Adoption of digital Games in Malaysia: Rasch Difference Item Functioning

Normal Mat Jusoh and Khalil Md Nor

Abstract—Digital games industry has spurred economic growth globally. However this industry is still at its early stage in Malaysia. There is a wide gap between wealth generations from digital games in Malaysia when compared to global market sector. This warrants an investigation on the adoption of digital games in Malaysia and perhaps a study on how digital games industry can be made as one of the engine of economic growth. In this study, Different Item Functioning (DIF) was used to investigate the pattern of adoption and gauge the effect of adoption attributes in Malaysia with regards to the digital games industry based on Item Response Theory in Rasch Model Measurement.

Index Terms—Digital Games, Different Item Functioning (DIF), Rasch Model Measurement, Adoption by commas.

1 Introduction

IDATE published its latest World Video Games market report in which it was stipulated that digital games sector will continue to be one of the economic recovery factors all over the world. New emerging hardware and software have enabled the industry to penetrate new markets all around the globe. The commercialization of new generation machines will inject the sector with a level of growth allowing digital games software to flirt with the idea of revenues of some EUR 60 billion by the end of 2015. Such new generation machine has popularized the game "Angry Bird" in which players, with the aid of touch screen , use slingshots to attack pigs which steal the bird's eggs. "Angry Bird" has stayed among the top games since it was launched for Apple iPhone in 2009 [1] .

Iskandar Malaysia Investment Guide reported that according to PwC's Global Entertainment and Media Outlook 2011-2015, the video games market in Malaysia is poised to grow at a compound annual growth (CAGR) of 6.8 % for the period from 2011 to 2015. By 2015, the global market digital game will be expected to be worth more than USD 60 Billion. Despite all this, digital games entertainment market in Malaysia is worth only a mere RM 0.042 billion (2008 figure). This low growth in digital games development is partly due to the lack of study and relevant information in digital game entertainment adoption in Malaysia. Studies and relevant information would normally help digital games industry to understand the specific factor of acceptance for local as well as global growth [2].

- *NormalMJ is with the UTM VicubeLab, Universiti Teknologi Malaysia, Malaysia, Johore 81310. E-mail: normal@ utm.my*
- *Khalil Md Nor is with the Technology Management Department, Universiti Teknologi Malaysia, Malaysia, Johore 81310. E-mail:m-khalid@ utm.my*

2 Literature Review

In Malaysia, research in the area of digital games is still relatively new. Acceptance studies of digital games in Malaysia are much to be desired even though publication data shows that this kind of research is expanding [3]. Currently, too little focus has being directed to any investigation on the adoption of digital games in Malaysia using the Different Item Functioning (DIF) model to see the demographic pattern and effect for the industry. It has been discovered that the application of Item Response Theory (IRT) and DIF in Rasch Measurement Model will give a clearer observation since it will be possible to focus more on the items and persons rather than the test score. This approach will give better synthesis and quantitative analysis with qualitative issues relating the human and the observed actions being assessed.

Personal economic status, users experience expectation and demographic factors will influence customer behavior [4]. The differential Item Functioning (DIF) model formulated under the Marginal Maximum Likelihood (MML) is capable of explaining and clarifying via statistical evidential suggestion to resolve the above issue which is one of the most dynamic research topics in psychology and educational measurement [5, 6]. Generally, Mantel-Haenszel procedures are used for DIF analysis. Lately, application of Rasch model and procedures for DIF investigation and estimation analysis has become a more preferred technique since it is robust and does away with large sample size.

3 THE GENERAL RASCH MODEL

3.1 Oveview of Rasch Model Measurement

In Rasch analysis , proper attention is given to determine the pattern of item response according to the Marginal Maximum Likelihood (MML) prediction of how a person at different levels of ability for a particular skill should respond to an item questionnaires from a certain level of difficulty .

The Rasch Measurement Model theorem is based on two principles [7]:

i. A person who is more capable or relevant (similar person sub-group) has a greater likelihood to answer all item questionnaires correctly; and
ii. An easy or base-line item questionnaires are more likely to be answered correctly by all persons.

The feasibility of the data in Rasch is based on fit statistics. For example , a more experienced or relevant (similar person sub-group) digital game player should be more likely to support item questionnaires of greater difficulty (pertaining to specific person sub-group) than all the other players. Feasibility of the data in Rasch is measured using the mean square and standardized value of the persons and item questionnaires according to a standard range of point measure correlation, depending on outfit mean square (MNSQ) and determined by outfit z standard (ZSTD). In other words, the term fit [7,8] refers to "infit' when the data is within the range dictated by the weighted value which is the distance between the person position and item difficulty and "outfit" when the data is outside this range (in Rasch, such situation is normally referred to as an unweighted measure). For Rasch model the mean square and the standardized fit expected values are 1.0 and 0.0 respectively. However, for the extreme responses, "outfit" are more sensitive when compared to "infit". The meaning of misfit item questionnaire refers to a condition when a particular item is too difficult to agree or too easy to agree for the person or it is not a measure of the desired latent trait. The verification of the fit and misfit for the item questionnaire or persons must follow the condition measurement;

i. Point Measure Correlation, $0.4 < x < 0.8$
ii. Outfit Mean Square (MNSQ), $0.5 < y < 1.5$
iii. Outfit Z standard (ZSTD), $-2.0 < Z < +2.0$

In summary, if the data is within the above range, an "infit" exists. If the data is not too far outside the above range, an "outfit" condition exists. However, if the data is way out of the above range , it is said that the data is a misfit.

Universiti Teknologi Malaysia (www.utm.my)

3.2 The Rasch DIF Model

Equation (1) applies when the digital games players share the same ability, skill and common demography such as gender or ethnicity ; but for some unknown reasons a certain demographic group may give unexpected responses on the questionnaires or tests. DIF analysis gives a clue of unpredicted behavior by item on a test when one or more item parameters differ across the group of digital games players.

The common form of the Rasch DIF model can be articulated as follows for a response of using a logit link function [5]:

$$\textbf{Logit}\ \{P(X_{ni}=1 \mid \theta_n, g)\} = \theta_n - \delta_i + \gamma_i G, \qquad (1)$$

where $\mathbf{x}_{ni}$ is the score of person $\boldsymbol{n}$ for item $\boldsymbol{i}$ (1 = *correct*, 0 = *incorrect*; $\boldsymbol{i}$ = 1, 2, . . ., *I*; $\boldsymbol{n}$ = 1, 2, . . ., *N*), $\boldsymbol{\theta_n}$ is a scalar proficiency (ability) parameter for person $\boldsymbol{n}$, $\boldsymbol{\delta_i}$ is the item difficulty parameter for item $\boldsymbol{i}$, $\boldsymbol{\gamma_i}$ is the DIF index parameter for item $\boldsymbol{i}$, and **g** indicates either the reference group or the focal group, **G = 1** if **g = R** (reference group), **G = 0** if **g = F** (focal group). In equation (1), $\boldsymbol{\gamma_i}$ is the item difficulty difference between the focal group and the reference group (i.e. **g = δF - δR**).

According to Rasch DIF Clasification Rules [9,10], if γ_i is greater than 0.5 logits , then there is evidence of DIF. However, in Eductional Testing Service (ETS) which frequently uses Delta units , it is useful to know that 1 logit = 2.35 Delta (δ) units and 1 Delta (δ) units = 0.426 logit).

4 THE METHOD AND RESULT

4.1 Sample

A total of 120 digital games players from 12 states of Malaysia with academic background in engineering, management, science and education participated in a survey exercise during which they were asked to answer several item questionnaires. Their ages range between 19 to 25 years . This age group was chosen because it represents the biggest member of the community of practice for Digital Games. Those who participated came from big cities, small towns and villages or rural areas. Games players from different demography (such as gender, academic background, hometown and different states of Malaysia) were chosen to review the different pattern of adoption of digital games entertainment amongst themselves .

4.2 Measure

A total of 120 surveys were conducted in this study . The respondents have several different background . They

give responses to the item questionnaires related to year of play, frequency of play, duration of play, what the favorite aspects of playing games, the level of sacrificing to play games, how they play compared to 7 years ago, how they learnt about the game, and their parents' attitude towards time spent on playing digital games (refer to Table 1).

The responses were then fed into the Rasch Unidimensional Model with the aided of Rasch analysis software (**WinSteps®**).

Further interviews have been carried out to a special focus of demography group to explore more tacit knowledge, experience and reasons from the respondents to confirm real reasons behind the unexpected result from the Rasch analysis.

TABLE 1. THE CODE FOR ITEM QUESTIONNAIRES

No	Codes	Item Questionnaires
1	1Q001_YearOf Play	How long your have been playing regularly on the system?
2	2Q002_Frequency	In average how many time you play per week?
3	3Q003_Duration	In average , how long duration you play for?
4	4Q004_FavoriteAspect	Your favorite aspect of playing games?
5	5Q005_SHobby	Sacrificing hobby to play games
6	6Q006_SSleep	Sacrificing sleep to play games
7	7Q006_SWork	Sacrificing work to play games
8	8Q008_SSocialising	Sacrificing socialicing to play games
9	9Q009_CompareTo7Years	How often you play games now compare to 7 years ago.
10	10Q0010_LearnAboutGames	How you learn about games
11	11Q0011_Concern	Parent concern over time spend playing games
12	12Q0012_PAttempts	Parent attempts to control play computer games
13	13Q0013_PParent	Parent approval of computer games play

4.3 Reliability

The summary statistics of the Rasch analysis and reliability display is as in Table 2. The data from Table 1 indicates that *Person Reliability* is 0.29 which is low, *Standard Error (S.E) of Person Mean* which is 0.03 and very high *Item Reliability* which is 0.99.

TABLE 2. THE SUMMARY STATISTICS

The data gives the interpretation that the item questionnaires used in this study is very reliable with a score of Item *Reliability* of 0.99, and since the *Standard Error (S.E) of Person Mean* is low which 0.03 is, it can be interpreted that the participants gave a sincere response to the item questionnaires. However the *Person Reliability* 0.29 is low which indicates that the respondents gave unexpected responses which are dependent on the several different demography. The Measured Person *Outfit Mean Square* (MNSQ) is 0.94 which is a value within the range of condition measurement.

4.4 Data Analysis

Result from Rasch analysis indicates that participants (respondents) give several unexpected responses which are varying according to their person subgroup.

Person subgroup gender does not show any evidence of DIF since its size (value) has not varied more than 0.5 logit or has gone less than -0.5 (logit). *Point1* (at 0.2 logit) and Point2 (at 0.15 logit) (refer to Fig. 1) are two relatively high peaks for DIF size. *Point1* indicates that female and male will probably give opposing result of responses. Inferring that male respondents will probably give a response indicating that they are more prepared to sacrifice their other hobby to play digital games compared to the Female respondents. However, *Point2* indicates that female and male respondents will probably give different responses as to how they learn about digital games. A significant number of male respondents would probably find it more preferable and easier to learn about games through web promotion whereas female respondents would probably learn playing games through their friend or via social network.

Fig. 1. Plot Graph DIF for Person Subgroup With Different of Gender.

Fig. 2 shows item questionnaires responses of person subgroup from different hometown (from village, from small town or from big cities). Although there is no evidence of DIF, reponses from person subgroup village may show variations as DIF size stretches to a value close to 0.5 (logit) as well as -0.5(logit). Person sub-group from village and person sub-group from small town display DIF sizes which swing widely to values close to 0.5 (*Point3*, *Point4* and *Point5*). The result implies that person subgroup from village would have opposite responses to item questionnaires when compared to person subgroups from small town and from big city. Person subgroup from village would be expected to have difficulties to agree sacrificing their hobby, sleep, work and time for socializing so that they have time to play digital games. On the other hand, person sub-group from small town are more likely play digital games more frequently now compared to seven years ago. DIF size at *Point 5* indicates that person sub-group from village would be more likely to learn about digital games which they play from their peers. This is not the case for person subgroup from small town who would have interest to learn playing games through web promotion.

Fig. 2. Plot Graph DIF for Person Subgroup with Different Size of Hometown.

Fig. 3 shows Rasch analysis and graph-plot of DIF sizes for person sub-groups of different academic background. *Point6* (DIF size nearly 0.8 logit) and *Point7 (DIF size more than 0.6 logit)* suggest that there is clear evidence of the presence of DIF. The results suggest that *person* sub-group with academic background in Science and engineering would be hard to agree sacrificing their work to play digital games. Person sub-group from Management academic background would be expected to give opposite responses. However, person subgroup with academic background in Education, would agree that parents have control over the playing of digital games. Person sub-group in Engineering and Science will think otherwise.

Fig. 4 shows graph plot of DIF sizes for person sub-groups from the different States of Malaysia. From the wild swings in the DIF sizes, it is evident that DIF exists in large doses. *Point8* (DIF size nearly -2.0 logit) indicates that person sub-group from the State of Pahang, Kedah, and Kelantan are more agreeable to learn about games from friends compared to person sub-group from the State of Johor. *Point9* (DIF size nearly 2.0 logit) suggests that person sub-group from the State of Sarawak, Pahang, Kedah began playing digital games less than 6 months ago , compared to Johor person sub-group who would have played digital games several years ago. *Point10* (DIF size more than 1.0 logit) indicates that parents of person sub-group from the state of Johor would be less likely to approve the playing of digital games; compared to parents of person sub-group from the state of Kelantan.

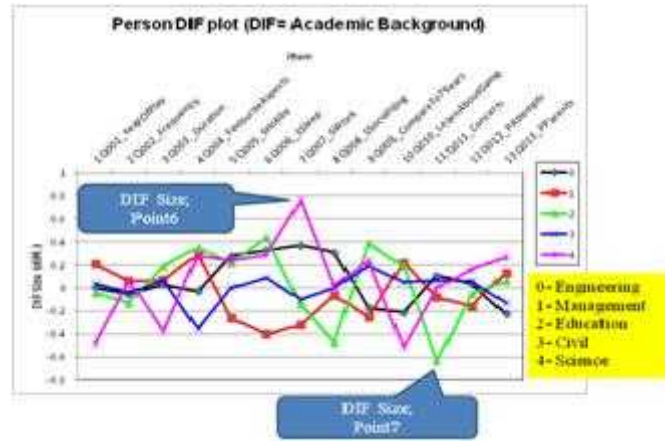

Fig. 3. Plot graph DIF for Person Subgroup With Different Academic Background.

5 CONCLUSION AND IMPLICATION

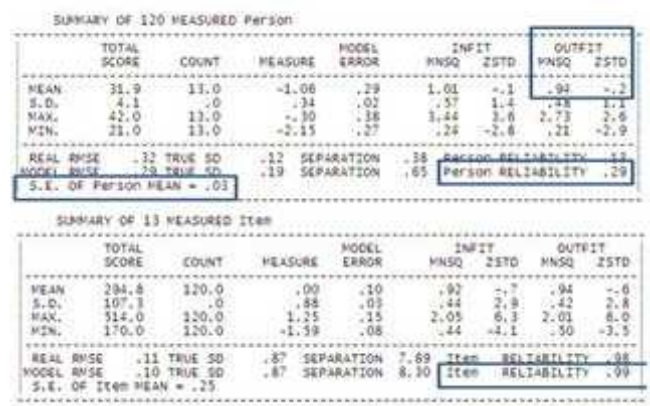

Fig. 4. Plot Graph DIF for Person Subgroup with Different State of Malaysia

Adoption pattern of digital games in Malaysia has been ascertained using the technique of DIF Rasch analysis on sampled data collected from surveys and followed by interviews of several selected group within this sample study to further fine tune factors associated with digital game adoption.

Feasibility of the data in Rasch is measured using the mean square and standardized value of the persons and item questionnaires according to a standard range of point measure correlation, depending on outfit mean square (MNSQ) and determined by outfit z standard (ZSTD).

The differential item functioning (DIF) size derived under the Marginal Maximum Likelihood (MML) is capable of explaining and clarifying via statistical evidential suggestion the degree of adoption of digital games in Malaysia

There is an indication that digital games in Malaysia are here to stay and will continue to grow into a full fledge industry as is happening in Korea. Compared to the state of affairs seven years ago, there are now an increasing number of digital games players in the big towns, small towns as well as villages in Peninsula Malaysia , Sabah and Sarawak.

Analysis has shown that there is positive perception and more willingness on the part of parents to allow playing of digital games.

Broadband infrastructure has vitalized and catalyzed the spread of digital games in Malaysia. West Peninsula Malaysia has seen the playing of digital games for several years, earlier than the other parts of Malaysia. However, with the availability of facilities (resources facilitating condition) , East Peninsula Malaysia, Sabah and Sarawak are fast catching up on the playing of digital games. Adoption of digital games has now taken centre stage in Malaysia.

The influence of friends, the existence of social network and web promotion has indeed encouraged the growth of digital games.

REFERENCES

[1] IDATE (2011) World Video Game Market Data & Forecasts 2011-2015 published by IDATE in June, 2011**.** **www.idate.org**

[2] Iskandar Malaysi Guide : Creative, Invest Creative Iskandar Malaysia: Asia's new creative destination. No 106, Edition I, Vol .1, (2011) Iskandar Regional Development Authority.

[3] I.Roslina, J.Azizah (2011) User Acceptance of Educational Games: A Revised Unified Theory of Acceptance and Use of Technology (UTAUT). World Academy of Science, Engineering and Technology 77 2011.Page 551-557

[4] J.H Falk, J.H., & L.D Dierking (1992). The museum experience, washington, D.C: Whalesback Books.

[5] I. Paek & M. Wilson (2011) Formulating the Rasch Differential Item Functioning Model Under the Marginal Maxmum Likelihood Estimation Context and Its Comparison With Mantel-Haenszel Procedure in Short Test and Small Sample Conditions Educational and Psychological Measurement. SAGE 71(6) 1023-1046.

[6] S.J Osterlind & H.T Everson (2009) Differential item functioning (2nd ed) Thound Oaks, CA: Sage.

[7] M.I Nor Irvoni & M.M .Saidfudin (2012) International Conference on Innovation, Management and Technology (ICINTR2012), Malacca, Malaysia, 21-22 May, 2012. 978-1-4673-0654-6/12 ©2012 IEEE

[8] K.E Greene and C.G Frantom(2002). Survey Development and Validation with the Rasch Model. A paper presentaed at the International Conference on Questionnaire Development, Evaluation and Testing, Charleston, South Carolina, November 14-17, 2002.

[9] R.Zwick, D.T Thayer, C. Lewis (1999) An Empirical Bayes Approach to Mantel-Haenszel DIF Analysis. Journal of Educational Measurement, 36, 1, 1-28

[10] A.Tristan (2006) An Adjustment for Sample Size in DIF Analysis, Rasch Measurement Transactions, 2006, 20:3 p. 1070-1