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Open Innovation Adoption: A Rasch Psychometric Analysis on Technology Exploitation

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ABSTRACT

Open innovation adoption continues to become an issue for high technological companies competing in local and global markets. As open innovation put forward the importance of pulling together the strength of internal and external means of organizations, as it is important to look and dwell into the reasons that will be able to explain the adoption of open innovation. The purpose of this study is to present the test development process that measures the technology exploitation towards open innovation adoption. Rasch measurement model was used for the instruments measurement analysis. Results from the reliability indices, unidimensionality and item-fit analysis exhibited an acceptable and satisfactory measure of the instruments used for measuring technology exploitation. Implication of these tests can be used for placement, diagnostics and predictive assessment purposes.

Key Words: Open innovation adoption, technology exploitation, Item Response Theory, Rasch Measurement Model

1. INTRODUCTION

The revolution of research and development (R&D) and the fast-moving technological changes have intensified the competition among business players across and within countries stipulating for continuous technological knowledge enrichment. In today's business world, it is almost impossible for businesses to craft competitive edges by pulling all in-house resources and capabilities (Abulrub & Lee, 2012). As innovation becomes a major strategic ingredient to a country economic stability and balanced social welfare (Ghili, Shams & Tavana, 2011; Hakikur Rahman & Ramos, 2014), companies' innovation activities demanded critical uplifting which requires a new dimension of strategy widely known as "open innovation".

Great interest has been shown in the study of open innovation where various fields of studies are now taking place in the attempt to best understand how open innovation can serve as a strategic competitive tools. Although research in open innovation adoption has grown dramatically in the past and currents years, yet it is distinguished by various approaches. One of the major issues in the study of open innovation adoption is the lack of solid theoretical aspects, which call for an inclusive effort to contribute to the knowledge expansion pertaining to the matters. This study was developed in the attempt to study the reasons for companies to shift from the traditional innovation strategy to an open base innovation strategy with the focus of leveraging the exploitation of the internal technological resources. It is inspired by the current level of uncertainties as to how the ability of organizations in exploiting technological activities among the companies to contribute to the adoption of open innovation. This attention stems from the belief that the adoption of open innovation and the successful implementation of technology exploitation creates sustainable competitive advantages and improve productivity in an increasingly competitive and global environment through empowering the technological activities.

2. OPEN INNOVATION

Open innovation has been introduced by Henry Chesbrough in 2003 as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". Further in 2006, Chesbrough provide a more detailed version of open innovation where he further addressed open innovation as a paradigm that assumes firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. According to Chesbrough, open innovation brings forward internal and external ideas into architectures and systems whose requirements are defined by the business model'. Unlike the closed innovation model which describes innovation activities that happened within the boundaries of an organization where it is conducted by the internal strength of employees, developed own new technologies and make use of the internal research and development (R&D) capabilities for their own products internally (Lichtenthaler, 2011).

3. TECHNOLOGY EXPLOITATION

Competitiveness in the long run calls for organization to constantly respond to the global market needs and strategies for their competencies to conform to the changing business environment. This calls for more receptive strategies for organizations to take advantage from the latest and advanced technology, with competitive pricing to customers in comparison to other players in the same industry. Exploiting technology resources which comes in the forms of intellectual properties, patents, licenses and others will ensure a stronger business viability and longer sustainability (Levinthal & March, 1993; Lichtenthaler, 2010; March, Science, Issue, & Learning, 1991; Speckbacher, Neumann, & Hoffmann, 2014; Williamson & Markides, 1994). From the context of knowledge management, technology exploitation is referred as purposive outflows activities of an organization to leverage existing technological capabilities outside the boundaries of organization (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009).

In the case of Malaysia, serious efforts in IP commercialization, for instance, has been an integral focus of the government since the Sixth Malaysia Plan (Govindaraju, Ghapar & Pandiyan, 2009). The government has since, emphasized on the function of public R&D to help companies to exploit and commercialize the research and technology products (Othman, Haiyat & Kohar, 2014). It can be understood that for business organizations aiming to leverage from the internal knowledge, they may well absorb in various practices. In this paper, three activities related to technology exploitation will be distinguished: venturing, outward licensing of intellectual property (IP), and the involvement of non-R&D workers in innovation initiatives (Gassmann, 2006).

3.1 Venturing

Venturing is defined as the starting up of new organizations based on the knowledge gathered within the organization. The potential of venturing strategies is regarded as being huge and beneficial (Chesbrough, 2003). This can be observed in the example of a success story of Xerox, where venturing strategy has brought success to the business. By venturing, the smaller companies or projects are pulled together and is governed and supported by the parent organization.

In open innovation, venturing brings along a few advantages such as the business opportunities that comes along with the advantages of being the early adopters of new technologies; delayed financial commitments; early exits due to the downward losses; and delayed exit in the case of spinning off a venture (Vanhaverbeke, Van De Vrande & Chesbrough, 2008).

3.2 Outward IP Licensing

Intellectual Properties (IP) plays a crucial role in open innovation as a result of the inflows and outflows of knowledge (Arora, Fosfuri & Gambardella, 2001; Chesbrough, 2003; Lichtenthaler & Ernst, 2007). In the Tenth Malaysia Plan, and continued in the Eleventh Malaysia Plan, for instance, the government of Malaysia has given the mandate to Innovation Malaysia Unit, to generate the IPs and help to commercialize the R&D outputs through a better IPs' management (EPU, 2010; EPU, 2015). Out-licensing of intellectual property (IP) allows business organizations to take advantage over their internally developed IPs, by selling it to other firms that might find it as profitable to their organizations. According to Arora et al., (2001), firms opting to out-license their IP are normally driven by the "anticipated revenues and profit-dissipation effects". For instance, it may come in the forms of licensing payments. However, an important note highlighted by the same study, is that the organizations might risk competition with the licensees when the IPs are used to compete in the same market. Hence, in order to upsurge the strategic advantage from the out-licensing (IPPTN, 2010; Lichtenthaler & Ernst, 2008; van de Vrande et al., 2009), it is important for the firms utilizing this approach to take a centre stage and build a reputation as a knowledge provider among the other players in the market.

Othman, Hayat and Kohar (2014), further confirm, that the study on technology commercialize products (patents, IP, copyrights) within the emerging country has been limited due to limited resources, knowledge bases and expertise. The study stands to the point the reason behind the poor performance of university-industry technology commercialization exists due to several gaps between the important stakeholders in the collaborative effort, which are, the university, the scientist, the industry, the government and the industry.

3.3 Employee Involvement

One of the best ways that can be deployed by companies wanting to take a leap from the internal knowledge is to take advantage from the knowledge and experiences within and among their current employees. This has been proven by several case studies, where informal ties among employees of the same organization or from other organizations are deemed to be one of the key sources to understand how new products are created and commercialized (Chesbrough et al., 2006b). A number of practitioners and scientists endorse the view that innovation by individual employees is a mean to foster organizational success (Tushman & O'Reilly, 2013; van de Vrande et al., 2009). Employee involvements are often being related to the enrichment of knowledge sharing activities (Bartol & Srivastava, 2002).

4. RASCH MODEL

Rasch measurement is a unique psychometric approach of mathematical modelling, which is based upon a latent trait and accomplishes additive conjoint probabilistic measurement of persons or respondents and the items on the same scale (Granger, 2008). In other words, Rasch measures the latent traits, such as the ability of persons in dealing with the various level of difficulties from the items being measured. The growing interest in Rasch studies has been substantially proven by the growing numbers of research conducted using the tools and has spread across various disciplines (Irvoni & Ishar, 2012; Mohd Norhasni et al., 2015; Noratisah et al., 2015; Saad, Yusuff, Abas, Aziz, & Saidfudin, 2011).

The underpinning theory that supports Rasch measurement is the Item Response Theory (IRT) which is classified under the Modern Test Theory (MTT). MTT was originated from Thurstone (1927), when he described a probabilistic model to reflect the connections between responses of a person to an item. It combines the two modes of Modern Test Theory (MTT) (Andrich, 2004), which are; the Item Response Theory (IRT), and the Rasch Model (Wright & Stone, 1979). The theory can first be understood by dichotomous responses, before it is generalized to present more than two ordered categories. An interesting point to consider is, in Thurstone's (1927) book, he represented populations rather than individuals. However, when a study seeks to answer issues on efficiency, the concern is immediately channelled to the parameterization of individuals (Andrich, 1978). Within IRT, the model is used to describe the data, and therefore requires the tested models to fit to the data. This is a traditional statistical paradigm of searching for a model to interpret the collected data (Andrich, 2004). One advantage of IRT is that it is able to provide information that allows a researcher to improve the reliability of the estimated situation, which can be achieved through the psychometric characteristics of the individual assessment items (Mohd Asaad, 2012). Additionally, the Rasch Model puts forward the quality control for measurements where, a set of prior requirements of invariance must be met to serve as the basis to items used; based on the measurement philosophy. These prior requirements of invariance are established in the form of a statistical model used as a means of quality control and for scaling of items (Bond & Fox, 2015). Furthermore, in Rasch, the model serves as a vital criterion, which summoned for the data to fit to the model. This paradigm of having data fit the model is consistent with Kuhn's analysis of the foundation of measurement in science (Andrich, 2004).

5. MATERIALS AND METHODS

The study intends to verify the instruments used to measure the construct of technology exploitation by using the Rasch analysis. This will ascertain the technological activities as far as technology exploitation strategy is concerned. In doing so, the construct validity for the persons and the items will be distinguished through several methods such as the reliability index, unidimensionality, and item fit analysis.

The population of the study involves high-tech companies which are involve in a triple-helix settings in nature. A triple-helix settings refers to the concept introduced by Etzkowitz and Leydesdorff (1995) which focuses on a highly potential relationship between the bodies of university-industry-government which focus on an interdependent role of each other. Additionally, the triple-helix setting denotes a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization (Etzkowitz, 2002). This study employed a five-point scale to measure the ability of the respondents to implement the items under venturing in technology exploitation. Five point likert scale is used from 1 to 5; ranging from *'very low', 'low', 'moderate', 'high'* and *'very high'*. In all, seventy two respondents completed the questionnaire which consist of 21 items which were developed from previous literatures by Rangus & Drnovšek (2013); van de Vrande (2009); and Zahra (1996).

5.1 Instruments

The instruments consists a total of 21 items, are made up of three parts. The first part entails 7 items which represents the venturing activities. The second part that follows consists of 4 items which represents the activities of outward IP Licensing and the final part had 10 items which signify the employee involvements.

5.2 Pre-Test

The instruments were pre-tested in two phases. The first phase involved the expert-content review to validate the instruments. Two experts from the industries and two Rasch experts were involved in the process and amendments were then conducted correspondingly following the advice and comments made by the experts involved.

The second phase involved the pilot study with the aim to further improve the instruments (Neuman, 2006) and to gather additional information pertaining to the construct. Ten Small Medium Enterprises (SMEs) particularly those from the high-tech industries were chosen to participate in the pilot study and respondents were encouraged to provide suggestions and views of the contents. The reason to focus on the high technology industry are due to the fact that these type of companies primarily engages with technological activities and possesses some level of knowledge in research and development (R&D).

5.3 Test administration and data analysis

The sampling frame was derived from the database owned by the Malaysian Technology Development Corporation (MTDC), an integrated commercialization solutions provider in Malaysia. The list comprises 193 companies in total. A cover letter addressing the ethical issues regarding the respondents' responses and optional participation were highlighted prior to the data collection. Finally, the number of questionnaires received and usable involved 71 pieces and indicated a 37% response rate. The numbers corresponds with Linacre (1994) guidelines where a minimum sample size acceptable for 95% confidence interval is around 16 to 36 respondents.

Rasch analysis evaluation entails readings taken from the test of reliability indices: dimensionality construct; goodness of fit analysis and response category analysis to determine the validity and reliability estimates of the test. Response category analysis investigates the suitability of the 5 point rating scales which range across from "Strongly Disagree" to "Strongly Agree" scale.

6. RESULTS AND DISCUSSION

The test was analysed using Winsteps version 3.9.1.0 for the purpose to examine the items' validity and reliability with the results as summarized below:

6.1 Reliability Indices

A total of 2960 data points are yielded from 71 respondents on 21 items measuring the importance of implementing technology exploitation activities in an organization. The data points suggested that the data provides a sufficient range to remain useful and stable as person measures estimates and so as to obtain useful and stable item calibrations. This generates a Chi-square value of 3559 with 3572 degree of freedom. The Cronbach's Alpha reported a value of 0.90, indicating a good internal consistency reliability of the items in the scale.

Table 1 : Summary Fit Statistics for Technology Exploitation

	Item (i = 21)			***Person (N=70)***		
	Measure	Outfit		Measure	Outfit	
		MNSQ	ZSTD		MNSQ	ZSTD
Mean	0.00	1.00	-0.30	0.21	0.99	-0.20
SD	0.56	0.18	1.20	0.62	0.50	1.80
Maximum Measure	1.32	1.48	2.7	1.26	2.76	4.50
Minimum Measure	-1.18	0.71	-1.8	-2.01	0.25	-3.90
Reliability Indices						
Seperation		3.74			2.66	
Reliability		0.93			0.88	
Std Error		0.13			0.12	
Cronbach Alpha (KR-20)				0.90		

Table 1 displays the summary statistics that explains the data-fit information to the Rasch model. In Rasch analysis, reliability is measured for both person and item. In the present study, 'Person'-reliability refers to the reliability of the organizations. The information is important prior to further Rasch analysis as it describes the goodness of fit of the interactions between items and respondents (person) involved.

The person reliability is at 0.88 with 0.13 Standard Error (SE) and the item reliability is at 0.93. In order to be accepted in Rasch analysis, reliability indices of > 0.5 and a separation index of >2 is regarded as adequate according to Bond and Fox, (2015). Additionally, the range is also deemed to be a 'good' figure in accordance to the measurement reliability index by Fisher (2007). In short, the 21 items used to measure technology exploitation within the organization have an acceptable range of difficulties to gauge the organization ability. The outfit MNSQ value is at 0.99 and the ZSTD is -0.20, which is very near to the expectation of 1 and 0. This shows that the instruments used has targeted the suitable groups of respondents in measuring the latent traits and the produced data is at a reasonable prediction level of the responses to the items. The person mean which equals to 0.21 denotes that the items used are moderately difficult for the respondents to attend. Another important point to note is the person separation index which is equal to

2.66 and is considered an acceptable separation indices of measures, as it shows the number of different levels of person performance that can be identified across the normal distribution that matches the person ability distribution (Linacre, 2009). These results conclude that the data fits to the measurement model.

6.2 Unidimensionality analysis

Table 2 depicts the strength of unidimensionality of the instruments where the items used must be related to the same construct (Bond & Fox, 2015). The reported raw variance explained by measures is 40.0%, which is very close to the variance expected by the model (40.2%) and can be considered as a strong measurement dimension (Conrad et al., 2009). Nevertheless, the unexplained variance in 1st contrast is at 13.2%, which explains that 13.2% of the variance supports unidimensionality and is considered as a 'fair' instrument to measure the construct of technology exploitation (Fisher, 2007). Thus, it can be concluded that the items measuring the construct of technology exploitation within the organization are indeed measuring the same composite of abilities (Bond & Fox, 2015).

Table 2 : Standardized Residual Variance

Description	Empirical	Modelled
Raw variance explained by measures	40.0%	40.2%
Raw variance explained by persons	13.9%	14.2%
Raw variance explained by items	26.1%	26.0%
Unexplained variance	60.0%	59.8%
Unexplained variance in 1st contrast	13.2%	

6.3 Item fit analysis

In order for data to fit to the Rasch model, a few criteria must be met (Azrilah, 2010; Bond & Fox, 2015; Fisher, 2007; Linacre, 2006). The three criteria to be met are listed in Table 3. When evaluating the point measure correlation (PTMEA), each value must carry positive index (Linacre, 2006) to ensure that all items used, works towards a parallel set of constructs (Bond et al, 2007). The acceptance level is set between 0.40 to 0.80. The outfit Z-Standard (ZSTD), reports significant chi-squared statistics which occur due to chance when the data fits the Rasch model. The accepted range is between ± 2.0; which reflects a 95% confidence interval, or, 5% of significant level (Azrilah, 2010). Thus, items located outside the range as listed in Table 3, are considered outliers and need to be separated for further investigation and modification (Linacre, 2006).

Table 3 : Quality Control for Rasch Fit Data

	Criteria	Acceptance Level
7.	‘Point measure correlation’ (PTMEA Corr)	0.4 to 0.8
8.	Outfit ‘Mean Square’ (MNSQ)	0.5 to 1.5
9.	Outfit ‘Z- Standard’ (ZSTD)	-2.0 to +2.0

Generally, as shown in Table 4, all items reveal positive PTMEA Correlation values, and all values from the outfit MNSQ are within the suggested range of 0.50 to 1.5. Hence, one item falls outside the acceptable range of outfit ZSTD. Item TE1 is considered a misfit item as the value of the outfit ZSTD amounts 2.70 and will be taken out for further investigation.

Table 4: Item Fit & Item Polarity Indices

Items	Division	Measure	Outfit		PTMEA
			MNSQ	ZSTD	
TE1	VNT	1.32	1.48	2.70	0.27
TE2	VNT	1.16	1.14	0.90	0.43
TE3	VNT	0.46	1.01	0.10	0.42
TE4	VNT	-0.48	1.13	0.80	0.60
TE5	VNT	-0.53	1.10	0.60	0.65
TE6	VNT	-0.62	0.91	-0.40	0.66
TE7	OIPL	-1.18	0.91	-0.40	0.72
TE8	OIPL	0.49	0.93	-0.40	0.58
TE9	OIPL	-0.33	0.71	-1.80	0.71
TE10	OIPL	-0.16	1.13	0.80	0.56
TE11	EMP	-0.25	0.92	-0.40	0.55
TE12	EMP	0.31	0.89	-0.70	0.51
TE13	EMP	-0.25	0.81	-1.10	0.55
TE14	EMP	0.15	1.33	1.90	0.45
TE15	EMP	0.29	1.14	0.90	0.39
TE16	EMP	0.14	1.08	0.50	0.51
TE17	EMP	0.31	0.92	-0.50	0.46
TE18	EMP	-0.39	0.98	0.00	0.69
TE19	EMP	-0.20	0.88	-0.70	0.69
TE20	EMP	-0.01	0.81	-1.20	0.61
TE21	EMP	-0.25	0.76	-1.50	0.64

7. CONCLUSION

The study uses Rasch analysis to evaluate the research instrument used in measuring the opinions from respondents towards technology exploitations within the organizations. The sub constructs of technology exploitation were listed as venturing; outward IP licensing; and employee involvement according to the literature review. Winstep application software was used to analyze the data according to the Rasch methods of analysis.

The results depict acceptable psychometric properties for the reliability as well as the validity of the research instrument being used. Additionally, the unidimensionality indices fulfill the minimum level of the 40.0% threshold and suggests a strong measurement that fulfils the required minimum total raw variance (Fisher, 2007). The inspections on the 21 items, reveals that item TE1 from the sub construct of venturing is considered a misfit item and need to be further investigated. It can be concluded that, generally, the instruments which make use of 21 items to measure technology exploitation can be used to measure the construct of technology exploitation. The findings suggest that the instruments may serve as a useful indicator to understand the strength of exploiting technological resources outside the organizations towards adopting the open innovation platforms. Nevertheless, the implication of these findings warrants further investigation to be conducted to understand the response from perhaps, a different context of target respondents.

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