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VALIDATING AN INSTRUMENT TO MEASURE OPEN INNOVATION PRACTICES IN RESEARCH COMMERCIALIZATION

Marina Muhammad Razaki[1*], Mohammad Ismail[2], Nur Izzati Mohamad Anuar[3]
[1,2,3]Faculty of Entrepreneurship and Business, Universiti Malaysia Kelantan, Kota Bharu, 16100, Malaysia
[1]Faculty of Management and Information Technology, Sultan Ismail Petra International Islamic University College (KIAS), Kota Bharu, 15730, Malaysia
*Corresponding author; Email: [1]marina@kias.edu.my; [2]mohammad.i@umk.edu.my; [3]nurizzati.ma@umk.edu.my

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Abstract

The open innovation practice became an effective strategy to boost research output commercialization rates. Implementing open innovation practices in academia fostered collaboration, knowledge sharing, and technology transfer between academic institutions and industries. This study aimed to investigate and assess the validity and reliability of the instrument used to measure open innovation practices. A quantitative methodology was employed, and data were collected via a survey from 109 respondents, consisting of lecturers from public universities in Malaysia actively engaged in the commercialization of research output. Then, the collected data was analyzed using Statistical Packages for Social Sciences (SPSS) version 26.0. The descriptive analysis revealed that the respondents often practiced open innovation in commercializing their research output. During the exploratory factor analysis (EFA), the findings demonstrated a Kaiser-Meyer-Olkin (KMO) value of 0.885, signifying no significant issue of multicollinearity. Barlett's test of sphericity showed a statistically significant result. Notably, no item was eliminated during the study. Furthermore, the reliability test for the nine instrument items related to open innovation practice exhibited Cronbach's Alpha of 0.916, confirming high reliability. In conclusion, this study's findings highlighted the instrument's high validity and reliability in measuring open innovation practices, indicating its readiness for further testing in future research stages.

Keywords: Open innovation practices, commercialization, research output, exploratory factor analysis.

Introduction

The idea of open innovation was initially presented by Henry W. Chesbrough in 2003. It stresses the importance of collaboration and knowledge sharing among organizations to propel the skill of innovation and the success of commercialization. Open innovation plays a crucial role in connecting academic institutions and industries, addressing the issue of universities and their research output (APEC, 2019). Universities are widely known for their excellence in research and always generate intellectual property through research activities. Nevertheless, applying the research output to using realities and commercialization products is quite challenging for university researchers. This is where the open innovation practice plays a role in easing the knowledge and technology transfer from universities to commercial sectors (Razak, Murray, & Roberts, 2014).

One of the core notions of open innovation, as suggested by Chesbrough, is the need for companies to get involved with foreign organizations (APEC, 2019). In the context of universities, the universities collaborate with the industries, entrepreneurs, and stakeholders to ensure their research output benefits the commercialization purpose. By actively participating in collaborations, universities could utilize their different skills, sources, and markets, contributing to their success in commercializing their research (Álvarez-Castañón & Palacios-Bustamante, 2021).

The commercialization of the research output, especially from universities in Malaysia, has been established as an income that contributes to the country's economy. In 2019, the commercialization rate of the research and development output in public universities was 4.3% and remained under the international rank of 5% (Institut Tadbiran Awam Negara (INTAN), 2022). Based on the products and technology status in the Malaysian Science and Technology Information Centre (MASTIC), the number of products and technology registered with the potential status to be commercialized is 1205. However, only 214 (17.76%) projects were successfully commercialized (Kementerian Sains, Teknologi dan Inovasi, 2023). According to Anuar, Zakaria, and Shamsuddin (2018), the commercialization rate of research results in Malaysia is still low and unsatisfactory (Ab. Aziz, Harris, Richardson, & Ab. Aziz, 2012; Ismail, Nor, & Sidek, 2017; Ismail & Sidek, 2019). Besides, open innovation practices have been proven to significantly influence university commercialization (Razak & Murray, 2017). Still, few

studies have been done in the context of commercialization, and this matter needs to be studied (Pundziene, Nikou, & Bouwman, 2022). Therefore, by considering the open innovation practice as a factor influencing the commercialization of research output, the objective of this study is to investigate and assess the validity and reliability of the measurement items used to gauge the constructs of open innovation practices among lecturers employed at public universities in Malaysia.

The Commercialization of Research Output

The Ministry of Higher Education has upheld the research and development (R&D) activities among the universities through researching culture (2006–2008), upholding high-quality research (2008–2010), and promoting the excellence of research activities with the production of innovation and commercialization afterward (2011–2012) (Ab. Aziz, Harris, & Norhashim, 2011). Generally, commercialization depicts the process of changing research into a practical application with commercial potential, acquiring the right of patent protection, and later transferring them to the industries through licensing agreements or publishing companies (Bansi, 2016).

On top of that, commercialization is a process that modifies the knowledge produced in the research organization into a marketable product (Salter & Martin, 2001). In line with Åstebro's (2004) research, the commercialization process refers to introducing a new product or service, which contributes to the economic growth of a nation and presents ample opportunities for job creation and company profitability. From an academic perspective, commercializing research aims to attain recognition and career advancement. Besides, commercialization would generate the research fund as their intrinsic motivational factor (Ismail, Nor, & Sidek, 2015).

Academicians' skills to transfer knowledge effectively into the industries are the keys for the universities to achieve the mission of entrepreneurship (Miller, McAdam, & McAdam, 2018). Aside from that, the significance of knowledge transfer from universities, serving as a fresh wellspring of ideas and inventions, has positioned universities at the forefront of the global innovation system (Schmitz, Urbano, Dandolini, de Souza, & Guerrero, 2017).

Open Innovation Practices

Innovation is remarkable for competitiveness and the success of an organization. Every organization needs innovation to raise the marketing section (Johannessen, Olsen, & Lumpkin, 2001). Organizations obtain motivations such as internationalization and innovation competition, as Harris, McAdam, McCausl, and Reid (2013) stated. The word innovation originated from the Latin word, which is innovated, which carries the meaning of reconditioning or changing (Mckeown, 2014). In 2003, Henry Chesbrough introduced a new method of innovation called open innovation. Open innovation is a concept of contemporary innovation. It opens the chances for entities to move across the traditional perspectives, creating values by considering alternative ways towards innovation and achieving profitable advantages. Open innovation is defined as to speed up internal innovation and broadening the scope of external utilization of innovation; there is a need for the exchange and expansion of knowledge in both incoming and outgoing directions (Chesbrough, 2006). Open innovation became one of the topics frequently discussed in the management of research about ten years ago (West & Gallagher, 2006).

Consequently, the proficiency of academics in effectively transferring knowledge to industries becomes crucial for universities to fulfill their entrepreneurial mission (Miller *et al*., 2018). The importance of universities as the leading entities in the global innovation system stems from their role as prominent sources of ideas and inventions through knowledge transfer (Schmitz *et al*., 2017). Nevertheless, according to Razak and Murray (2017), the lack of innovation practices among individuals and organizations involved in the commercialization process is probably one of the main factors of the low rate of commercialization.

On the other hand, Chesbrough (2012) states that the open innovation concept has recognized that valuable innovations and ideas could come from internal and external sources. This matter has shown that researchers, faculty members, and other stakeholders from varied sectors are involved in the context of universities. This could implant a collaborative and inclusive environment leading to the growth of products and new services and commercially viable. Practically, open innovation practices in universities might involve many activities. It might include establishing shares with the industry players, easing the technology transfer and a licensing agreement, creating an incubator for university research support, and actively promoting entrepreneurship among students and faculty members.

Open Innovation Practices in Commercializing Research Output

Open innovation practices are a project or research that could be infused in and out in multiple

ways. Projects or research are possibly conducted from internal or external technology resources; new technology could enter the process at various stages. Projects or researches are marketable through multiple ways, such as licensing or downstream companies (Razak & Murray, 2017).

Open innovation practices are strategies that focus on breaking the barriers of companies to be explored and integrating knowledge and different kinds of resources to commercialize potential innovation (Bogers, 2011). According to Razak and Murray (2017), implementing an open innovation strategy by innovators acts as a catalyst for generating brilliant ideas and fostering collaborative efforts. This strategy also plays a crucial role in building trust among innovators, enabling them to exchange resources effectively during commercialization. Within the fundamental framework of universities, the innovation process commences with the generation of ideas by academics. Subsequently, business partners become involved either during the execution phase (Kamariah, Senin, Soong, Wong, & Musibau, 2012) or in production and marketing (Azmi & Alavi, 2013). On the other hand, open innovation enables the knowledge and innovation sources to stream freely either Z (Chesbrough, 2003; Garriga, Von Krogh, & Spaeth, 2013; Liao, Fu, & Liu, 2020).

Past studies by Wu, Welch, and Huang (2015), Kankanhalli, Zuiderwijk, and Tayi (2016), and Camerani, Denicolai, Masucci, and Valentini (2016) have acknowledged the significance of open innovation. It is a new concept in innovation management and critically impacts the organization's performance. Executing open innovation, ideas, and innovation in an organization could be advanced and helpful in the innovation environment (Cheng & Huizingh, 2014). In the context of open innovation practices suggested by Chesbrough (2003), collaborations among companies, individuals, and public agencies are encouraged in product inventions and new services. This concept is no longer taking innovations as individual initiatives. Still, it is considered to rely on the stream exchange of knowledge involving external sources to push ahead the value of innovation.

Research Methods

Before conducting the primary field research, researchers needed to perform a pilot study to validate the constructed survey and ensure that respondents comprehended it thoroughly. The pilot study is a small-scale study conducted to validate the survey before executing the primary research (Anderson, 1998). According to Zikmund (2003), a pre-test is a trial stage before conducting a real group of respondents to ensure the effectiveness of the applied design of the study. In this context of the study, a pilot study helps the researcher improve the items in the survey, especially in the aspects of language, the accuracy of questions and instructions, and the time allocated for the respondents to complete the survey. This pilot study was conducted on 109 respondents consisting of lecturers who have been involved in the commercialization of the research output. This number fits the theme of a pilot study that suggests at least 100 samples to acquire a valid result for exploratory factor analysis implemented (Hair, Thomas, Hult, Ringle, & Sarstedt, 2017). The sampling method used was a simple random sampling where every respondent has a similar probability of being chosen as the primary study sample.

This research used exploratory factor analysis (EFA) to identify and categorize survey items into specific constructs (Tabachnick & Fidell, 2014). EFA is used to explore the underlying factor structure of a construct when researchers lack a pre-existing theory or hypothesis about it. As this study aimed to investigate and assess the validity and reliability of the instrument used to measure open innovation practices, EFA was chosen as the appropriate statistical method.

The primary reason for selecting EFA over Confirmatory Factor Analysis (CFA) was the absence of a pre-existing theory or hypothesis about the underlying factor structure of open innovation practices. EFA allowed the researchers to explore and identify the factor structure, whereas CFA is typically used to confirm an existing theory. By conducting EFA, the researchers could discern the underlying factor structure of open innovation practices and evaluate the instrument's validity and reliability.

Meanwhile, to ensure the consistency of the study constructs, the reliability of instruments was tested using Cronbach's alpha value, which is considered the most accurate method for quantitative studies (Sekaran, 2006). As per Sekaran and Bougie (2016), a higher Cronbach's alpha value indicates better reliability. In line with Hair, Black, Babin, Anderson, and Tatham (2010) recommendation, a Cronbach's alpha value of 0.70 and above is accepted to measure reliability.

Nine measurement items derived from studies conducted by Chesbrough and Brunswicker (2014), Razak and Murray (2017), and Freixanet, Braojos, Rialp-Criado, and Rialp-Criado (2021) are utilized to assess the extent of open innovation practice. The responses were recorded on a 5-Likert scale, with 1=Never, 2=Rarely, 3=Sometimes, 4=Always, and

5=Often. The measuring of nine items perceived as relevant for open innovation practice is shown in Table 1.

Table 1
Items Representing the Open Innovation Practices

Item		Coding
1	I establish formal collaboration with others to get commercialization ideas.	AIT1
2	I explore commercialization ideas from people outside of the university.	AIT2
3	I share my commercialization ideas with others outside of the university.	AIT3
4	I promote my commercialization ideas to people outside of the university.	AIT4
5	I outsource part of my research projects to people outside of the university.	AIT5
6	I contribute my ideas to others.	AIT6
7	I get ideas (in the form of intellectual property) from others.	AIT7
8	I adopt ideas from others for further research and development.	AIT8
9	I get input from others for the improvement of my research ideas.	AIT9

Results and Discussion

The outcome of the frequency analysis and percentage for respondents' demographic information using Statistical Package for the Social Sciences (SPSS) version 25 is displayed in Table 2. There are six demographic characteristics of the respondents explained, which include types of universities, designation, gender, age, experience as a researcher, and the field of research. Based on the types of universities, 40.4% of respondents come from focused universities, 31.2% from research universities, and the rest 28.4% from comprehensive universities. For the designation category, 41.3% of respondents are senior lecturers with the title of associate professors, 30.3% as professors, 26.6% are senior lecturers, and only 1.8% are a lecturer. As for gender, most of the respondents are male, which is 65.1%, and 34.9% are female. This number indicates that male respondents are more responsive in this survey as compared to females. Looking at the distribution of ages, most respondents consist of 40 to 49-year-olds, covering 56%. 23.9% and 18.3% are respondents aged 50 to 59 years old and 30 to 39 years old, respectively. In the meantime, only 1.8% of respondents are 60 and above.

Considering the aspect of the experience as a researcher, almost all respondents involved in the commercialization of the research output have more than ten years of research experience, which is 84.4%. In terms of the research field, 40.4% of the respondents are from applied and pure science fields, while 28.4% represent researchers from the technology and engineering field. The area with the smallest number of respondents in this study is Information and Communication Technology which covers 1.8%.

Table 2
Respondent Demographic (*n* = 109)

Demographic	Frequency	Percentage (%)
Type of University		
Research University	34	31.2
Comprehensive University	31	28.4
Focused University	44	40.4
Position		
Professor	33	30.3
Associate Professor	45	41.3
Senior Lecturer	29	26.6
Lecturer	2	1.8
Gender		
Male	71	65.1
Female	38	34.9
Age		
30–39 years old	20	18.3
40–49 years old	61	56.0
50–59 years old	26	23.9
>= 60 years old	2	1.8
Experience as a Researcher		
6–10 years	17	15.6
More than ten years	92	84.4
Research Field		
Pure & Applied Science	44	40.4
Technology & Engineering	31	28.4
Social Science	16	14.7
Information & Communication Technology	2	1.8
Clinical & Health Science	11	10.1
Arts & Applied Arts	5	4.6

Descriptive Analysis

The mean score for the open innovation practice is 3.47, with a standard deviation of 0.756, as shown in Table 3. Item AIT6, which is 'I contribute my ideas to others', obtained the highest average value as compared to other items with a mean score of 3.74, followed by item AIT3, which is 'I share my commercialization ideas with others outside of the university' (mean value of 3.71). Besides that, the respondents almost establish formal collaboration with other people to gain

commercialization ideas (AIT1) with a mean value of 3.66, gaining input from other people to improve the idea of research (AIT9) with a mean value of 3.62 and promoting commercialization idea to foreigners of the university (AIT4) with the mean value of 3.56. The data distribution in the descriptive analysis also explains that respondents explore commercialization ideas from people outside of the university (AIT2), gain ideas (in the form of intellectual property) from other people (AIT7), outsource parts of research projects to people outside of the university (AIT5) and adopt ideas from others for further research and development (AIT8).

Table 3
Descriptive Analysis of Open Innovation Practice Instruments

Item	Mean	Standard Deviation
AIT1	3.66	0.945
AIT2	3.45	1.004
AIT3	3.71	1.021
AIT4	3.56	0.957
AIT5	3.08	1.001
AIT6	3.74	0.966
AIT7	3.39	0.980
AIT8	3.03	1.013
AIT9	3.62	0.911
Total	3.47	0.756

Exploratory Factor Analysis

The open innovation practice construct consists of nine items. To assess multicollinearity and compatibility for factor analysis, the Kaiser-Meyer-Olkin (KMO) test was conducted. The results showed a KMO value of 0.885, indicating no severe multicollinearity issues and sufficient compatibility for factor analysis. Furthermore, Barlett's test of sphericity is used to identify the correlation coefficient items for the factor analysis to be conducted. The value of Bartlett's test of sphericity for the construct of open innovation practice is significant, which is $p<0.05$, explaining the correlation coefficient and factor analysis is possibly conducted. The cumulative variance of open innovation practice was 69.142%, surpassing the minimum value of 60%, as Hair *et al*. (2010) suggested. The factor loading values for open innovation practice, ranging from 0.781 to 0.887, are displayed in Table 4. The factor loading value exceeding 0.45 is accepted (Tabachnick & Fidell, 2014). Consequently, all items analyzed contribute to the depiction of the construct of open innovation practice.

The Scree test, introduced by Cattell in 1966, is a statistical method employed to determine the ideal number of factors to extract from a dataset. It aims to identify how the amount of unique variance starts to outweigh the shared variance structure. By examining the eigenvalues of factors or principal components in an analysis, the Scree plot, which is a graphical representation of the eigenvalues, helps select the significant factors or components to retain. The Scree plot in Figure 1 indicates that one component has emerged from EFA.

It is essential to note that the primary purpose of conducting EFA in this study was to investigate and assess the validity and reliability of the instrument used to measure open innovation practices. The researchers used EFA to uncover the underlying factor structure and evaluate the instrument's validity and reliability. The Cronbach's Alpha value of 0.916 indicated high reliability for the nine instrument items in open innovation practice.

Therefore, while the study primarily focused on analyzing factors using EFA, this analysis served the purpose of investigating and assessing the validity and reliability of the measurement instrument for open innovation practices. The results reinforced the credibility of the findings and provided valuable insights into the construct of open innovation practice.

Table 4
Factor Analysis of Open Innovation Practices

Item	Factor Loading
AIT1	0.887
AIT2	0.831
AIT3	0.878
AIT4	0.874
AIT5	0.845
AIT6	0.781
AIT7	0.782
AIT8	0.808
AIT9	0.790
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.885
Bartlett's Test of Sphericity	
Approx. Chi-Square	812.562
df	36
Sig.	0.000
Total	6.223
% of Variance	69.142

Reliability Analysis

The reliability of a measurement instrument refers to the consistency and stability of the results obtained from the instrument. Cronbach's Alpha is a commonly used measure of reliability that assesses the internal consistency of a set of items in a scale or instrument. In this study, the Cronbach's Alpha value for the reliability test of the nine instrument items for open innovation practice was 0.916, which is very high. According to

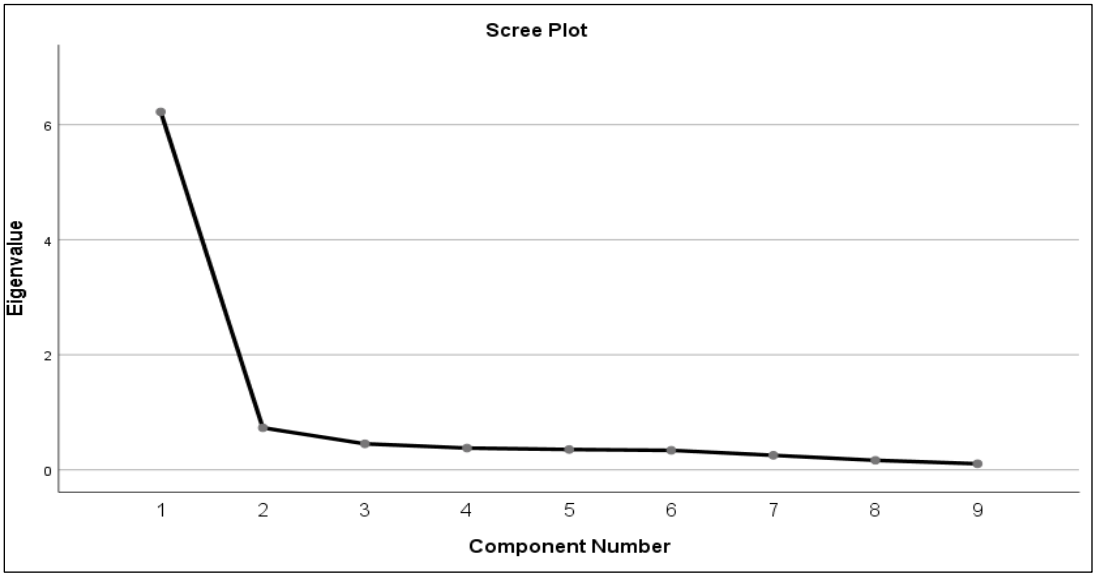

Figure 1. Scree plot of open innovation practices

Hair *et al.* (2017), a Cronbach's Alpha value of 0.70 or above is generally accepted as an indication of good reliability. Therefore, the high Cronbach's Alpha value obtained in this study suggests that the instrument used to measure open innovation practices is reliable and consistent and that the construct measurement is suitable and relevant for lecturers from public universities in Malaysia.

Table 5
Reliability Analysis of Open Innovation Practices Instrument

Item	Cronbach Alpha
AIT1	0.902
AIT2	0.901
AIT3	0.905
AIT4	0.903
AIT5	0.910
AIT6	0.908
AIT7	0.911
AIT8	0.913
AIT9	0.899
Total	0.916

Conclusions and Implications

This paper aims to comprehensively explore and evaluate the value of open innovation practices in universities' research output commercialization activities through a preliminary survey. The research results demonstrate high validity and reliability for this instrument, paving the way for future in-depth investigations. By embracing open innovation practices, universities have the potential to significantly enhance their ability to commercialize research outcomes, leading to notable economic growth and societal impact. These practices foster stronger partnerships and knowledge exchange between academic institutions and industries, creating ample opportunities for technology transfer and research findings' commercialization. Notably, open innovation practices emerge as a crucial factor driving the active involvement of lecturers in conducting and devising commercially viable research.

In today's rapidly evolving technological landscape, exploring the impact of open innovation practices on research commercialization holds great importance and urgency. As research and development continue to grow more complex and interdisciplinary, exploring novel ways of fostering collaboration and knowledge sharing between academic institutions and industry partners becomes essential. This study contributes significantly to the existing body of research by comprehensively analyzing the effectiveness of open innovation practices in promoting research commercialization. By identifying the most effective practices in facilitating collaboration and technology transfer, valuable insights are offered on how academic institutions can better engage with industry partners to drive innovation and economic growth. Overall, this study represents a noteworthy contribution to the research and innovation management field, carrying significant implications for policymakers, academic institutions, and industry partners alike.

This study presents several vital recommendations that shed light on positive and negative impacts. On the positive side, research output commercialization empowers universities to create opportunities for entrepreneurship, drive innovation, and contribute significantly to the country's economic growth. Open

innovation practices also foster stronger partnerships and knowledge exchange between academic institutions and industries, providing ample opportunities for technology transfer and commercialization of research findings. By translating research outcomes into commercial ventures, universities enhance their potential to address societal challenges and positively impact society effectively. Furthermore, successful research output commercialization can lead to increased research funding, which, in turn, can be channeled to support further research and development endeavors.

However, it is essential to acknowledge potential negative implications arising from open innovation and research commercialization. Intellectual property issues represent a significant concern, as open innovation practices might create challenges in protecting intellectual property rights when collaborating with external partners. Moreover, there is a risk of reduced academic freedom, as researchers may encounter pressure to prioritize commercially viable research over purely academic pursuits. Lastly, open innovation practices can foster increased competition among universities and researchers as they strive to capitalize on commercializing their research output.

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