

# Exploring the Attractive Factors of Mobile Tower Defense Games

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**Abstract**—Tower Defense (TD) game has always been a very popular video game. The purpose of this study is to explore the attractive factors of TD games and the relationship between these factors. The evaluation grid method was used to find the attractiveness of TD game, and the quantification theory type 1 was applied to get the influence weight between these elements. The results show that there are four main charm factors in TD game: sense of control, sense of challenge, sense of urgency and Sense of enjoyment. The quantitative statistical results show the weight relationship between the attractive factors. The results can be used as a reference for game developers.

**Keywords**—mobile MOBA games; Miryoku Engineering; EGM; quantification theory type 1

## I. INTRODUCTION

The gaming industry has grown rapidly, with global revenues surpassing those of the film and music industries [1]. The sale of video games is directly related to the entertainment of games [3]. There are many elements of entertainment or playability, but the ultimate goal is to keep attracting players. It is important for many video games to recognize the factors that trigger certain experiences [8]. It has great research value. Research on games has been going on for a long time, and is still popular today. There are many reasons to encourage such research. The human fascination with games is ancient and pervasive [2]. In recent years, tower defense game is a very popular video game and has more and more players [1]. Tower defense games have many different characteristics compared with other types of games. Game developers should understand these characteristics and clarify the reason why tower defense games attract players so as to have more players. Developers and designers of tower defense games should accurately analyze the reasons why tower defense games attract players. On this basis, game details and experience can be optimized to expand the player market and continue to attract players. At present, many scholars have studied the attractiveness of integrated PC games or mobile games, as well as artificial intelligence algorithms in tower defense games, or use tower defense games as tools to improve the teaching effect. But few studies have systematically analyzed how effective tower defense can be in attracting players. Generalizing elements of the game's appeal will help game developers expand the game market. This study uses the theory of Miryoku engineering to obtain the charm factors of tower defense games and applies the quantification theory type 1 methods to calculate the

relationship between attractive factors. There are two main purposes of this study: the first one is exploring the attractive factors of tower defense games. The second one is analyzing the weight and intensity between each factor.

## II. LITERATURE REVIEW

### A. Tower Defense Games

Tower defense is a strategy game in which the player prevents moving enemy units, usually through a fixed number of discrete waves to the end point, and through the placement of static "towers" that are fired at enemy units [2]. Strategic planning is needed because of cost and resettlement issues. In addition, each type of enemy may need its own tower to handle [1]. Aura found that playing tower defense is a complex problem-solving activity [3]. To be successful, players should be forced to make meaningful choices about which towers to build, where to build them and when to build them. There should be multiple strategies available to increase replay value and encourage players to experiment [2]. Brich believed that tower defense games could effectively arouse people's various emotions, and developed education tower defense games based on this feature to popularize knowledge of protecting liver. Peyman's research is related to enhancing the entertainment of tower defense games. He used the artificial intelligence algorithm of fuzzy logic to optimize the dynamic difficulty of tower defense games to achieve the purpose of lasting entertainment [7]. Hugo found that games developed with GEM significantly improve UX by increasing the puppetry and consequently reducing player frustration [9].

Most of the literature mentioned above is about the research on the attractiveness of comprehensive games or the research on improving the game experience of tower defense in a certain aspect. However, for game designers and developers, the charm of tower defense games should be comprehensively and specifically analyzed. The question remains to be studied

### B. Miryoku Engineering and Evaluation Grid Method

Attractiveness, Japanese for Miryoku, it is the user's subjective preferences. It mainly comes from its value judgment system, which comes from users' sensory reception, psychological decision-making, sociology, art evaluation and other categories [6]. Ujigawa initiated the research of "Miryoku engineering" in 1991 with a group of scholars, with the purpose

of "creating the technology and knowledge of products and space with charm". Charm engineering was incorporated into Japanese kansei engineering in 1998. The term "charismatic engineering" was developed by Kelly, a clinical psychologist, Sanui and Inui reference, in the book "The psychology of personal finance". The research method was to capture personal cognitive concepts and compile lists [8].

"Evaluation structure method" is an important research method in miryoku engineering, derived from the psychology category, mainly through by capturing individual cognitive concept and list finishing method, this method is mainly through An interview, through the content of A and B is relative, discuss A clear object, similar or different relations and sort out its target objects of individual traits. Sanui [5] takes this approach further. First, in the evaluation of target objects, respondents need to answer their preferences or dislike of objects. The second step is to clarify the respondents' answers or conditions through additional questions, and integrate their answers, to specifically analyze the attractive factors of products to consumers' preferences, and to sort out their related construction network. This research Method is called "Evaluation Grid Method" (EGM for short) [5].

### III. RESEARCH PROCESS AND METHODS

The focus of this study is to find out the attractive factors of tower defense games. The research methods and procedures are divided into two parts. The first part is to use "questionnaire survey" to screen the interviewees. The second part mainly conducts the in-depth interview with the "evaluation grid method" in miryoku engineering. The method is summarized as follows:

#### A. Sample Selection

Firstly, the top 10 tower defense games were selected from the authoritative game websites, and five tower defense games were finally determined as the research sample by combining the download times and daily active users (DAU) of the games. They are two PC game plants vs zombies and desktop tower defense, and three mobile game kingdom defense, radish and gold defense. They dominate most of the tower defense market.

#### B. Participants

In this study, six researchers with experience in game development were invited to conduct interview training. They conducted in-depth interviews with 11 high-involvement players in the tower defense game. The high involvement players selected in this study were those who had played more than 3 of the 5 sample games and had played the tower defense game for more than 2 years. The 11 players included six male and five female, ages 18-35.

#### C. Indepth Interview

This study used EGM to extract the charm factor of tower defense game. In the EGM method, researchers should first conduct semi-structured interviews, and the entire interview process will be recorded. As the game and product are different in a time process, a classic game of tower defense generally lasts 20-50 minutes. According to cognitive behavioral theory,

some information in the brain is stored only in short-term memory. Therefore, in this study, in addition to the standard interview procedure, the EGM interview was also conducted with the help of loud thinking, so that players could express their thoughts at that time while playing the game. This is an oral analysis method, which helps to obtain information that is difficult to recall in post-interview interviews. The specific interview method and process are described below:

First, 11 subjects were asked to select one of the most familiar tower defense game samples to play for 15 minutes. And choose a sample game you're unfamiliar with or haven't played for 15 minutes. Participants were asked to think aloud as they played the game, as much as possible to express their thoughts at the time.

After the participants finished playing the game, the researchers interviewed them and asked them which game was more appealing to you and why. The answers to these questions will be recorded and collated as the Middle Item in the EGM hierarchy diagram, the original reason. The researchers then asked the participants about their abstract feelings (Upper Item), such as, "How do you feel about these reasons? The researchers then asked again, "What kind of details made you feel this way about the original reason", which led to the Lower Item being the main attraction of the tower defense game.

After the interview, the researchers should immediately sort out the notes and recordings of the EGM interview and clearly divide them into three levels: original (middle), abstract (upper) and specific (lower). Next, each participant's elements are organized into an EGM hierarchical table. Finally, the EGM table of all subjects was integrated, and the elements with repeated statements were combined to simplify overly complex statements. At the same time, the number of mentions of the subjects was marked on each charm element, and the connection was made according to the correlation of charm elements. The final EGM hierarchical table of the magic elements of the tower defense game is then obtained.

#### D. Statistical Analysis — Quantification Theory Type 1

For the second purpose of the study, this study used quantitative theory type 1 methods to analyze the relationship between charm factors extracted from the previous step. Firstly, Likert scale was used to make questionnaire to evaluate the importance of the median. The subjects were then asked to select one of the most important lower elements according to each middle element. In this study, 193 questionnaires were issued through the network questionnaire website, among which 161 valid questionnaires were recovered. The statistical results of the questionnaire were used to calculate the influence weight between the charm factors.

## IV. RESULTS AND DISCUSSION

### A. The Result of EGM

The final evaluation grid method hierarchical diagram of tower defense game is shown in "Fig. 1".

Upper layer: abstract user psychological perception

Middle layer: original TD game appeal feature

Lower layer: concrete TD game features or design elements

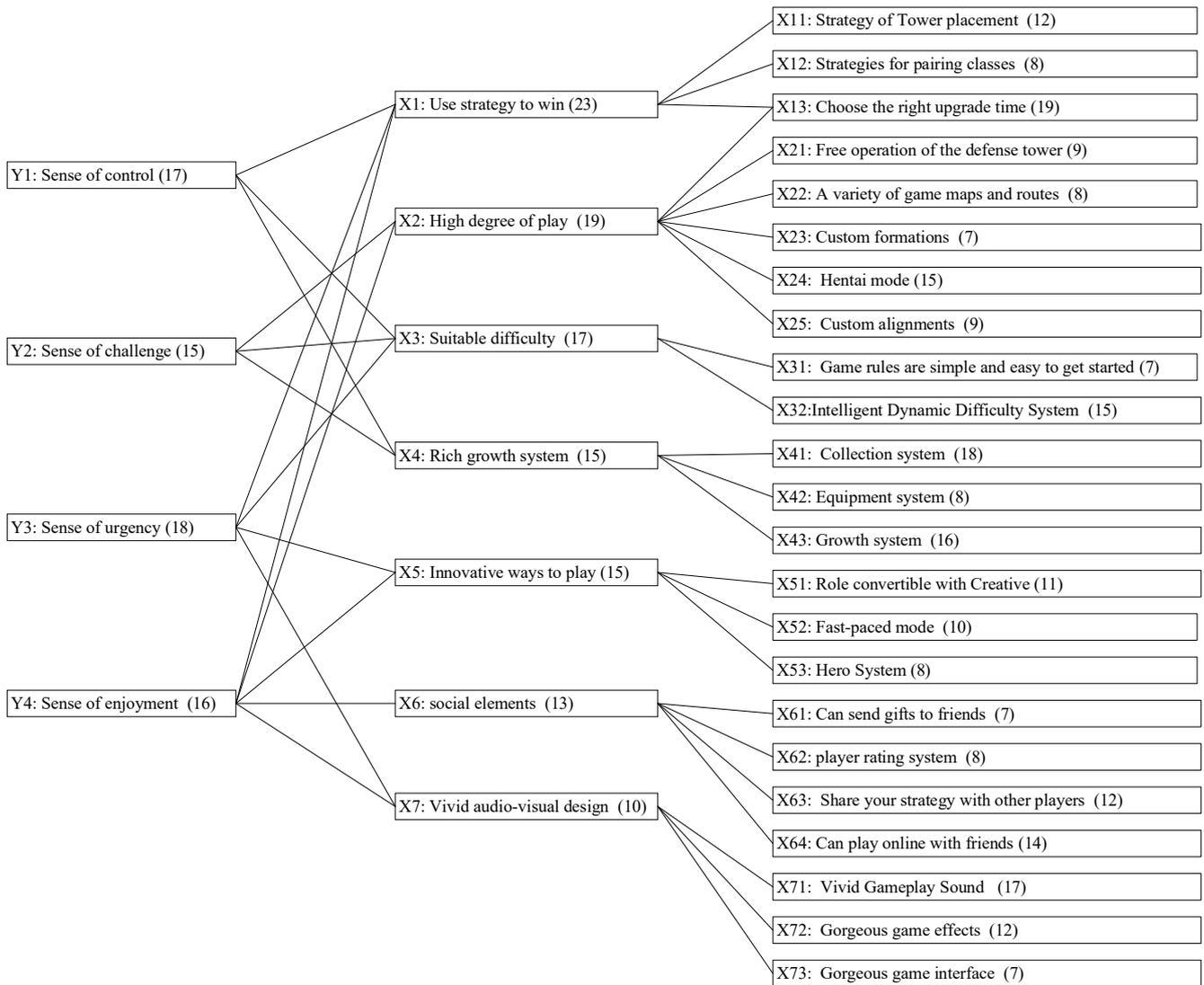


Fig. 1. The EGM hierarchical diagram of TD games appeal features.

The result in "Fig. 1" shows that the charm factors of TD game contain 4 abstract reasons: Sense of control, sense of challenge, sense of urgency and Sense of enjoyment. 7 of the original reasons are listed in the middle column of the chart. The concrete reasons associated with each original reason are listed on the right side of the chart. The Numbers in each bracket represent the number of mentions

**B. Weighting the Attractiveness of the "Sense of Control"**

The Multiple correlation from "Table I" was 0.793 which was high correlation, it showed that the Sense of control had a high correlation with TD games. It can be seen from each PPC value that Use strategy to win has the greatest influence on sense of fairness. CS values show that Strategy of Tower placement is free has the greatest influence on Use strategy to win.

TABLE I. QTTI RESULTS FOR "SENSE OF CONTROL"

Original reasons	Concrete reasons	CS <sup>a</sup>	PCC <sup>b</sup>	Ranking
X1	X11	0.759*	0.847	1
	X12	-0.216		
	X13	-0.147		
X3	X31	0.321	0.754	2
	X32	0.762*		
X4	X41	0.962*	0.632	3
	X42	0.136		
	X43	0.596		
Constant		0.812		
R=0.793	R2=0.629			

<sup>a</sup>. Category scores

<sup>b</sup>. Partial correlation coefficients.

**C. Weighting the Attractiveness of the “Sense of Challenge”**

The Multiple correlation from "Table II" was 0.823 which was high correlation, sense of challenge had a high correlation with TD games. It can be seen from each PPC value that High degree of playability has the greatest influence on Sense of challenge. Hentai mode has the greatest influence on High degree of playability.

TABLE II. QTT1 RESULTS FOR “SENSE OF CHALLENGE”

Original reasons	Concrete reasons	CS <sup>c</sup>	PCC <sup>d</sup>	Ranking
X2	X13	0.543	0.823	1
	X21	-0.128		
	X22	-0.223		
	X23	0.059		
	X24	1.032*		
	X25	0.067		
X3	X31	0.632*	0.785	2
	X32	-0.225		
X4	X41	1.030*	0.663	3
	X42	-0.522		
	X43	-0.465		
Constant		0.948		
R=0.782	R <sup>2</sup> =0.612			

a. Category scores

b. Partial correlation coefficients.

**D. Weighting the Attractiveness of the “Sense of Urgency”**

The Multiple correlation from "Table III" was 0.729 which was high correlation, it showed that the Sense of urgency had a high correlation with TD games. It can be seen from each PPC value that Suitable difficulty has the greatest influence on Sense of urgency. CS values show that Intelligent Dynamic Difficulty System has the greatest influence on Suitable difficulty.

TABLE III. QTT1 RESULTS FOR “SENSE OF URGENCY”

Original reasons	Concrete reasons	CS <sup>e</sup>	PCC <sup>f</sup>	Ranking
X1	X11	0.813*	0.426	3
	X12	0.628		
	X13	0.125		
X3	X31	-0.157	0.864	1
	X32	1.226*		
X7	X34	0.957*	0.703	2
	X51	0.623		
	X52	-0.635		
Constant		0.894		
R=0.854	R <sup>2</sup> =0.729			

a. Category scores

b. Partial correlation coefficients.

**E. Weighting the Attractiveness of the “Sense of Enjoyment”**

The Multiple correlation from "Table IV" was 0.716 which was high correlation, it showed that the Sense of enjoyment had a high correlation with TD games. It can be seen from each Partial correlation coefficients value that Use strategy to win has the greatest influence on Sense of enjoyment. CS values show that Strategies for pairing classes has the greatest influence on Use strategy to win.

TABLE IV. QTT1 ANALYSIS RESULTS FOR “SENSE OF ENJOYMENT”

Original reasons	Concrete reasons	CS <sup>e</sup>	PCC <sup>h</sup>	Ranking
X1	X11	0.685	0.864	1
	X12	0.823*		
	X13	0.362		
X2	X13	0.652	0.765	3
	X21	0.681		
	X22	0.364		
	X23	0.648		
	X24	0.861*		
	X25	0.645		
X5	X51	0.832*	0.812	2
	X52	0.349		
	X53	1.365		
X7	X71	0.749	0.365	4
	X72	0.765*		
	X73	0.263		
Constant		0.856		
R=0.846	R <sup>2</sup> =0.716			

a. Category scores

b. Partial correlation coefficients.

**V. CONCLUSION**

This study explores the attractiveness of tower defense games and analyzes the weight relationships between them. Fill in the lack of research on the attractiveness of this game type in TD games. As shown in the results, game designers should focus on these charm factors in the results during the development of TD games. The mathematical model between attractiveness factors can provide scientific reference for the game design. In addition, it can be seen from the results that the combination of EGM and quantification theory type 1 is very effective in extracting the product charm factor and analyzing the relationship between the user's psychological feeling and the specific design elements of the product. The results of this study can be used as a reference for game developers.

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