher likelihood of frequent purchase since their eagerness to play can be tied to their willingness to commit fraud to do so. Such patterns can be found in the behavioral variables such as battle time and rest time, as well as number of party members. Members of group 2 are expected to know much about how to play online games. However, the play time for group 3 was found to be the longest. Such findings can be interpreted in that users in group 3 spend less cash on items and more time raising the level of the avatars in that purchase of items can be an alternative for play time.

The second set of data is for the average behavioral variables according to age for the cluster analysis. Table 4 describes the descriptive statistics of averaged behavioral variables for every 93 age in the population. The purpose of this data set is to classify all the ages into clusters and clarify the similarities of

the behaviors among the ages.

Table 4. Descriptive Statistics for the Behavioral Variables by Age				
Variable	Mean	Std. Dev.	Min	Max
age	48.07527	27.19504	0	97
purchase	1.134993	1.371962	0	11.29412
Play time	2.17E+08	2.39E+08	4663	9.87E+08
Battle time / Rest time	0.158507	0.022251	0.051188	0.20468
Party member	260.9842	231.8671	0	1295.375

Notes: Number of users in the sample: 93.

## CHAPTER 4 METHOD AND MODEL

To analyze the behavioral differences by age group, negative binomial regressions with dummy variables were utilized. The robustness of this analysis was further demonstrated by the conducting of an ANOVA/MANOVA and cluster analysis.

### 4.1. Negative Binomial Regression with Dummy Variables

Differences among user age groups were sought. The dummy variable model will clarify any differences which exist in regard to the frequency of item purchase.

$$Y_i = \beta_0 + \beta_1 \ln(\text{Play time}_i) + \beta_2 \ln(\text{Battle time/Rest time}_i) + \beta_3 \ln(\text{Number of Party Members}_i) + \delta_1 (\text{Age\_Group}_i) + \delta_2 (\text{Gender}_i) + \epsilon_i$$

(1)

In the model used in this study, the frequency of item purchase was used as an independent variable to compare differences among the groups. As an independent variable that

represents frequency exists, the negative binomial regression model was utilized. A logarithm value of play time, the ratio between battle time and rest time and the number of party members was used due to highly skewed distributions of variables.

<b>Table 5. Variable Definitions and Descriptive Statistics</b>	
Variable	Definition
<b>Dependent Variable</b>	
Purchase Frequency ( $Y_i$ )	The number of purchase of items for user $i$
<b>Independent Variables</b>	
$\ln(\text{Play time}_i)$	The natural logarithm of playtime for user $i$
$\ln(\text{Battle time}/\text{Rest time}_i)$	The natural logarithm of the ratio between battletime and resttime for user $i$
$\ln(\text{Number of Party Member } s_i)$	The natural logarithm of the number of party members for user $i$
<b>Dummy Variables</b>	
Age_Group $_i$	Age group for user $i$ (minto14=1)(15to35=2)(36to45=3)(46tomax=4)
Gender $_i$	Gender for user $i$ (Male=1),(Female=2)

## 4.2. ANOVA / MANOVA and Cluster Analysis

To clarify any gaps which may exist among age groups as defined above, all the behavioral variables such as play time, the ratio between battle time and rest time, and the number of party members are analyzed using ANOVA/MANOVA and a cluster analysis technique. A one-way ANOVA was used to test for differences in the behavioral variables among age groups. MANOVA is also taken to consider existence of variance-covariance among the behavioral variables when testing the statistical significance of the mean differences. Based on the product of model variance matrix,  $\Sigma_{model}$  and inverse of the error variance matrix,  $\Sigma_{res}^{-1}$ , or  $A = \Sigma_{model} \times \Sigma_{res}^{-1}$ , the hypothesis of this analysis will be  $\Sigma_{model} = \Sigma_{residual}$  implying that the product  $A \sim I$ .

A cluster analysis was implemented to categorize user age. A hierarchical clustering system was used with the idea that the behavior of game users would have similar patterns within the same age group. Hierarchical clustering creates hierarchically related sets of clusters. Hierarchical clustering methods of agglomerative hierarchical clustering methods were taken by following the process that the closest two groups are combined (92 groups, one of size 2 and the rest of size 1), with this

process continuing until all observations belong to the same group. This process creates a hierarchy of clusters (Kaufman & Rousseeuw, 1990).

## CHAPTER 5 RESULTS

In this section, the results and the key findings from the econometric and multivariate models are briefly summarized. The results show that the variances among the behavioral variables represent the patterns of age groups. In 5.1, the authors present the negative binomial regression estimation results of purchase frequency equations. These results shed light on the differences of item purchase among age groups. In 5.2, we look at the ANOVA/MANOVA and cluster analysis results to gain additional insights into behavioral differences among age groups.

### 5.1. Negative Binomial Regression with Dummy Variables

A negative binomial regression model provides the opportunity to clarify the relationship that purchase frequency is significantly affected by which age groups users belong to. Table 6 describes the results from the negative binomial regression model and Ordinary Least Square (OLS) model, as well. Both models show that the explanatory variables such as logged play time, logged

battle time and rest time, and logged party members are all statistically significant to explain the dependent variable of the purchase. The negative binomial regression with dummy variables demonstrate that a user's age group significantly influences the purchase frequency. It was found that in the coefficients of dummy variables, all the coefficients are positive and statistically significant. That is, groups 2, 3 and 4 were interpreted to have a higher purchase frequency than group 1. However, the degree of influence of group 3 proved to be the least, results which show that age group 3 is most similar to group 1 among all the age groups in that the coefficient for the group 4 is 0.703 bigger than those of other groups, while the coefficient of the dummy variable for the group 3 is as small as 0.244. the dummy variable coefficient for the under 14 age group was omitted, as differences with other groups will be compared.

Table 6. Negative Binomial Regression Results		
Purchase	(1) NBREG	(2) OLS
ln_play time	0.625***	0.759***
	-0.00692	-0.0148
ln_battle time/ rest time	-0.521***	-1.065***
	-0.0207	-0.0536
ln_party member	0.00562	0.679***
	-0.00888	-0.0213
_Iage_group_2	0.342***	0.927***
	-0.0238	-0.0592
_Iage_group_3	0.244***	0.246***
	-0.0271	-0.0639
_Iage_group_4	0.703***	0.926***
	-0.0395	-0.102
_Igender_2	-0.119***	0.149***
	-0.0206	-0.0507
Constant	-11.68***	-14.64***
	-0.1	-0.217
Observations	138,420	138,420
R-squared		0.122

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5.2. ANOVA/MANOVA and Cluster Analysis

The ANOVA shows that as the age group increases, so does the emphasis on purchase frequency ( $F(3, 284190)= 908.45, p < 0.001$ ), playtime( $F(3, 284190)= 454.91, p < 0.001$ ), battle time/rest time ( $F(3, 284190)= 675.41, p < 0.001$ ), and party member ( $F(3, 284190)= 1263.12, p < 0.001$ ). My multivariate MANOVA with purchase, play time and battle time/rest time as between behavioral variables with an emphasis on the dependent variables reveal a main effect on age groups ( $F(3,284190)= 522.44, p<0.001$ ). ANOVA/MANOVA results confirm the econometric model above that shows the statistically significant existence of behavioral differences among the age groups.

The cluster analysis provides an extensive hierarchy of age clusters that merge with each other at certain distances. The cluster analysis resulted in the Dendrogram (Figure 2), which illustrates a hierarchical clustering of four age groups of ages. Figure 2 shows both the cluster structure and the joining sequence to demonstrate how each of the ages in the study is combined into a new aggregate cluster until all 93 ages are grouped into one final cluster. However, the dendrogram is constructed to show only four clusters of ages. It also exhibits more clustering procedures below the cutoff line, if a ten cluster solution is desirable.

The tree diagram vividly shows that the age tree consists of two main branches and 4 clusters ± 2 clusters. The cluster with the under 14 group, that is the ages belonging to group 1, appears to include the ages from age group 4 and 3. Not one age in group 1 is clustered with the ages from group 2. Thus, it can be inferred that the users under 14 behave differently from those in group 2 based on the cluster analysis which considers behavior variables such as purchase, playtime, battle time/rest time and party member. The ages included in group 2 are mostly clustered with the ages in group 4, albeit with a few exceptions. A few exceptions in group 4 can be explained with identity fraud, as I see that some of the older users have a high ratio of battle time/rest time, which can be interpreted to have very high skills with which to grow levels. Therefore, the results from the cluster analysis confirm the previous analyses with the finding that group 1 behaves similarly to group 3 and that group 2 behaves similarly to group 4.

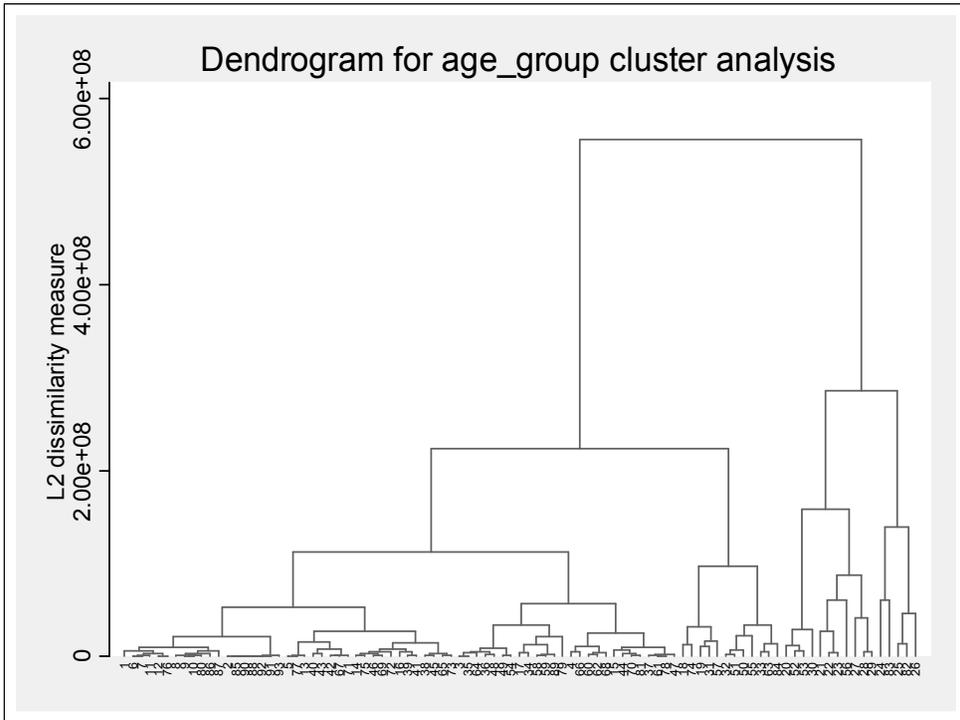
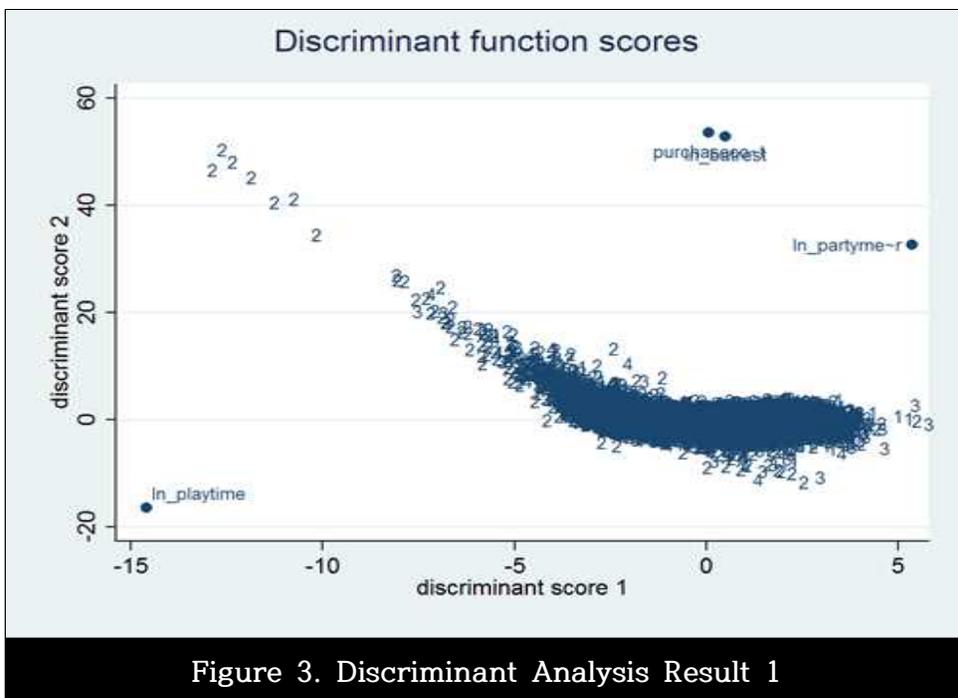


Figure 2. Dendrogram for User Ages

## CHAPTER 6 ADDITIONAL STUDIES

The result of the Discriminant Analysis is presented in figure 3 and figure 4, which analyze the variables (playtime, purchase count, party member and battle time / rest time) from group 1 to group 4. The rate of group 3 classified into group 1 (46.44%) is 1.7 times higher than that of group 3 classified into group 2 (27.61%). This shows that the group 3 is more similar to group 1 than group 2.



True age_group3	Classified					Unclassified	Total
	1	2	3	4			
1	28,117 49.28	13,703 24.02	10,321 18.09	4,918 8.62	0 0.00	57,059 100.00	
2	12,323 28.63	22,956 53.33	5,271 12.24	2,498 5.80	1 0.00	43,049 100.00	
3	13,738 46.44	8,168 27.61	5,302 17.92	2,374 8.03	0 0.00	29,582 100.00	
4	3,455 39.58	3,302 37.82	1,387 15.89	586 6.71	0 0.00	8,730 100.00	
Total	57,633 41.64	48,129 34.77	22,281 16.10	10,376 7.50	1 0.00	138,420 100.00	
Priors	0.2500	0.2500	0.2500	0.2500			

Figure 4. Discriminant Analysis Result 2

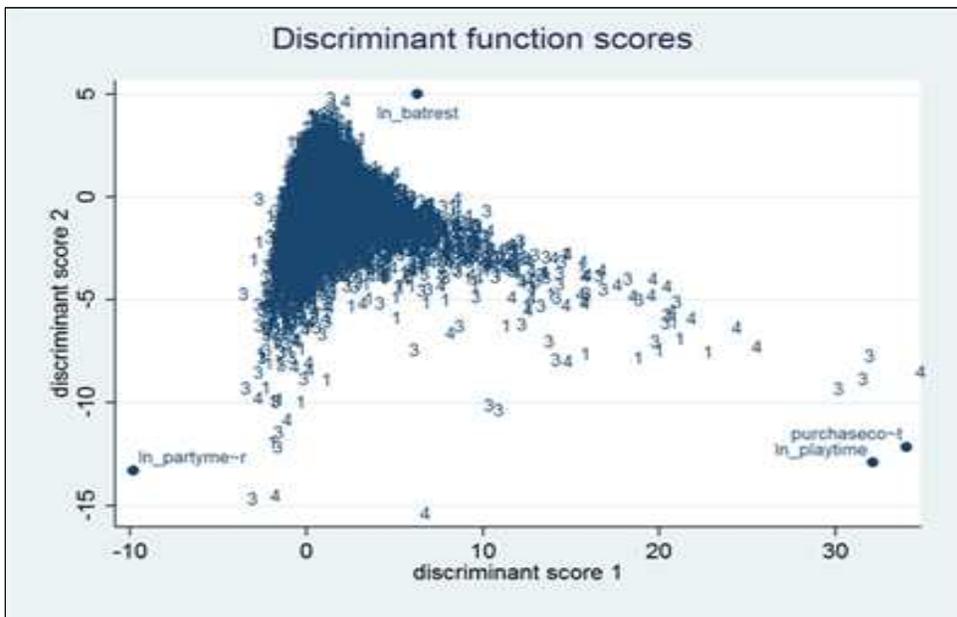


Figure 5. Discriminant Analysis Result 3

True age_group3	Classified			Total
	1	3	4	
1	30,690 53.79	11,734 20.56	14,635 25.65	57,059 100.00
3	14,885 50.32	5,969 20.18	8,728 29.50	29,582 100.00
4	3,712 42.52	1,578 18.08	3,440 39.40	8,730 100.00
Total	49,287 51.68	19,281 20.22	26,803 28.10	95,371 100.00
Priors	0.3333	0.3333	0.3333	

Figure 6. Discriminant Analysis Result 4

The next analysis is conducted without group 2 which consists of a variety of styles of game players. It is shown in the figure 5 that number 2 which represents group 2 spreads out widely. Accordingly, this can negatively affect Discriminant Analysis by causing noises since group 2 which has the biggest sample size overlaps with other groups easily.

It is also shown that the rate(which represents the true group is categorized into the same group after the classification) of group 3 is relatively low compared to group 1(53.79%) and group 4(39.40%). It is implied that the characteristic of group 3 is more unique than that of other groups. Moreover, it is shown that the

users who are actually in group 3 are divided into the users who have the characteristic of group 3 and 4. Thus, It is suspected that the above results are due to ID frauds.

To estimate how often ID frauds occur, this study uses the transaction data that changes rapidly before and during elementary school vacation. This is due to the fact that most of the users in group 1 are elementary school students and MMORPGs are difficult games for pre-school children to have access to.

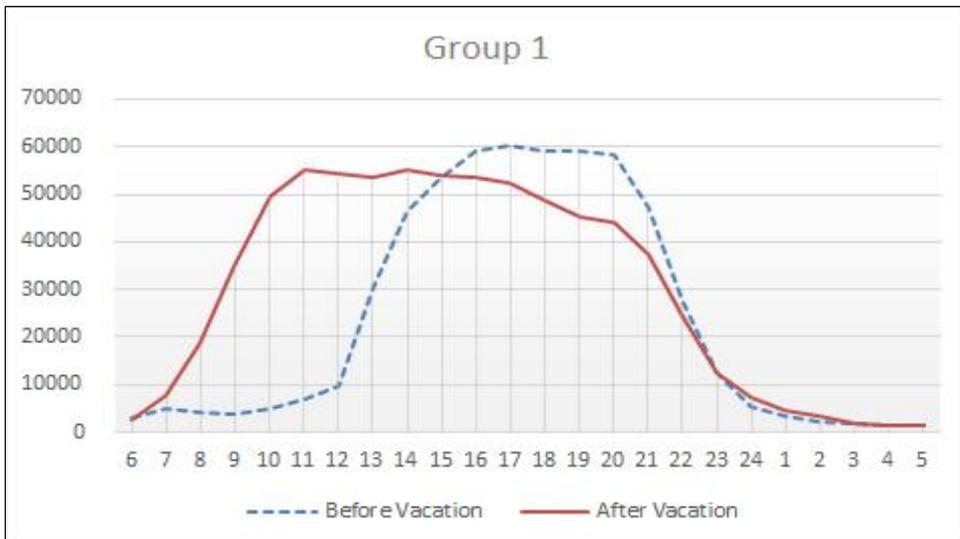


Figure 7. Log Traffic in Group 1

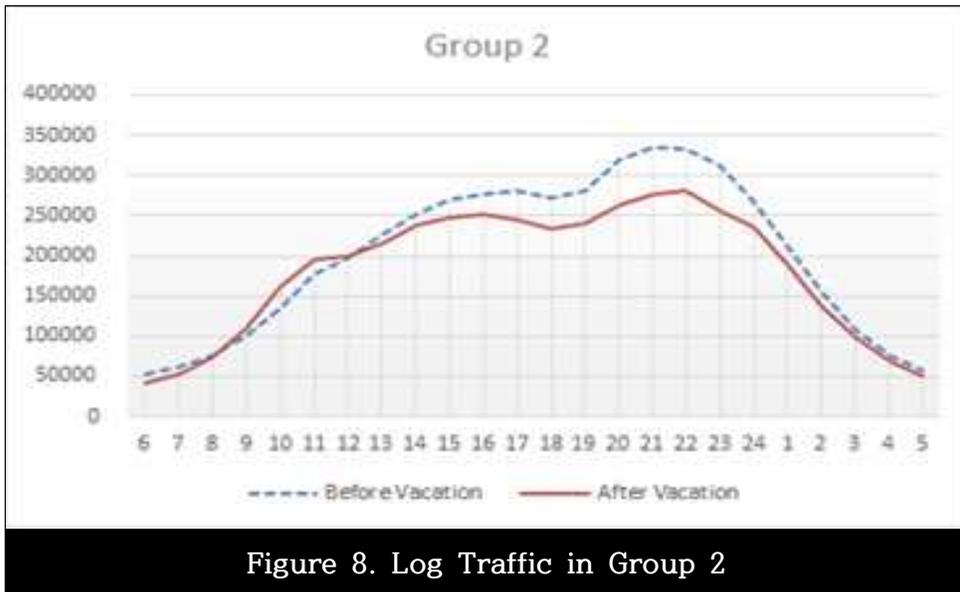


Figure 8. Log Traffic in Group 2

In this study, transaction data is used, which is collected for one week before and during elementary school vacation. Additionally, according to the all-time analysis conducted in this study, the results show that each traffic pattern (before and during vacation) is almost the same. Also, If the whole data is used, there is a possibility to be affected by noises by contents updates or events. This is why the period of the analysis is restricted to one week before and during vacation.

It is presented that group 2 which consists of adults has a similar traffic pattern regardless of elementary school vacation. On the other hand, it seems that there are dynamic traffic changes in group 1 (most of them are elementary school students) before and during vacation. This is because elementary school

students are able to have access to online games in the morning during vacation while they normally used to be in school before vacation.

It is obvious that depending on whether it is after vacation or during vacation, there is a difference in traffic patterns between child groups and adult groups.

Therefore, the traffic pattern of group 3 which is suspected of committing ID frauds will be shown based on these results. If ID frauds occur in group 3, the traffic pattern of group 3 should be somewhat similar to that of group 1.

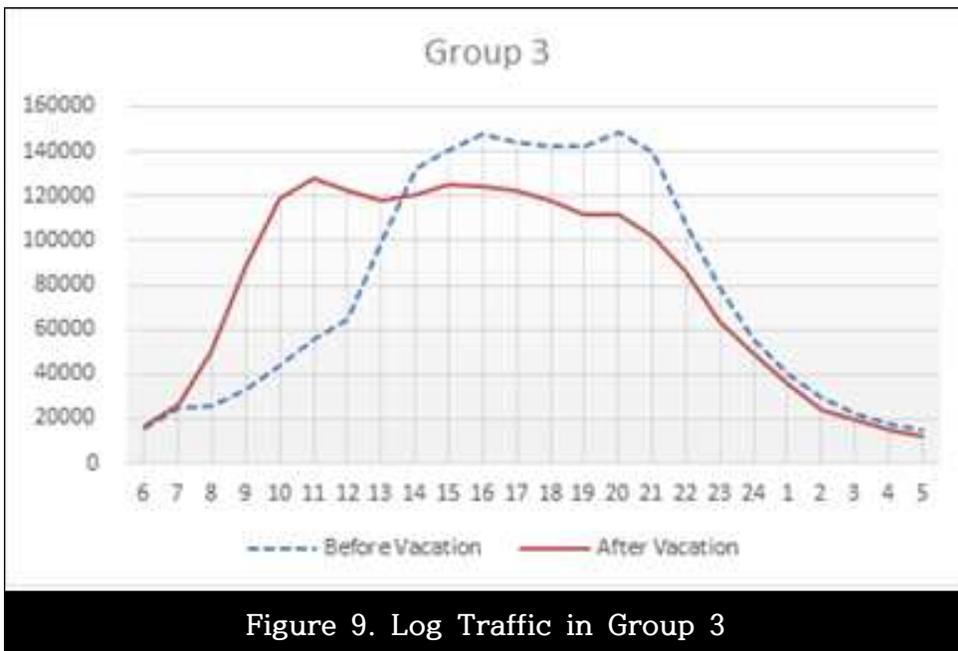


Figure 9. Log Traffic in Group 3

Figure 9 is the graph of the traffic pattern of group 3. As expected, group 3 has a similar traffic pattern to group 1. This demonstrates that there are ID frauds in group 3.

Next, the actual rate of ID frauds will be estimated by using traffic data. The specific point of time is 12pm since it is the time when elementary students begin having access to online games before vacation. It can be observed that traffic increases rapidly after 12pm. On the other hand, during vacation, most of the users in group 1 and 3 can freely have access to online games from 12pm. As a result, at 12pm, the gap of the traffic patterns between before and during vacation is the actual number of elementary school students committing ID frauds.

**Table 7. Average traffic data before and during vacation**

Time	Average Traffic Data Before Vacation					Average Traffic Data After Vacation				
	Group1	Group2	Group3	Group4	Total	Group1	Group2	Group3	Group4	Total
6	2870	53532	16000	16873	89274	2607	42600	16751	12558	74517
7	4939	61929	24842	16135	107845	7702	52968	26849	14920	102439
8	4346	76861	26143	18133	125482	18800	72921	50576	22956	165253
9	3711	100776	33104	23965	161556	35200	108836	87740	34840	266616
10	5133	134072	44039	32256	215500	49605	162682	119097	51250	382634
11	7075	176652	55281	40075	279083	55328	194633	128193	55838	433993
12	9776	198278	64632	42457	315143	54543	200382	122395	55810	433131
13	30210	227876	99750	53487	411323	53536	216495	118131	60944	449107
14	46382	253068	131994	61834	493278	55014	237929	120608	67835	481386
15	53652	269218	140392	69218	532479	54120	247658	125487	65955	493220
...	...	...	...	...	...	...	...	...	...	...
<b>Total</b>	567147	4840848	1868081	1134882	8410958	724941	4367246	1911323	1114543	8118053

**Table 8. Elementary Schoolchild Ratio**

	Group 1 (14 and Under)	Group 2 (15 ~ 35)	Group 3 (36 ~ 45)	Group 4 (46 and Older)
Difference between During Vacation and Before Vacation	44,767	2,104	57,763	13,353
Elementary Schoolchild Ratio	82 %	1 %	47 %	24 %

Consequently, it has been found that around 47% of group 3 has a similar traffic pattern to the users of group 1 (Most of the users in group 1 are elementary school students). Around 24% of group 4 also has a similar traffic pattern to the users of group 1. All of these results seem to be related to possibilities of ID frauds. In group 2, 99% of the users show the constant traffic pattern regardless of vacation and this suggests that most of them are the users who do not commit ID frauds. Considering that, 82% of the users in group 1 indicate the traffic pattern of elementary school students and the rest of the users (18%) are suspected to be either pre-school children who use their own ID or adult users who use children's ID which could be also ID frauds.

## CHAPTER 7 DISCUSSION

In this article, the authors present behavioral evidence of identity fraud in that a number of users in MMORPG may use the identities of individuals in other age groups. The accurate estimation of the identity fraud is less clear. However, the results of the above estimation can be interpreted in several ways.

First, one interpretation of the ANOVA/MANOVA suggests that behaviors among users in different age groups differ from one another. The frequency of item purchases, play time and battle participation differ by age group. Another interpretation of the above estimates with the dummy variable model in the robustness check chapter is that the number of items purchased will increase as the age level goes higher. However, the increasing pattern is not linear at all in that the frequencies of item purchases with age groups around 40 years old are reduced, while those in the over 45 group show an increase. Those results lead us to reason that behavioral differences have a similar pattern to that of distribution of age. Second, the results of the cluster analysis throughout all age groups that ages near or above 40 correspond to those below 15.

Through both econometric and multivariate models, similar behavior patterns between users in group 1 and group 3 were found. It was predicted that a substantial number of children

playing online games use the identity of a parent with easy access to either an identity number and/or credit card number. However, to date a study containing an analysis of the real transactional data has not been conducted. Users around 40 years of age are empirically classified with the 14 and under age group, thus resulting in an inability to understand their genuine behavioral characteristics. It can be inferred that the majority of the users in the group have the traits of the age group under 14. The most likely explanation is that juvenile users fraudulently use a parent's identity. Taking demographics into the consideration, the authors infer that users under 14 are less likely to commit identity fraud than members of group 4 in that although the size of the nuclear family is decreasing, the number of nuclear-family households is increasing.

This study provides managerial implications for MMORPG service providers by showing them, for example, that a marketing campaign targeted to a specific user demographic could be mis-targeted due to a substantial portion of the targeted adult age likely to be, in fact, younger users who have committed identity fraud. In the study, it was found that users in group 2 have a higher skill level and more willingness to pay for items used in the game. Such information will allow MMORPG service providers to segment their market properly. The number of users over the age of 50 is also increasing, which should draw the attention of game developers. However, a plausible explanation of

this can be that there exists a substantial number of users who aren't actually members of that age group. Experiments carried out to identify reactions by age group will provide the opportunity to confirm this study. For example, a service provider can offer a deal on items exclusively targeted for a certain group or during the hours when a certain group is more or less likely to access the game. Other implications regarding include that regulations which affect policies based on a user's age can be ineffective in control the amount of play time per day or in preventing juvenile users from playing games during certain time of the day. The systems to ensure that identities are real could be required additionally in order to implement such regulations.

While the findings of this study have considerable implications for understanding the possibility of identity fraud in online games, it is important to note its limitations. More specifically, the possibility of behavioral differences among age groups was inferred. The database of the service provider did not supply information on whether users were real or not.

Furthermore, identifying whether users are using their real identity is difficult even though MMORPG service providers try to identify fraudulent users in various ways including authentication of identity through a mobile device and ad hoc questions for users. Considering the reasonable amount of doubt regarding the existence of identity fraud, there are additional research

opportunities through which to identify the optimal level MMORPG service providers should target using a utility maximization framework that considers the benefits and cost of an improved classification system.

## REFERENCES

1. Alemi, F. 2007. "An Avatar's Day in Court: A Proposal for Obtaining Relief and Resolving Disputes in Virtual World Games," *UCLA Journal of Law and Technology* (11:2), pp. 1-54.
2. Assmann, J.J., Drescher, M.A., Gallenkamp, J.V., Picot, A., Welp, I.M., and Wigand, R.T. (2010) *Mmogs as Emerging Opportunities for Research on Virtual Organizations and Teams*, Americas Conference on Information Systems (AMCIS), Lima, Peru.
3. Barfield, W. 2006. "Intellectual Property Rights in Virtual Environments: Considering the Rights of Owners, programmers and Virtual Avatars," *Akron Law Review* (39:3), pp. 649-700.
4. Bell, M.W. (2008) *Toward a Definition of "Virtual Worlds"*, *Journal of Virtual Worlds Research* 1, 1.
5. Castronova, Edward (2006). *Synthetic Worlds: The Business and Culture of Online Games*. University Of Chicago Press. p. 10, 291. ISBN 0-226-09626-2.
6. Castronova, E. (2007) *Exodus to the Virtual World: How Online Fun Is Changing Reality*. Palgrave Macmillan: New York, NY.

7. Datenschutz und Datensicherheit - DuD Volume 30, Number 9, 553-556, DOI: 10.1007/s11623-006-0141-2  
Schwerpunkt Identity theft, identity fraud and/or identity-related crime Bert-Jaap Koops and Ronald Leenes.
8. Digi-Capital Global Games Investment Review 2011.
9. ESRB <http://www.esrb.org>
10. Farrell, J., and Saloner, G. 1985. "Standardization, Compatibility, and Innovation," RAND Journal of Economics (16:1), pp. 70-83.
11. Federal Trade Commission, Talking about identity theft: a how-to guide, 2010,  
<http://www.ftc.gov/bcp/edu/microsites/idtheft/downloads/TalkingAboutIDTheft.pdf>
12. Forbes, 02-16-2012,  
<http://www.forbes.com/sites/carolpinchefskey/2012/02/16/south-korea-may-limit-young-online-gamers-to-2-hours-a-day-to-prevent-bullying/>
13. Fujun Lai, Dahui Li, Chang-Tseh Hsieh, Fighting identity theft: The coping perspective, Decision Support Systems 52 (2012), pp. 353-363.

14. Gensollen, M. 2007. "L'Economie Réelle des Univers Persistants: Vers une Propriété Virtuelle?," in *Culture d'univers: Jeux en réseau, mondes virtuels, le nouvel âge de la société numérique*, F. Beau (ed.), Paris: FYP éditions, pp. 1-13.
15. [http://articles.timesofindia.indiatimes.com/2011-09-01/gaming/29953270\\_1\\_identity-theft-gaming-data-breach](http://articles.timesofindia.indiatimes.com/2011-09-01/gaming/29953270_1_identity-theft-gaming-data-breach)
16. <http://www.chinahearsay.com/chinas-online-game-real-id-system-take-two/>
17. <http://www.devicemag.com/2012/02/17/timed-online-gaming-restriction-possibly-coming-to-south-korea/>
18. <http://us.battle.net/wow/en/forum/?topicId=25712374700&sid=1>
19. Itsuki, H., Takeuchi, A., and Fujita A., 2010, Exploiting MMORPG log data toward efficient RMT player detection, *Proceeding ACE '10 Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology*.
20. Katz, M. L., and Shapiro, C. 1985. "Network Externalities, Competition, and Compatibility," *American Economic Review* (75), pp. 424-440.
21. Kaufman, L., and P. J. Rousseeuw. 1990. *Finding Groups in Data: An Introduction to Cluster Analysis*. New York: Wiley.

22. Kozinets, R. V. (2010). *Netnography. Doing Ethnographic Research Online*. Sage Publications Ltd London.
23. McKenna, Brad; Gardner, Lesley; and Myers, Michael D., "Issues In The Study Of Virtual World Social Movements" (2011). PACIS 2011 Proceedings. Paper 129. <http://aisel.aisnet.org/pacis2011/129>
24. McKenna, Brad; Gardner, Lesley A.; and Myers, Michael, "Social Movements in World of Warcraft" (2011). AMCIS 2011 Proceedings - All Submissions. Paper 83.
25. Roquilly, Christophe. 2011. Control Over Virtual Worlds by Game Companies: Issues and Recommendations, *MIS Quarterly*, (35: 3) pp. 653-671.
26. Rheingold, H. 2000. *The Virtual Community: Homesteading on the Electronic Frontier*, London: MIT Press.
27. R.S. Lazarus, Coping theory and research: past present, and future, *Psychosomatic Medicine* 55 (3) (1993) pp. 234-247.
28. Shankar, V., and Bayus, B. L. 2003. "Network Effects and Competition: An Empirical Analysis of the Home Video Game Industry," *Strategic Management Journal* (24:4), pp. 275-384.
29. Shy, O. 2001. *The Economics of Network Industries*, Cambridge, MA: Cambridge University Press.

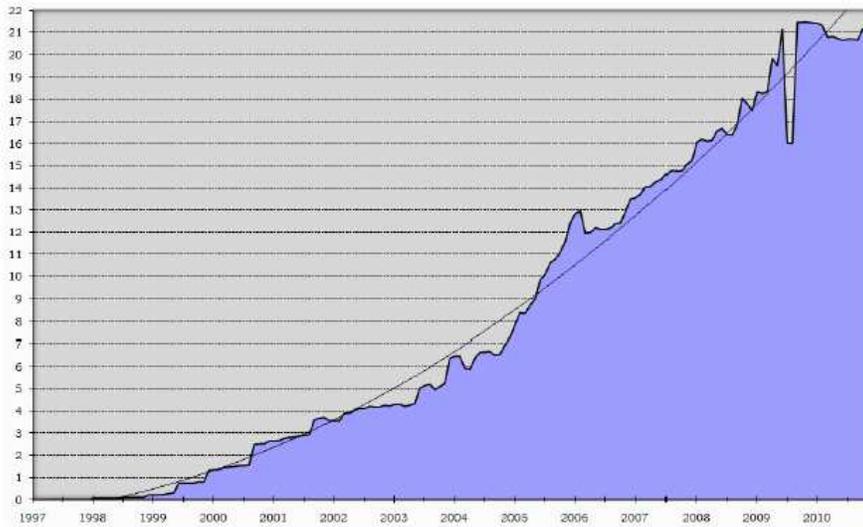
- 30.V.M. Ramaswamy, Identity-theft toolkit, CPA Journal 76 (10)  
(2006) pp. 66-70.
- 31.Wall Street Journal, December 14, 2011. Gaming's New Frontier  
After Zynga.  
<http://online.wsj.com/article/SB10001424052970204443404577051992472392070.html>
- 32.Wikipedia <http://en.wikipedia.org/wiki/MMORPG>

## 국 문 초 록

MMORPG는 지난 십 년 간 가장 크게 성장한 게임 분야로서 다양한 계층의 유저들에게 보편적인 인기를 끌고 있으며, 최근에는 가상세계에서 일어나는 새로운 형태의 협업과 사회적 활동들이 크게 주목받고 있다. 본 연구에서 저자는 MMORPG에서 일어나는 신분도용에 관해 실제 데이터를 활용한 연구를 실시하였다. 대부분이 MMORPG에 있어 어린 유저들의 경우 추가적인 인증과 게임 내에서의 사회적 활동상의 불이익 때문에 신분도용을 할 가능성이 있다. 실제 연구결과는 이러한 주장을 뒷받침해주며 게임 내에서 실제 신분도용이 일어날 가능성이 매우 높다는 점을 증명하고 있다. 이러한 결과를 도출해내기 위해 본 연구에서는 다중회귀분석과 판별분석, 분산분석을 시행하였으며, 여기에 보다 정확한 신분도용의 규모를 추정하기 위해 게임 로그 분석을 추가적으로 시행하였다. 결과적으로 40대 집단의 행동양식이 14세 이하의 어린 사용자 집단과 매우 유사하다는 점과 40대 집단 내의 약 50%의 사용자가 어린 사용자와 같은 로그 접속 패턴을 갖는다는 결론을 도출했다.

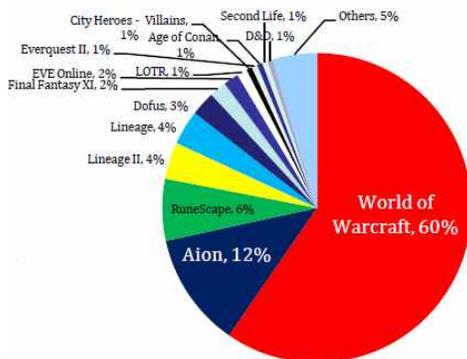
## Appendix A. MMORPG Users

### MMO subscribers (M)



Sources: MMOData Feb 2011, Companies, CapitalIQ, GLG

### Global MMO subscriptions



### Global MMO genres

