

THE DESIGN DECISION OF ONLINE GAME DEVELOPMENT BASED ON A MCDM MODEL COMBINING DEMATEL WITH ANP METHOD

¹ BANG-NING HWANG, ^{2*} NAI-YUAN PAI ³ CHENG-CHANG LU, ⁴ YUN KEN

^{1,2,3} Department of Business Administration, National Yunlin University of Science & Technology, Taiwan.

⁴ Graduate Institute of Patent, National Taiwan University of Science and Technology, Taiwan.

E-mail: ¹ bnhuang@yuntech.edu.tw, ² billypai7212@gmail.com, ³ billypai7212@gmail.com,
⁴ yunken@mail.ntust.edu.tw

ABSTRACT

As game users are the main body of the gaming market, the allocation of design resources should be undertaken to meet the requirements of game users. Based on the literature on online games, this paper constructed a hierarchical system structure for online games, including three major design dimensions and nine design criteria. Then, DEMATEL with the ANP (DANP) method was adopted to evaluate the relationships among different game design items and to rank their importance, thus ascertaining the design strategy of online games. The study results show that extrinsic motivation is the most important design factor, and that game motivation can be influenced by game content design and game quality. This study suggests that online game developers invest design resources in virtual products and role customization functions, and continue to assign new game objects to game users to encourage them to continue playing the game. Additionally, there is no need to invest large amounts of resources in game content design and game quality. However, a mechanism that can satisfy users' game motivations should be added to help the game to stand out in the online game market.

Keywords: *Online game design, Game motivation, DEMATEL with ANP*

1. INTRODUCTION

The ultimate purpose of any economic activity is to satisfy people's demands or desires. As people's quality of life improves and technologies evolve, products on the market start to include entertainment elements to provide higher value perception to customers. This new economic form is called the "entertainment economy", and the entertainment industry has developed under its continuous growth. In the 21st century, the entertainment industry now contains various content, such as digital games, film and television media, and tourism, etc. Among these, the online gaming industry accounts for a considerable share of the entertainment market. According to the US Intelligence [1] report, the value of the global online game market reached three billion US dollars in 2005 and, despite the 2008 global economic crisis, the online game industry continued to grow [2]. It was estimated that the value of the global online gaming market would exceed 24 billion US dollars in 2013 [3].

Although the market contains huge business opportunities, only a few games have managed to survive in the fiercely competitive gaming market [4]. The magazine Edge, that leads the UK gaming industry, has demonstrated that as more and more games are released, the number of low-quality games increases. This phenomenon shows that there is a gap between the ideas of the game design experts and the game users. The development of many games cost a large amount of money, but fails to satisfy game users. Therefore, game design companies should begin to prioritise the favored aspects of the game users when they are designing high-quality games, which will greatly reduce the cost of failure [5].

Game users are the main body of the gaming market. Therefore, game design companies should be game-user-oriented. They should try their best to understand what products and services are expected by most game users [6], and master the crucial factors to achieve game user satisfaction. Existing studies have evaluated the elements of game design from the perspective of game users. For example, Jacobs and Ip [5] used the AHP method to consider

the ranking of game users' preferences, and simulated the design strategies of car race games. Hsu, Lee [4] confirmed 39 key points for game design from frequent buyers of action games. Lo and Wen [7] used the Fuzzy AHP to investigate the game users of MMORPG, and confirmed the key points for the design of MMORPG. The above mentioned literature ranked the key design points considered by game users, and made the developers reconsider the strategies of game design and invest resources in the design of key parts so as to get closer to the real requirements of game users.

Nevertheless, it is nearly impossible to design a perfect game that considers the opinions of all game users. The resources of game design companies are limited, and it is impossible for them to invest unlimited resources in each design item of the game. The study by Lo and Wen [7] showed that game design companies' resources for development are limited. Consequently, they should confirm the design items that would influence the competitiveness of the game, rank the importance of these items, and then think about how to invest resources in items that would actually enhance the competitiveness of the game. It is not necessary to distribute resources evenly to each item. Therefore, this study aims to use DEMATEL with the ANP (DANP) to compare the relationships among different game design items and confirm their ranking importance, thus discovering an online game design strategy that can meet the requirements of game users.

Many MCDM techniques are based on the additive concept along with the independence assumption, but each individual criterion is not always completely independent [8]. To solve the interactions among elements, the analytic network process (ANP) was proposed by Saaty. This technique is a mathematical theory that can solve all kinds of dependence systematically, but it doesn't work completely or perfectly. This is because using the ANP to solve MCDM problems leads to different influence levels among the criteria based on the network relationship map (NRM). If we don't comprehend the causal relationship, and utilize the average method to calculate the final global priorities, the results of the assessed weights could be higher or lower than the real situation [9]. Consequently, the decision-making trial and evaluation laboratory (DEMATEL) was introduced. This is a powerful technique which can convert the relationship between cause and effect criteria into an intelligible structural model of the system, and propose the most important criteria which affect

other criteria [10]. This technique will allow the decision-makers to acknowledge the criteria of greater influence [11]. As the ANP and the DEMATEL have these advantages, this paper used an effective solution based on a combined ANP and DEMATEL approach to find the interrelated relationships and important online game design factors.

The remainder of this paper is organized as follows: the online gaming literature is reviewed in Section 2. A hybrid MCDM model combining DEMATEL with the ANP for online game design is introduced in Section 3. Research results and findings are shown in Section 4. Finally, conclusions are presented in the last section.

2. LITERATURE REVIEW

This paper summarized the design dimensions that would influence the competitiveness of online games, and constructed a hierarchical system structure for online games (shown in Table 1), including three major design dimensions for game content design, game quality, game motivation, together with nine design criteria.

2.1 Game Content Design

Game content design is the fundamental part of a game, but it is rather complicated and difficult to discuss all the factors related to game design. As a result, Schell [12] proposed a method with four categories. All elements can generally be divided into aesthetics, mechanics, technology, and story.

Aesthetics. Aesthetics refers to the sensory phenomena that game users experience when playing, such as visual and auditory experiences. The aesthetic dimension of the game design model by Bishop, Eberly [13] included music and graphics. Norman [14] believed that sound and light effects have a crucial influence on the success of a game. Lo and Wen [7] used sound and light effects to evaluate the design elements of role play games, and believed that the evaluation of sound and light effects included the liveliness of the animation design, the appropriateness of the music, and whether the game provided high definition pictures. Kosmadoudi, Lim [15] believed that, apart from aesthetic experience, the design of the graphic interface should be included. Therefore, the aesthetic dimensions discussed should include music [7, 12-16], animation [7, 12, 15, 16], graphics [7, 12-16], and a graphic operation interface.

Table 1: Explanation Of Dimensions And Criteria.

Dimensions and criteria	Descriptions
Game content design (D_1)	
Aesthetics (C_1)	The sensory phenomena that game users experience when playing, such as visual and auditory.
Mechanics (C_2)	All rules of the game system.
Technology (C_3)	The breakthrough of the virtual environment brought by the progress of the physics engines of games
Story (C_4)	A game allows users to get involved in a story and influence the ending of the story.
Game quality (D_2)	
Information quality (C_5)	The information provided by an online service possesses the traits of the software
System quality (C_6)	System quality refers to the efficacy provided by a system.
Service quality (C_7)	The performance of customer service in a game company.
Game motivation (D_3)	
Extrinsic Motivation (C_8)	Game users join online games due to the influence of external aspects.
Social motivation (C_9)	The interpersonal relationships and social interactions of game users.

Mechanics. Bishop, Eberly [13] proposed a general module for game content design. The module contains incident processing and the input of game users' actions (continuation of the game following the next action of the game users), level data (stores the static information of game roles) and dynamic modules (stores the motion behavior of game roles). Lo and Wen [7] once used a role system (including the appearance, skills, and personalized setting of a role), rules of the game world (the game world will generate an operating rule to manage game users and the relationships with other game units). According to Kosmadoudi, Lim [15], game mechanics usually set in place the motions that may be displayed by game users, together with the files on the motion design of the game users, as well as all rules of the game system. Thus, mechanic dimensions discussed include static and dynamic information of the roles, and the rules of the gaming world.

Technology refers to 3D graphics technology, the breakthrough of the virtual environment brought about by the progress of the physics engines of games, as well as new playing methods resulting from the somatosensory interactions of the wii and the gravity sensation of mobile phones [15]. Lo and Wen [7] once used the dimension of environmental setting, including (1) immersive game world, (2) boundless game map, and (3) vivid scenes. These brand new virtual environment experiences are brought to game users due to the progress of game technologies. Therefore, the technological dimensions discussed include the setting of the game environment [7, 12, 15, 16] and the logics of physical control [12, 15, 16].

Story. A game allows users to get involved in a story and influence the ending of the story. Thus,

the story is the core of the game. If a game has an epic story, or can enable game users to do things that they are unable to do in real life, the attraction of the game will be increased [15]. Bishop, Eberly [13] proposed a general module for game content design. The module contains game logics (which are responsible for the maintenance of the story). Lo and Wen [7] used plots and a task design for game users (in the gaming world, tasks are a kind of game objective given to game users. Game users can experience the satisfaction of the game by completing tasks) as the design dimensions that supported the story of the game. Therefore, the story dimension discussed include plots [7, 12, 13, 15] and task design [7].

2.2 Game Quality

Customer satisfaction is influenced by the service quality perceived by customers (Cronin and Taylor, 1992). This concept can be extended to online customer satisfaction ([17]. With respect to the studies on online games, several papers have used the evaluating dimensions of information service quality to measure online games. Armitage and Zander [18] believed that highly interactive online games needed higher network service quality. Chen, Huang [19] considered the QoS (quality of service) network as the index for the service quality of games. This could be used to measure the satisfaction of the users of the online game. Yang, Wu [20] used service quality as the index for measuring satisfaction with the online games, and proved that service quality was positively related to online game satisfaction, thus further influencing the game users' loyalty to the game. According to the information system model proposed by Rodgers, Negash [21], the quality of the game design can be divided into the three major items of

information quality, system quality, and service quality.

Information quality: information quality refers to whether the information provided by an online service possesses the traits of the software, such as timely traits and convenience (DeLone and McLean [22]). Rodgers, Negash [21] considered information quality to ascertain whether the system could provide real-time, which is the latest, and most complete information. Lo and Wen [7] believed that the dimension of service quality refers to whether the official game party could provide useful information and regularly update the game system. Thus, the design items for information quality can be defined as those issued from official channels or from other spreading channels, i.e., the game can (1) provide accurate information, (2) provide real-time information, (3) update the latest information, and (4) provide complete information.

System quality: system quality refers to the efficacy provided by a system. It is measured by whether or not customers can have simple interactions with the system (DeLone and McLean [22]). Rodgers, Negash [21] believed that the measuring items of system quality included interactivity and data access. Interactivity refers to whether a system can make quick responses, as well as ascertaining whether the operating interface is a proper one. Data access refers to whether a system can make quick responses during a busy time, and provide supporting information and real-time information to customers. Lo and Wen [7] proposed the idea that system quality refers to whether the game server can provide a quick and stable service. Therefore, the design items for system quality should be defined as (1) whether the game can operate quickly and stably, (2) whether the game can respond quickly, even at a busy time, and (3) game users can easily access supporting information.

Service quality. Rodgers, Negash [21] believed that service quality covers tangibility, reliability, responsiveness, assurance, and empathy. While applying the dimensions of service quality to the field of online games, Yang, Wu [20] only considered four dimensions, namely, reliability, responsiveness, assurance, and empathy. Lo and Wen [7] also mentioned friendly customer service. As previously mentioned, information quality and system quality cover the quality items provided by the game itself, with respect to service quality. After considering the definitions of service quality given by Yang, Wu [20] and Lo and Wen [7], this study limits the evaluating object of service quality

to the performance of customer service in a game company. The design items of service quality are defined as (1) reliability, meaning that customer service can provide an accurate and reliable service; (2) responsiveness, meaning that customer service can satisfy game users' requirements promptly; (3) assurance, meaning that customer service can provide sufficient knowledge to obtain game users' trust; and (4) empathy, meaning that customer service can identify certain customers to provide a personalized service.

2.3 Game Motivation

During the study of game motivation, the motivations of game users can be divided into three categories: intrinsic motivation, extrinsic motivation, and social motivation. However, as this study mainly discussed the design items of online games and the fact that intrinsic motivation belongs to game users' spiritual responses, which are not able to correspond to design items, intrinsic motivation was excluded from the discussion scope of this study.

Extrinsic motivation. Extrinsic motivation means that game users join online games due to the influence of external aspects, such as money, fame and interest, status, and trophies, etc. Wu, Wang [23] mentioned that the dimension of extrinsic motivation is the service mechanism provided by the game, such as fairness, incentives, and security. Studies by Park and Lee [24] and Lo and Wen [7] mentioned the attractiveness of the virtual channels of online games, including the help offered to increase the abilities of the roles, visual effects, and the value of currency. Billieux, Van der Linden [25] believed that extrinsic motivation included advancement, mechanics, and customization. Therefore, the design items of extrinsic motivation include (1) the reward mechanism that encourages game users to upgrade their levels, (2) virtual tools that can provide help to increase the abilities of roles and have a monetary value, (3) the customization functions of environment and role settings, (4) equal opportunities for each game user, and (5) assurance that information on game users will not be accessed by external programs.

Social motivation. Social motivation refers to the interpersonal relationships and social interactions of game users taking part in the game [26]. Koo [27] considered "interpersonal relationships" as social motivation. Lo and Wen [7] mentioned the dimension of a social communication system, including (1) complete social support, (2)

friendships that can be easily managed, and (3) actual social interactions. Wu, Wang [23] used social presence. Social motivations evaluated by Billieux, Van der Linden [25] included socializing, relationships, teamwork, and competition. Therefore, the discussion on social motivation should include “the social interface that is easy to manage”, “the requirement for teamwork”, and “the competition system among game users”.

3. METHODOLOGY

3.1 Data Collection

A DANP questionnaire was mainly used to collect the specialized knowledge of experts. Consequently, the study objects had to be professional. The statistical results of Koo [27] study on online games showed that game users who take part in a study generally have five to ten years' experience of game playing, and spend an average of 14 hours each week on online games. Therefore, this study defined that professional game users should have online game playing experience of more than 10 years, and spend more than 14 hours each week on online games. The investigation was conducted in January 2014. A total of 10 qualifying professional game users from Taiwan took part in the study. Each subject spent 30 minutes completing the questionnaire.

3.2 An Integrated Method Combining DEMATEL And ANP

This study adopted the DEMATEL technique to ascertain the influencing structure between the criterions and try to find the problems that need to be improved. After examining the influencing structure between each criterion, they were weighted by combining with the ANP method to find the most important criterion that will help to create an online game design strategy. Thus, the framework of evaluation contains two main phases: (1) constructing the impact-relations-map (IRM) among the criteria using the DEMATEL technique, (2) calculating the weights of each criterion by combining the ANP based on the IRM.

3.2.1 The DEMATEL process

The DEMATEL method can confirm the interdependence among variables/criteria and restrict the relations that reflect characteristics within an essential systemic and developmental trend. The methodology can be summarized as follows [28, 29]:

Step 1: Generating the direct-relation matrix.

The integer score x_{ij}^k is given by the k th expert and indicates the influential level that criteria i has on criteria j . The $n \times n$ matrix A is calculated in Eq. 1 by averaging the individual experts' scores,

$$a_{ij} = \frac{1}{H} \sum_{k=1}^H x_{ij}^k \quad (1)$$

where H is the total number of experts.

Step 2: Normalizing the direct-relation matrix

On the base of the direct-relation matrix A , the normalized direct-relation matrix X (Eq. 2) can be obtained through an equation:

$$X = k \cdot A \quad (2)$$

$$k = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}}, \quad i, j = 1, 2, \dots, n \quad (3)$$

Step 3: Attaining the total-influence matrix

Once the normalized direct-relation matrix X is obtained, the total-influence matrix T_C can be acquired by using Eq. 4, in which I is denoted as the identity matrix:

$$T_C = X(I - X)^{-1} \quad (4)$$

Step 4: Producing a causal diagram.

The sum of the rows and the sum of the columns are separately denoted as vector r and vector c through Eq. 5-6. Then, the horizontal axis vector ($r + c$) named "prominence" is made by adding r to c , which reveals how much importance the criterion has. Similarly, the vertical axis ($r - c$) named "relation" is made by subtracting r from c .

$$T = [t_{ij}]_{n \times n}, \quad i, j = 1, 2, \dots, n \quad (5)$$

$$r = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1} = [t_i]_{n \times 1}$$

$$c = \left[\sum_{i=1}^n t_{ij} \right]_{1 \times n} = [t_j]_{1 \times n} \quad (6)$$

where vector c and vector r , respectively, denote the sum of the rows and the sum of the columns in the total-influence matrix $T = [t_{ij}]_{n \times n}$.

3.2.2 The ANP process

In this section, the integrated MCDM method converts the total-influence matrix of the DEMATEL into the super- matrix of the ANP.

Step 5: The normalized total-influence matrix T_z

The total-influence matrix T_p has been determined according to the DEMATEL method result. Because the influence degrees between the criteria in the total-influence matrix T_p are different, all the criteria of the total-influence matrix T_p should be normalized. The normalized elements of the total-influence matrix T_p are

$$t_{ij}^z = \frac{t_{ij}^p}{\sum_{j=1}^n t_{ij}^p} \text{ and the normalized total-}$$

influence matrix T_z is represented as follows:

$$T_z = \begin{bmatrix} t_{11}^z & \dots & t_{1j}^z & \dots & t_{1n}^z \\ \vdots & & \vdots & & \vdots \\ t_{i1}^z & \dots & t_{ij}^z & \dots & t_{in}^z \\ \vdots & & \vdots & & \vdots \\ t_{n1}^z & \dots & t_{nj}^z & \dots & t_{nn}^z \end{bmatrix} \quad (7)$$

Step 6: The weighted supermatrix W_w

Furthermore, the weighted supermatrix W_w , such as Eq. 8, can be calculated by multiplying the unweighted supermatrix W and the normalized total-influence matrix T_z . That is

$$W_w = T_z \times W \quad (8)$$

Step 7: Limit the weighted supermatrix

Finally, the weighted super-matrix was raised to the limiting powers, such as Eq. 9, until the super-matrix converged to ascertain the global priority vectors or weights.

$$\lim_{l \rightarrow \infty} W_w^l \quad (9)$$

4. RESEARCH RESULTS AND FINDINGS

4.1 Measuring Relationships Among The Dimensions And Criteria Using DEMATEL

The DEMATEL technique is used to model the influential relationships among dimensions and criteria, and to establish an INRM for those dimensions and criteria using pair-wise comparisons [30].

The online gaming experts were asked to determine the influence of the relationships among the criteria. The average initial direct-relation 9×9 matrix A , obtained using pair-wise comparisons in terms of influences and directions between criteria, is shown in Table 2. As matrix A shows, the normalized direct-relation matrix X is calculated using Eqs. (2) and (3). Then, using Eq. (4), total influence T_C (Table 3) and T_D (Table 4) were derived, and by using Eq. (6), the IRM was constructed by the r and c in the total direct-influence matrix T_C and T_D (Table 5) as shown in Figs. 1 and 2.

4.2 Weighting Of Each Criterion Ascertained By Combining The DEMATEL With ANP Methods (DANP Technique)

Having determined the relationship structure of online game design criteria, the DANP method was applied to obtain the influential weights of the criteria.

First, the total-influence matrix T was normalized. By calculating the limiting power of the weighted supermatrix, $\lim_{l \rightarrow \infty} W_w^l$ is applied until a steady-state condition is reached (Tables 6-7). Each row represents the weight of each criterion. As seen in Table 8, the results showed that the experts were most concerned with extrinsic motivation (0.1683), social motivation (0.1669) and information quality (0.1518), and the least concerned with aesthetics (0.0641).

From the standpoint of dimensions, the experts considered that the first three important online game design factors are game quality (0.3503), game motivation (0.3351), and game content design (0.3146).

Table 2: The Initial Influence Matrix A For Criteria.

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	0.000	0.400	1.400	1.700	2.100	1.000	0.200	0.800	1.800
C_2	0.300	0.000	2.500	2.000	2.800	2.100	0.700	2.500	2.100
C_3	1.600	2.200	0.000	1.300	1.700	2.900	0.800	1.300	1.500
C_4	2.000	1.300	0.600	0.000	1.400	0.600	0.300	1.400	1.600
C_5	1.500	2.300	1.900	1.100	0.000	3.500	1.900	2.300	1.800
C_6	1.300	2.400	2.800	0.500	3.400	0.000	2.300	1.500	1.200
C_7	0.300	0.800	0.800	0.300	1.900	1.100	0.000	0.900	0.900
C_8	0.500	1.400	0.600	1.000	1.700	0.700	0.800	0.000	1.200
C_9	1.300	1.600	1.500	1.600	1.600	0.700	0.400	1.200	0.000

Table 3: The Total-Influence Matrix T_c For Criteria.

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	0.1385	0.2157	0.2580	0.2355	0.3428	0.2515	0.1311	0.2247	0.2755
C_2	0.2291	0.3014	0.4175	0.3260	0.5110	0.4200	0.2297	0.4164	0.3870
C_3	0.2741	0.3877	0.2656	0.2712	0.4312	0.4297	0.2183	0.3280	0.3326
C_4	0.2348	0.2458	0.2062	0.1378	0.2965	0.2145	0.1254	0.2463	0.2571
C_5	0.2973	0.4390	0.4120	0.2918	0.3976	0.5051	0.3068	0.4213	0.3883
C_6	0.2813	0.4372	0.4481	0.2561	0.5587	0.3297	0.3229	0.3766	0.3524
C_7	0.1209	0.1973	0.1914	0.1265	0.2876	0.2198	0.0986	0.1941	0.1882
C_8	0.1412	0.2385	0.1911	0.1770	0.2913	0.2075	0.1472	0.1555	0.2179
C_9	0.2123	0.2838	0.2717	0.2388	0.3299	0.2447	0.1445	0.2558	0.1863

Table 4: The Total-Influence Matrix T_D For Dimensions

Dimensions	D_1	D_2	D_3
D_1	0.2591	0.3001	0.3084
D_2	0.2916	0.3363	0.3202
D_3	0.2193	0.2275	0.2039

Table 5: The Sum Of The Influences Given And Received On Dimensions And Criteria.

Dimensions/Criteria	Row sum(d)	Column sum(r)	$d+r$	$d-r$
Game content design (D_1)	0.8676	0.7699	1.6376	0.0977
Aesthetics (C_1)	2.0733	1.9296	4.0029	0.1437
Mechanics (C_2)	3.2381	2.7464	5.9845	0.4917
Technology (C_3)	2.9384	2.6617	5.6001	0.2767
Story (C_4)	1.9645	2.0607	4.0252	-0.0963
Game quality (D_2)	0.9481	0.8640	1.8120	0.0841
Information quality (C_5)	3.4593	3.4466	6.9059	0.0127
System quality (C_6)	3.3630	2.8226	6.1856	0.5404
Service quality (C_7)	1.6245	1.7244	3.3489	-0.1000
Game motivation (D_3)	0.6507	0.8325	1.4831	-0.1818
Extrinsic Motivation (C_8)	1.7671	2.6187	4.3858	-0.8516
Social motivation (C_9)	2.1679	2.5853	4.7531	-0.4174

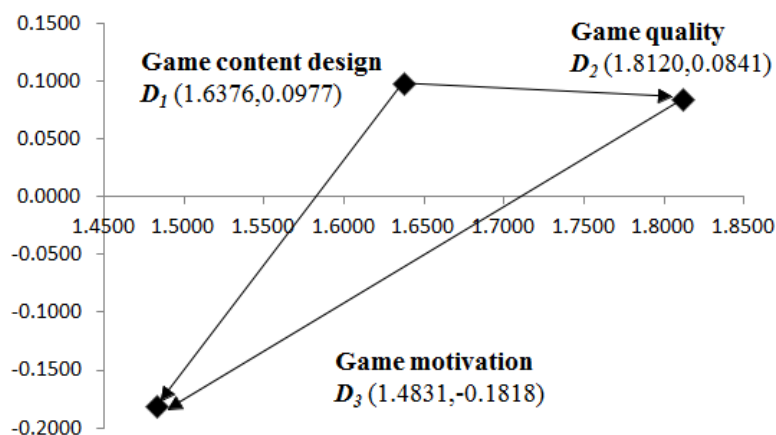


Figure 1: The Impact-Relations-Map Of Relations Within Dimensions

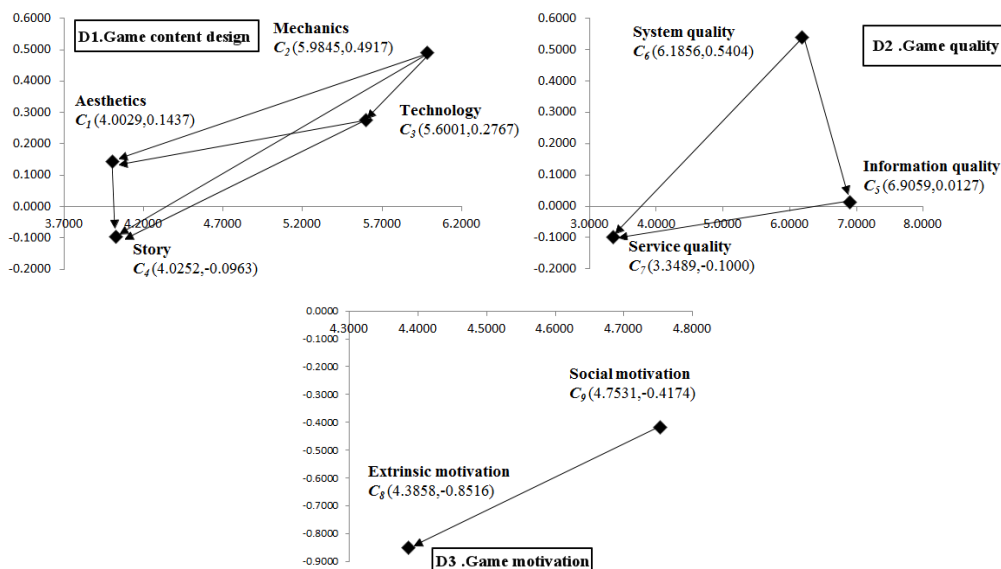


Figure 2: The Impact-Relations-Map Of Relations Within Criteria

Table 6: The Unweighted Supermatrix *W*.

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	0.1634	0.1798	0.2287	0.2847	0.2064	0.1977	0.1901	0.1888	0.2109
C_2	0.2545	0.2366	0.3235	0.2980	0.3049	0.3073	0.3101	0.3190	0.2819
C_3	0.3043	0.3277	0.2216	0.2501	0.2861	0.3149	0.3009	0.2556	0.2699
C_4	0.2778	0.2559	0.2262	0.1671	0.2026	0.1800	0.1989	0.2367	0.2372
C_5	0.4726	0.4402	0.3996	0.4659	0.3287	0.4612	0.4746	0.4509	0.4587
C_6	0.3467	0.3618	0.3982	0.3370	0.4176	0.2722	0.3627	0.3213	0.3403
C_7	0.1807	0.1979	0.2022	0.1971	0.2537	0.2666	0.1626	0.2279	0.2010
C_8	0.4492	0.5183	0.4965	0.4892	0.5204	0.5166	0.5077	0.4164	0.5786
C_9	0.5508	0.4817	0.5035	0.5108	0.4796	0.4834	0.4923	0.5836	0.4214

Table 7: Weighting The Unweighted Supermatrix Based On The Total-Influence Normalized Matrix W_w .

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	0.0488	0.0537	0.0683	0.0850	0.0635	0.0608	0.0585	0.0636	0.0711
C_2	0.0760	0.0706	0.0966	0.0890	0.0938	0.0945	0.0954	0.1075	0.0950
C_3	0.0909	0.0979	0.0662	0.0747	0.0880	0.0969	0.0926	0.0861	0.0910
C_4	0.0830	0.0764	0.0676	0.0499	0.0623	0.0554	0.0612	0.0798	0.0800
C_5	0.1635	0.1523	0.1382	0.1612	0.1166	0.1636	0.1684	0.1577	0.1604
C_6	0.1199	0.1252	0.1377	0.1166	0.1481	0.0966	0.1287	0.1123	0.1190
C_7	0.0625	0.0685	0.0700	0.0682	0.0900	0.0946	0.0577	0.0797	0.0703
C_8	0.1597	0.1843	0.1765	0.1739	0.1757	0.1745	0.1714	0.1305	0.1813
C_9	0.1958	0.1712	0.1790	0.1816	0.1620	0.1632	0.1663	0.1829	0.1320

Table 8: Weights And Ranking For Online Game Design Factors.

Dimensions/Criteria	Local weights	Global weights (ranking)
Game content design (D_1)	0.3146	
Aesthetics (C_1)	0.2038	0.0641(9)
Mechanics (C_2)	0.2960	0.0931(5)
Technology (C_3)	0.2793	0.0879(6)
Story (C_4)	0.2209	0.0695(8)
Game quality (D_2)	0.3503	
Information quality (C_5)	0.4335	0.1518(3)
System quality (C_6)	0.3495	0.1224(4)
Service quality (C_7)	0.2170	0.0760(7)
Game motivation (D_3)	0.3351	
Extrinsic motivation (C_8)	0.5021	0.1683(1)
Social motivation (C_9)	0.4979	0.1669(2)

4.3 Research Finding

4.3.1 Extrinsic motivation is the most important factor for online game design

By combining the DEMATEL and ANP methods, it was found that extrinsic motivation, which was weighted 0.1683, is the most important factor in online game design. The online game design factors of extrinsic motivation included virtual items, customization, fairness, security and incentives.

Virtual roles are the embodiment of game users in the society of an online game. With specific regard to MMORPG game users, they interact with other members of the game society by operating virtual roles and game content. Therefore, the operation of virtual roles will influence the game users' motivation to join the game [31]. This study discovered that game users considered virtual tools to be an important design factor. The tools can help game users to change the abilities and appearance of their roles, thus making roles closer to the ideal ones, as game users expect. Lo and Wen [7] obtained the same result. They believed that virtual

tools could help game users to establish a personal identity in the virtual world, and that this would encourage them to continue to play the game.

Bailey, Wise [32] discovered that role customization increased game users pleasure from a game. Lo [33] discovered that the external attractiveness of roles could help to improve the interpersonal attraction of online game users. With respect to the extrinsic motivation discussed by this study, "customization" had already received same attention from online game users. The so-called role customization includes the choices of appearance, race, and profession. The process of customization can fulfill game users' fantasies and requirements, increase the game users' immersion satisfaction, and enhance their loyalty to the game [34].

Fairness and security are more crucial to the evaluation of online services while incentive is also a significant factor [23]. Fairness refers to the fact that "the services are provided to assert 'justice' in the online game context, including procedural justice, distributive justice and interactional justice"

[35]. Security is defined as when “online game publishers restrict access to certain data to protect information confidentiality, integrity, system availability, and applications from manipulation to contamination” [36]. Incentives are tailored as “the activities which online game publishers offer to enhance players’ utilities, thereby aligning their goals with that of the developers and motivating players to continue playing the online game”. According to this finding, Wu, Wang [23] suggested that both online game publishers and developers need to enhance better service mechanisms on the basis of fairness, security with some attractive incentives to gratify gamers’ primary needs (such as pursuing achievements, and interacting with others) and finding enjoyment in the online game community.

4.3.2 Game motivation is influenced by game content design and quality

In addition, the design factors of an online game are just starting and can be improved based on the impact-relations-map (Fig. 1), which utilizes the DEMATEL method to understand the interaction between dimensions and criteria. In the impact-relations-map, $(r + c)$ provides an index of the strength of the influences given and received, that is, $(r + c)$ shows the degree in which each dimension and criteria play in the problem. If $(r - c)$ is positive, then each dimension and criterion is affecting other factors, and if $(r - c)$ is negative, then each dimension and criterion is being influenced by other factors [30].

Using $(r + c)$ and $(r - c)$ in Fig. 1, it can be determined that the game content design factor should be the first to improve. Second is game quality. Both of these deals influence game motivation. In other words, motivate and be better. They can also begin on the criteria of game mechanics to improve the game content design and the criteria of system quality to improve the game quality factor (see Fig. 2).

As seen in Fig. 2, the game motivation factor is being influenced most, that is, the game motivation factor represents an important problem to which more attention should be paid, and online game developers can improve this using the criterion of extrinsic motivation.

4.3.3 Managerial implications

The hybrid MCDM model combining the DEMATEL and ANP methods demonstrated a useful decision making model, which helped to clarify the complicated problems and rank the priority of this study. The MCDM model also

helped to find the most important game design feature and ascertain how to improve the design factors of the online game. These indicate and suggest that online game developers design online games using the findings of this study.

Firstly, according to the weight rankings calculated by the DANP method, this study discovered that extrinsic motivation was the design factor that received the most attention, and was influenced by two major layers of a “virtual role system” and “service mechanism”.

The virtual role system is a very important design factor for online games. It not only ensures game users continue to play games but also makes them more and more willing to consume virtual tools so as to satisfy the expectations on their roles. This makes virtual products bring in annually increasing income for the online game industry [24]. Therefore, it is suggested that online game developers invest their design resources in virtual products and the role customization function. On the one hand, it can satisfy game users’ fantasies and requirements, and enhance their motivation to continue to play the game. On the other hand, it can increase game design companies’ income, and achieve a win-win result.

Service mechanism includes fairness, security, and incentives. As online games have problems, such as multiplayer connections and personal information upload, maintaining the fairness of a game and protecting the personal information of game users have become two basic service programs that game design companies should pay attention to. This study suggests that, while guaranteeing the fairness and security of a game, online game developers should continue to provide a reward mechanism, such as upgrading, continuing to assign new goals to game users, higher levels, and better equipment. In addition, the ranking of game achievements can increase the extrinsic motivation of game users, and by continuously fulfilling the game users’ sense of achievement, they will be encouraged to continue to play the game.

Additionally, according to the impact-relations-map calculated by the DANP method, this study discovered that game motivation could be influenced by game content design and game quality.

Games are popular because their content satisfies game users’ fantasy and entertainment requirements. Therefore, the motivation for game users to join a game is constructed and based on the content of the

game. Nowadays, the content design of online games are all of a high standard, and game design companies all provide good level of performance regarding game quality by maintaining software and hardware. As a result, it is difficult to tell which online game is better from the content and quality of the games. The real factor that can influence game users' loyalty to a game is a mechanism that is proposed, based on existing game content, that can satisfy game users' motivation. This study suggests that it is not necessary for online game developers to invest a large amount of resources in game content design and game quality, but based on existing game content, they should consider adding a mechanism that can satisfy game users' motivations (intrinsic motivation, extrinsic motivation, and social motivation). It is only in this way, which they can stand out from the online game market.

5. CONCLUSION

As game users are the main body of the entire game market, the allocation of design resources should be conducted to meet the requirements of the game users. Based on the literature on online games, this paper constructed a hierarchical system structure for online games, including three major design dimensions and nine design criteria. The DEMATEL with the ANP (DANP) method was adopted to evaluate the relationships among different game design items and to rank their importance, thus ascertaining the design strategy of online games.

The study results show that extrinsic motivation is the most important design factor and contains two layers, namely "virtual role system" and "service mechanism". Additionally, this study discovered that game motivation can be influenced by game content design and game quality. Therefore, this study suggests that online game developers invest their design resources in virtual products and the function of role customization. They also need to guarantee the principles of fairness and security, provide a reward mechanism for upgrading, and continue to assign new game objects to game users to encourage them to continue playing the game. As different game design companies have similar performances in game content design and game quality, there is no need to invest a large amount of resources in these two aspects, but companies should try to add a mechanism that can satisfy users' game motivations, based on the existing game content. It is only in this

way that they can stand out from the online gaming market.

This study acknowledges the following research limitations.

First, concerning cultural issues, this study was conducted in Taiwan, and the question of whether the findings obtained from Taiwanese participants can be applied to represent the requirements of game users from other countries should be examined in further research.

Second, games that require the internet and have a structure that supports the access of multi-players to servers [37], regardless of type or carrier, are included in the scope of online games discussed by this study. Nonetheless, based on the hierarchical system structure for online games constructed by this study, future research can further discuss the differences that may be caused by different game types and carriers.

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