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**A SYSTEMATIC REVIEW ON THE CRITICAL SUCCESS
FACTOR OF RESEARCH COMMERCIALIZATION**

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Abstract

The evolution of science and technology nowadays leads to the fast development of research institutions around the world. Developing new products or technologies and moving them into a market place efficiently and effectively are essential in gaining a competitive edge to ensure a long term success. The level of public value is important in order for the potential products and technologies are eligible for commercialization as it could result in overall profitability. The purpose of this paper is to illustrate the critical success factors on the research commercialization that can assist organizations to identify the key elements for a successful process. The success factors are derived from 159 research articles that were published from 2003 to 2018 from several databases like Web of Science and Scopus. Based on the systematic literature review (SLR) method, there are five elements that have been recognized as successful commercialization in the research and innovation product. The key success factors are by having strong financial resources, good management skills, market research, wide networking and linkages and good partnerships.

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Keywords: Commercialization, innovation, research management, new product development, success factor.



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1. Introduction

The process of a new product or service introduced to the market is called commercialization (Adams, Bessant, & Phelps, 2006). The commercialization of product or technology is like an engine of growth for the nation in the globalized economy. Commercialization is one of the activity in the product innovation. Commercialization generally is the final process where the actual product launching is at the final stage of the product development. Figure 1 shows the funnel of the product development process that illustrates the flow of the product development process. The widest part of the funnel is the idea generation where many ideas are introduced. At this stage, the company generate ideas based on logistics, costs, economic trends, consumer and feasibility. This followed by sorting ideas and selecting the best one to move to the next stage for project development. Referring to this funnel, the commercialization is illustrated as the narrowest area meaning that it is the least developed area of the process. As a conclusion of this commercialization funnel, the whole stages are important as it can encompass the company formation, intellectual property, proof of concept, prototyping, demonstration plants, team building, market research and so on.

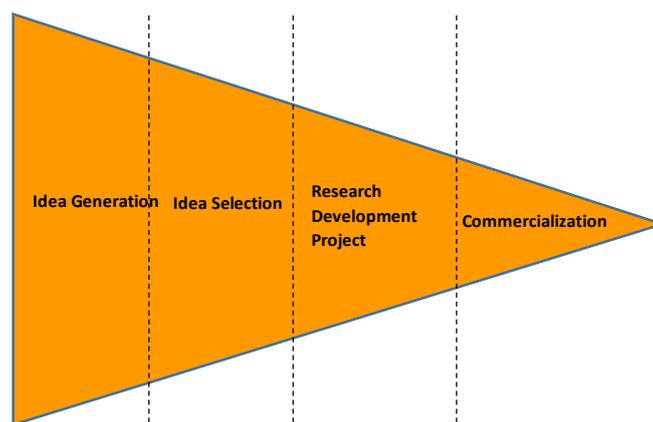


Figure 01. Funnel of pre-development process

Commercialization is a part of research and development process. The research phase is incomplete without the commercialization of that particular of research product. It is important to introduce new products to the market as it will contribute to the growth of the economies (Crawford & Benedetto, 2010). In addition, the importance of the commercialization can be seen through the establishment of the spin-off companies by many universities (Steffensen, Rogers, & Speakman, 1999) and its contribution to the development towards local economy (Etzkowitz, 2003; Shane, 2004). Other important of commercialization is it help to generate income for the organizations as it can create new businesses and job opportunities (Shane, 2004; Shane & Cable, 2002; Shane, 2004). As for the policy makers, they have recognized the influence of the science park like a Science Park in Cambridge, UK as a source of the industrial innovations that could trigger and provide job opportunities (Etzkowitz, 2003). As in Malaysia, the establishment of Pusat Sains Negara, Taman Teknologi Malaysia and Putra Science Park are one of the government initiative to expand knowledge in Science and Technology by creating and promoting awareness and interest among Malaysian citizens.

2. Problem Statement

There is no clear process on how an invention or innovation gets to market and succeeds. It is believed that the success of the commercialization always involves the market throughout the whole process (Natsheh, Gbadegeshin, Rimpiläinen, & Zambrano, 2015). Throughout this process, there are factors that affecting the success of the commercialization. Based on the input provided by the research department in Universiti Teknologi Petronas (UTP), the main problem in commercialization is the financial support. In view of the current global economy situation, it is hard to secure funding from the industries which the allocation for the research now is limited. This is due to the effect from the current economy crisis around the world. At this time, the technology transfers office (TTO) is a very important department in assisting researchers and university in order to sustain the research commercialization activities. One of the TTO role is to manage the Intellectual Property (IP) of the research product (Crawford & Benedetto, 2010). The improper management of the intellectual property (IP) and protection will delay in the process of diffusion of the technology from universities to industries and leads to the problem in technology transfer process (Caulfield & Ogbogu, 2015; Wonglimpiyarat, 2014a, 2014b). Other problem that the research institution mostly faces is the lack of the university engagement with government and industries which are leads to the less emphasis for commercialization (Kaur et al., 2014; Rasmussen, 2008). Other important criteria that the research institution should have for a successful commercialization is by having skills or expert peoples in the organization (Khademia, Ismaila, Leeb, & Shafaghatac, 2015; Sidek, Ismail, & Mohd Nor, 2014). It is difficult to assess the strength of the research product if there are less number of experts and skills people in the organization. In addition, without these experts, it is difficult to identify potential collaborators or buyers as they are very familiar with the eco-system.

Table 1 below shows the summary of the problems in commercialization based on the input from the Technology Transfer Office (TTO), Universiti Teknologi Petronas (UTP).

Table 01. Commercialization problems in Universiti Teknologi Petronas

| Problem | Effect |
|--|--|
| Management of Innovation | Improper management leads to the problem in technology process transfer |
| Financial support | Unable to move to the next stages which require more money to maximize the chances for success |
| Intellectual Property (IP) | Improper managing the intellectual property rights (IPRs) and protection of research product commercialization related process will slow down the diffusion of technology from universities to industry |
| Engagement and networking | Lack of engagement with other research institution, government and industries will lead to less emphasis for commercialization |
| Experts/skills in commercialization | Less experts or skills in commercialization will drag to the difficulty to evaluate the competitive strength of that research products. Besides, it is difficult to identify potential collaborators or buyers as they are familiar with the eco-system. |
| Research done and academic understanding | Limited number of study on research commercialization |

3. Research Questions

The following are the research questions in conducting the research study;

- (i) What are the success factors identified in the earlier researches on the commercialization?

- (ii) What are the highest and the lowest variable of the success factors found from the studies?

4. Purpose of the Study

The main purpose of this study is to identify the success factors addressed by the previous researchers on the research commercialization. Furthermore, the study was to determine the most success factors that the most authors highlighted in their research study. The outcome from the study will assist policy makers and researchers to moving forward for successful commercialization.

5. Research Methods

The literature review is the key start of the research work where the information was gathered and brainstormed the ideas to make the research more impactful. The Systematic Literature Review (SLR) was used to compile all the data. In this study a total of 159 articles have been categorized. The research is based on the process flow chart as in Figure 2 below. A few data bases like Web of Science and Scopus were selected. The next step was the search on the articles that were published within the fifteen-years duration of 2003 to 2018 from a different journal. By screening the articles according to the commercialization success, there are 159 articles were obtained. The articles were then tabulated in Figure 2 according to the year of publication. In Figure 3, the articles were segregated by the type of the articles; qualitative, quantitative, mixed method and conceptual paper. The result of the most critical success factors from the studies were shown in the Figure 4.

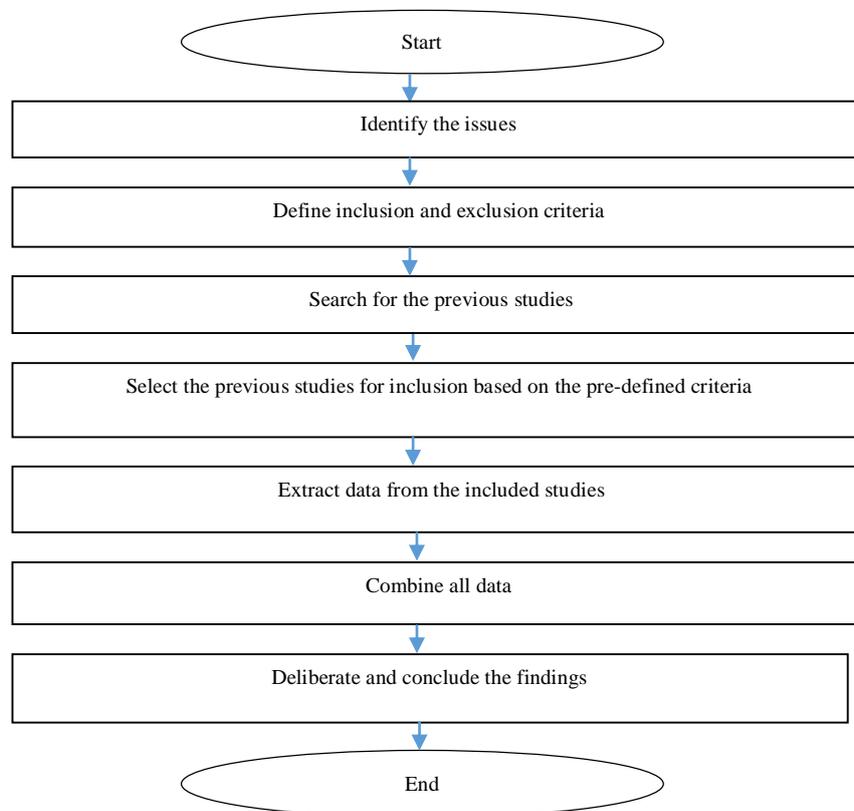


Figure 02. Flow chart for systematic literature review

6. Findings

6.1. Overview of Studies

Based on the studies, the topic on the commercialization has attracted so many scholars from local and abroad. Figure 2 shows the total number of paper reviewed according to the year of the publication from 2003 to 2018. At this stage, all types of papers have been included. Based on this table, it is proven that the commercialization is one of the important element in the research and innovation process. The publication is keep on going although the results shown the inconsistent number of studies. This indicate that the study on the commercialization performance is very significant to the most organizations and research institutions.

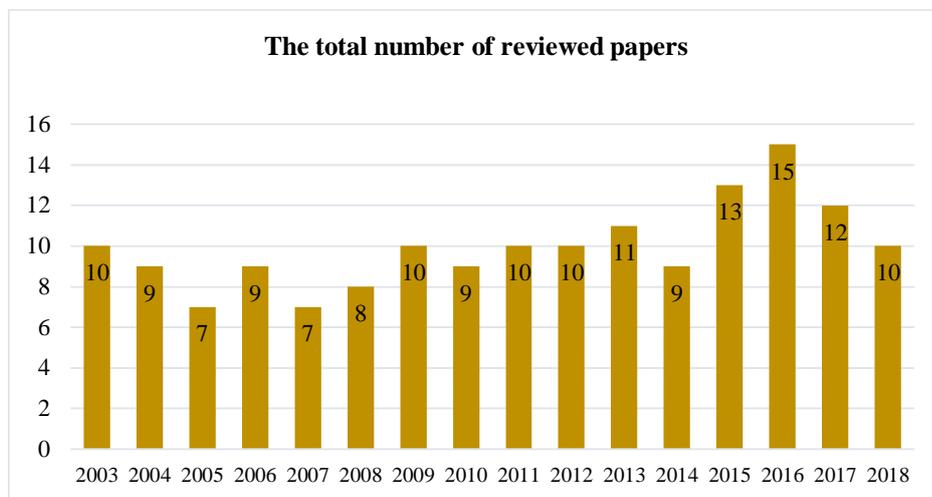


Figure 03. Reviewed articles from 2003 to 2018

Figure 3 shows the number reviewed paper based on the four methods; qualitative, quantitative, mixed mode and conceptual paper. According to this figure, the most common method used by the scholars for their research studies is quantitative method. This followed by the qualitative, conceptual and mixed mode methods.

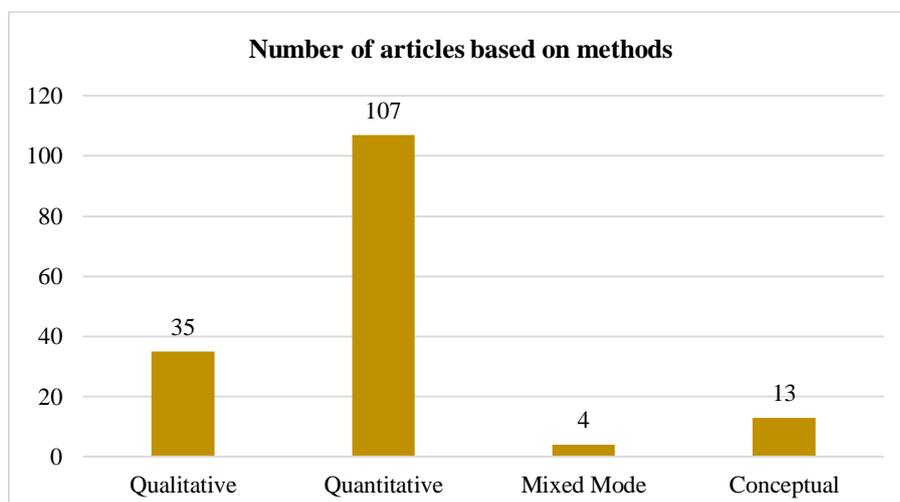


Figure 04. Number of reviewed paper based on methods

6.2. Research Commercialization Success Factors

The main goal of this paper is to study the most critical success factors of the research commercialization. Therefore, the studies were then furthered by screening the results based on the quantitative methods as this were given the very significant results to the main goal. As a results, there are five factors that contribute to the biggest success in the commercialization of research product. The factors are by having a strong financial resources, good research management, market research, networking and linkages, and good partnership. Figure 4 shows results of the key success factors on the research commercialization product.

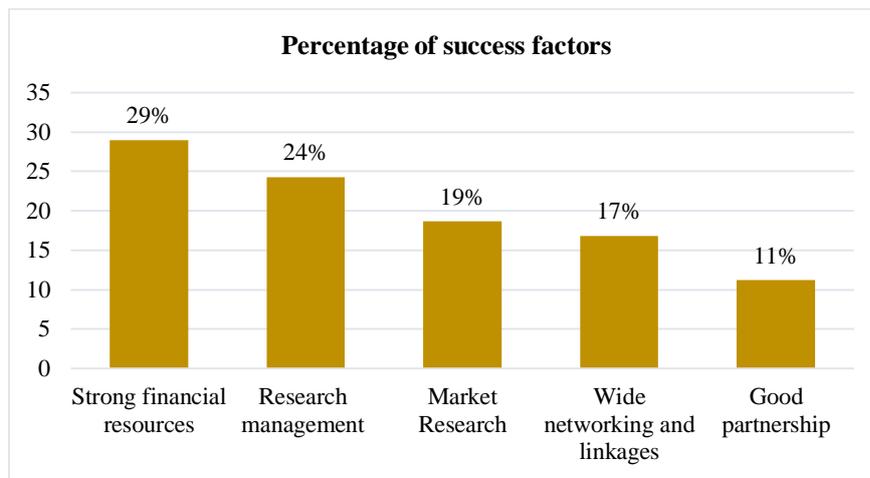


Figure 05. Success factors of research commercialization

Based on Figure 5 above, a strong financial resource is the highest variable by having a 29% of the overall results. This indicate that by having a strong financial resource, the organizations are able to moving forward in achieving the successful commercialization. The availability of funding is a key success factor for commercialization especially to the new patented technology generally for start-up operation with no returns at the early stages (Khademi & Ismail, 2013; Khademia et al., 2015). Good financial support also enables to the growth of the research by focusing the sales growth and controlling the operating expenses (Thomas, Hansen, & Nordman, 2004). The fund is also very crucial in the newly patented technology as it is associated with many costs mainly are for start-up operation (Khademi & Ismail, 2013).

The second highest of key success factor as per studies is 24% of good research management skills. Many studies shows the research management skill is capable in commercializing the research product (Mian, Lamine, & Fayolle, 2016; Mishra & Saji, 2013; Narayanan & O'Connor, 2010; Simula, 2012; Thorburn, 2000). As for the example, Technology Transfer Office (TTO) is handling the commercialization unit at the universities. TTO is established to encourage researchers and inventors to implement the commercialization strategies as well as support them in the process of the commercialization (O'Gorman, Byrne, & Pandya, 2006). TTO also support in many aspects such as in the management of the intellectual property right (IPR) (Hsu, Shen, Yuan, & Chou, 2015) and managing the contract research agreement with the industries and licensees. A good management by the TTO accelerates the process of the commercialization effectively and efficiently thus enable to the successful commercialization.

The market research is also identified as a key factor of the research commercialization with 19% of the study. Normally, the research team starts the process with identifying the research problem. By recognizing the problem, they will find the solution for it (Hindle & Yencken, 2004). As studied by (Sidek et al., 2014), there are seven guidelines in identifying the product within the eco-system; identify the problem that the researcher intended to solve, identify the people who benefited from the product, identify the user of the product, identify the purchaser of the product and develop networking in the product eco-system.

Networking is one of the element for a successful commercialization (Aarikka-Stenroos & Sandberg, 2012; Bøllingtoft, 2012; Lee & Park, 2006). The figure shows that 17% of the studies have stressed that the networking is a key factor for the organizations to move forward. Through networking, the organizations are linking to the financiers which will enable the access to a broader network such as suppliers, customers and other resources (Shane, 2004). The networking through collaboration with the universities, industries and government will give a greater chance for the inventions for marketable (Thursby, Jensen, & Thursby, 2001).

The least discussed area is on the partnership. A good partnership is one of the key factor with 11% of studies. It is important to choose the right partner (Aziz & Norhashim, 2011; Nor Kamariah Kamaruddin, 2013; Putit, Hasan, Suki, & Shahbodin, 2014) in order for the project to progress smoothly. The partner should be necessarily competent in marketing as well as sales, in order to market and sell the product. They also should have a technical basic knowledge in convincing the potential buyer. According to (Sidek et al., 2014), a good business partner have all these attributes; transparent and trustworthy, basic technology knowledge, available in providing the financial support, good marketing and sales skills, and able to share common goals and interest.

7. Conclusion

Based on the findings, instead of developing an innovative product, the organizations should have a strong financial resources, good management skills, market research, wide networking and linkages with internal and external parties and good partnerships in order to successfully commercialize their product. These are the most important elements that the study found for the benefit of researchers in any organizations or research institutions to move forward.

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