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INITIAL FINDINGS ON THE EMPIRICAL FACTORS THAT INFLUENCE MALAYSIAN OWNED SME MANUFACTURERS TO UNDERTAKE DIVERSIFICATION OF TECHNOLOGIES AT THE PRODUCT LEVEL

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Abstract

This paper assesses the initial findings on the empirical factors that influence Malaysian owned Small-Medium Enterprise (SME) manufacturers in the Electrical & Electronics sector to undertake diversification of technologies at their product level. The empirical factors of technology diversification are based on literature reviews and categorized under six main groups namely the capabilities required to diversify, customer demands, additional resources, support or partnerships, source of market and economies of scope. In particular, these factors would be tested to determine the most influential factor of Malaysian owned SME manufacturers to diversify their technologies at the product level. The analysis is based on surveys of 30 Malaysian owned SME manufacturers in the Electrical & Electronics sector that have new or diversification projects from 2012-2016 whereby the data were obtained from the Malaysian Investment Development Authority (MIDA). The results showed that the capabilities required to diversify as the most influential factor. The results may bring an initial understanding of Malaysian SME's in diversifying their technologies at the product level.

Keywords: Core capabilities, Electrical & electronics, Malaysian SME, SME manufacturing, Technological diversification.

1. Introduction

As technology becomes more significant in a company's growth and innovation of their product line, diversification of technologies plays a huge part in the company's strategy to diversify its product technologies. Technology diversification refers to the expansion of a companies' overall technology base into more broader technological fields [1, 2]. Literatures on the research of technology diversification in companies have extracted many empirical factors such as technological specialization, core competencies and capabilities [3], economies of scope [4], R&D expenditure and sales growth [5], absorptive capacity and environmental dynamism [6], firm growth and firm-specific core-technology competence [7]. Most of these literatures however are focused in larger corporations or multi-technology companies rather than Small-Medium Enterprise (SMEs). Therefore, the SMEs faces different challenges when it comes to diversifying their own technologies at the product level.

SME's in Malaysia are defined as enterprises or firms that provide services or manufacturing with annual turnover not exceeding RM25 million and employs full time workers of not more than 150 people [8]. In 2016, SME's in Malaysia contribute about 36.6 percent of the nation's Gross Domestic Product (GDP) and share 65.3 percent of the total job employment [9]. Currently there are 47,698 SME manufacturers and about 2,000 of them are from the Electrical and Electronics sector [10].

Looking at the historical background of the SME's in the E&E sector, several of these SME's started off as suppliers of Multi-National Companies (MNC's) in the 1970s by supplying parts electronic parts and components to MNC's such as Intel, National Semiconductor, Osram and Bosch. Today most of these SMEs support the MNCs and Large Local Companies (LLC's) as semiconductor producers involved in the back end, from outsourced assembly and testing to manufacturing integrated circuit (IC) parts, printed circuit boards, sensors and precision tools [11]. Despite being long term partners with the MNC's for decades, there seems to be a low creation of locally owned E&E high-technology companies.

According to the statistics provided by the Malaysian Investment Development Authority, there are less than ten Malaysian owned E&E high-technology companies in the list of top 100 E&E high-technology companies. The low number of Malaysian owned high-technology entity has brought the concern of the dependence on foreign technology transfer rather than the creation of own local technology innovation and diversification as also agreed upon by Razali et al. [12].

On the other hand, low R&D intensity is constantly being seen as one the biggest issues in diversification of technologies at the product level. Although most of the R&D efforts are undertaken by Government and MNC's, there are also a number of public research institutes that undertake R&D activities in specific sectors but often do not match the industry requirements [13]. In many ways so, R&D would enable to strengthen the SME's capability to innovate and create indigenous technology and market new products [14]. Therefore, the lack of R&D would face the assumption that local firms including SMEs are mostly adopters rather than creators of technology.

2. Initial Findings and Theoretical Framework

Based on comprehensive reviews from various sources and previous studies related to technology diversification, the proposed factors that make up our initial findings of the empirical factors that influence the Malaysian owned SME manufacturers to diversify were made as follows :

2.1. Local capabilities required to diversify to new technology at product level

The capabilities of the local SME's in producing complex products by virtue of diversification of technologies have been clearly identified from [14]. Malaysia's complexity of products shows that there is a level of technology and experience that companies should possess besides having the technology qualification that could be translated as technologically certified or technologically capable. In tandem, a strong financial base was countlessly mentioned as the one of the most critical factors to enable the current capabilities into producing new complexity products which was also consistently supported by Wang et al. [6] and Reichert and Zawislak [15] which regarded financial performances and greater investments in technological capability. Technological capability is the firm's capability of operating, maintaining, adapting, and assimilating the transferred technology whereby two main dimensions are considered which are activities consisting of R&D [16].

2.2. Customer demands that propels diversification

According to the report by the Economic Planning Unit of Malaysia [14], it is imperative to identify the types of customer demands that encourages firms to technology diversify. Based on most priority sector products there are significant demands from either the international as well as local market. The ecosystem is another important element for firms to serve as we can see that Malaysia has three catalytic sub-sectors in the manufacturing sector which is electrical and electronics, chemicals and machinery & equipment, that will drive the transition towards more high-value, diverse and complex products [17]. Most of the high-technology manufacturing firms are from the electrical and electronics sector which are mostly foreign owned, and demand is understandably from the multinationals including their broad base of customers worldwide [18]. There are other sectors such as automotive that is increasing its high-technology content particularly in automotive electronics which is a new growth area [19]. It is also essential to include the government sector as well because most of Malaysia's priority sectors have many links with sectors that are government related customers such as in oil and gas and healthcare.

2.3. Additional resources required for the diversification process

To capture the additional technological activities (diversification) of a firm, Granstrand [19] suggested that the additional resources of staff with higher education in engineering and science and the use of engineer counts to determine the specialized type of engineers during the diversification of a product or redefined as specialized engineers. Furthermore, we will also assume that the addition of these specialized engineers will also have additions to skilled laborers to assist with the handling of additional tools or equipment's for new and diversified products. Garcia-Vega [20] and Watanabe et al. [21] both emphasized patents as the

determining addition of the increase in the degree of technological diversification. New patents or specialized intellectual properties (IPs) are the backbone of new product technology that could also be applied to the technological diversification of products. In order to strengthen the determinants in additional resources, new materials and vendors also act as a part of the operational management of new products as collaborative efforts are initiated from the vendors for parts or materials which is the motivating factors to cope with the increasing complexity of technological and product development [22]. As for the Malaysian context, it was recognized that strong vendor-customer relationship as the key element for Malaysian technology users to improve technology management processes [23].

2.4. External support or partnerships required for diversification

There are less literatures from the international context stating the needs of external support and partnerships as main determinants, however there are many technology development government agencies in Malaysia such as MIDA, MTDC, MOSTI and EPU that were involved including other international government agencies that assist manufacturing and non-manufacturing firms in technological diversification [14]. Murad and Thomson [24] also agreed that the Malaysian Government placed many efforts to strengthen the local manufacturing firms by having many avenues of support in technology programmes, funding's, marketing, skills and infrastructure development and many more. In addition, there are alignment exercises where the government also gained views from various industry associations and industry experts for the viability of production and supports from other non-government parties were mentioned such as investors, partnerships and venture capitalist to provide diversification of portfolios [25]. To sum it up, Alcalde Heras [26] demonstrated that firms with R&D elements or technological diversified firms might also dwell towards external collaborations or partners to penetrate new markets via the diversification of technology and products.

2.5. Post diversification market potential

In this factor, each and every market opportunity that was mentioned through the Malaysia Investment Performance Report 2014 [18] and Abdul Aziz and Garip [25] with relation to technology related projects were singled out. Apart from consumer and technology-based customers that were commonly understood, other markets that were synonym to Malaysia's industry such as the ASEAN market, industrial market, Europe, USA and the markets for the rest of Asia. Though it did not mention specifically on technology diversification projects but most of the projects or firms were related with technology advancement elements such as R&D, high-quality and high-technology projects.

2.6. Economies of scope

One of the strategies to realize technology diversification is to gear towards reaping economies of scope [19]. By definition, economies of scope are the average total cost of production decreases as a result of increasing the number of different or diversified products or goods produced [27]. Economies of scope here refer to cost savings from simultaneously producing several outputs in the same firm, rather than producing each output separately in a specialized firm. It exists when joint production of two or more products by one enterprise is less costly than the total

[28]. In this manner, cost plays a huge role in strategizing to the best output which requires the cost in operations, technology, R&D and sourcing of materials. Increased technological complexity and rising R&D costs are, in many cases, likely to increase both the market supply of and the demand on the market for new technologies. R&D intensity is the ratio of corporate R&D spending to total sales [5]. As such the growth of sales is also one of the critical factors of R&D that tallies with the economies of scope.

As a conclusion to the literature review on subjects related to the empirical factors of diversification at the product level as above, a framework as per Fig. 1 was developed depicting the issues of technology advancement that Malaysia faces as well as the empirical factors of diversification at the product level.

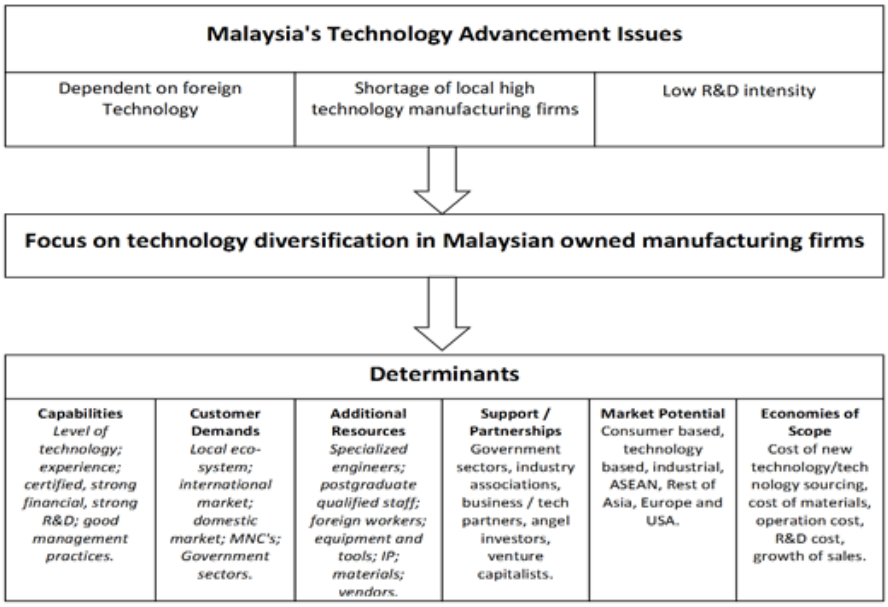

Fig. 1. Investigated shapes of projectiles (Geometry and dimensions).

3. Methodology

The objective of this study is to investigate the top most factors that encourage Malaysian manufacturing E&E SME's to diversify their technologies at the product level. Both primary (literature review) and secondary data (questionnaire) were used for the study. The questionnaire was validated through expert validation and pilot testing. A sample of 59 E&E SME's were selected from the statistics list of MIDA and the Small and Medium Corporation Malaysia (SME Corp.) database. In addition to this, the respondents chosen were those which had diversification or expansion projects only from 2013-2016. Thirty-four (33) variables which were identified in the literature review to have influence on E&E SME's to diversify their technologies at the product level were presented to the SME's to solicit their views. Questionnaires were sent through email via professional acquaintances. The questionnaire has two parts which consist of the company profile and the questions posed to companies on the influencing factors of technology diversification at

product level. All of the questions will be in Likert scale of 1 until 5 with 1 as strongly disagree and 5 as strongly agree. Table 1 shows the value and interpretation of the Likert scale.

Table 1. Level of coefficient value interpretation (α).

Coefficient Value (α)	Interpretation Level
≥0.9	Excellent
≥0.8	Good
≥0.7	Acceptable
≥0.6	Questionable
≥0.5	Weak
<0.5	Unacceptable

Data's obtained from the research questionnaires were organized by using the Microsoft Excel 2013 software and then analysed by using the Statistical Package for the Social Science (SPSS) version 20.0 software. This technique was chosen based on its compatibility with the requirements of the research in measuring the level of influence of technology diversification at the product level among Malaysian owned SME manufacturers.

4. Results and Findings

4.1. Profiles of SME's

A total population of 59 Malaysian owned SME manufacturers in the electrical or electronics sector was identified for this research. They were identified as having either expansion or diversification projects within the period year of 2012-2016. The respond rate that replied to the questionnaires sent for surveys were 50% or 30 firms. The profiles of the 30 firms are as shown as per Tables 2 and 3.

Table 2. Number of workers and years of operation in each firm.

	No. of Full Time Employees			**Years of Operation**		
	1-50	**51-100**	**101-150**	**1-15**	**16-30**	**31-40**
	N	**N**	**N**	**N**	**N**	**N**
Total	13	8	9	17	11	2
Percentage (%)	(43.3)	(26.6)	(30.1)	(56.6)	(36.6)	(6.8)

Based on Table 2, 13 out of the total 30 firms possess less 50 or less full-time employees while 9 firms have more than 100 full time employees. The rank shows that 43.3% of the total firms have less than 50 full time employees while 30.1% have more than 100 full time employees but less than 150. About 26.6% of the total firms that have more than 50 but less than 100 full time employees. This shows that all of these firms are SME's. In terms of years of operation which indicates the experiences of these firms, most of the firms have less than 15 years of operating experiences. The rest of the firms have more than 15 years but less than 40 years of operating experience. The rank shows that 56.6% of the total firms have less than 15 years and 36.6% has more than 15 years but less than 30 years of experience. The third rank is 6.8% for firms that have more than 30 years but less than 40 years of operating experience. Based on the Economic Complexity Report 2014, there is a level of technology and experience that firms should have in order

to become technological qualified. As such, the years of operating plays a crucial part for firms in technology diversification at the product level.

Table 3. Number of technical staff and R&D staff in each firm.

	Number of technical employees				Number of R&D staff		
	0-10 N	11-50 N	51-100 N	101-x N	0-10 N	11-50 N	51-100 N
Total	11	9	7	1	22	7	1
Percentage (%)	(39.3)	(32.1)	(25.0)	(3.6)	(73.3)	(23.3)	(3.3)

Table 3 shows the number of technical and R&D employees of each firm whereby the technical abilities to diversify products can be seen through the numbers of technical staff and R&D of the firms as suggested by [28]. Most of the firm's number of technical and R&D employees are less than 10 employees. This is understandable as the majority of the total numbers of employees in each firm are less than 50. Based on average, we could assume that the percentage of technical and R&D staff makes up to at least 20% of the total workers of each firms. The rank for number of technical employees shows that 39.3% of the total firms have less than 10 employees while 32.1% of the firms have more than 11 but less than 50 employees 25.0% of the firms have more than 50 but less than 100 employees. This rank shows a balanced spread of technical employees among the firms.

4.2. Reliability and validity of data

The internal reliability of the items was verified by computing the Cronbach Alpha (α) and suggested that a minimum a of 0.6 was sufficed for early stage of research [29]. The Cronbach Alpha estimated for all items were well above 0.9 which shows that the items are relatively reliable, and all respondents understood well the questions posed. To further analyse each of the items, the Corrected item - Total Correlation was done to analyse the correlation between each item. Based on the results, all correlations are well over 0.8 and has relatively high relations to one another. Summaries of both Cronbach and Correlation is as per Table 4.

Table 4. Corrected item-Total correlation analysis.

Factors that influence SME's to diversify	Corrected Item-Total Correlation	Cronbach's Alpha (*α*) if Item Deleted
Capabilities	.931	.958
Customer Demands	.880	.963
Additional Resources	.909	.960
Support / Partnerships	.880	.963
Market Demand	.885	.962
Economies of Scope	.892	.962

4.3. Ranking and summary of factors

The ranking of all factors by mean value as per Table 5 shows that the capabilities to diversify as the highest overall mean with a mean value of 4.2235 which is followed by the overall mean of Economies of Scope with a mean value of 4.2059. The rank also revealed the customer demands as the least overall mean in

influencing SME's to diversify with an overall mean of 3.7235. It is also noted that the highest individual mean came from specialized engineers / technical staff with a mean value of 4.8529 followed by growth of sales with a mean value of 4.7941 which indeed is one of the main rules in Economies of Scope. The lowest individual mean came from government with mean value of 2.5588 and additional foreign workers with mean value of 2.7647.

Table 5. The mean of main factors.

Category	Factors	Mean	Overall Mean
Capabilities	Level of technology	**4.6176**	**4.2235**
	Experienced to venture to new products	4.2059	
	Certified (to qualify for new products)	3.8824	
	Strong financially (cash flow)	4.4118	
	Strong in R&D (patents / IP produced)	4.0000	
	Good management & communication practices	3.7647	
Customer Demands	Domestic market	3.8529	3.7235
	Local ecosystem	3.4706	
	International market	4.3529	
	Multi-National Companies	4.3824	
	Government projects	2.5588	
Additional Resources	Additional equipment and tools	4.4118	3.7647
	Specialized engineers / technical staff	**4.8529**	
	No. of Masters/PhD qualified staff	3.1176	
	Additional foreign workers	2.7647	
	New materials	4.0294	
	New vendors	3.5588	
	Specialized IP/ patents	3.6176	
Support / Partnerships	Government sector	4.0294	3.8176
	Industrial associations	3.8235	
	Business / tech partners	4.5294	
	Angel investors	3.4412	
	Venture capitalists	3.2647	
Market Demand	ASEAN market	3.8235	3.9706
	Rest of Asia	3.6176	
	Consumer based market	3.9412	
	Europe and USA	3.9412	
	Industrial market	4.1471	
	Technology based market	4.3529	
Economies of Scope	Growth of sales	**4.7941**	**4.2059**
	Operation cost	3.9412	
	R&D cost	3.6765	
	Cost of new technology	4.3529	
	Cost of materials	4.2647	

5. Discussion and Conclusion

The results of the highest category by rank shows that the capabilities to diversify and the economies of scope as the highest factors that influence Malaysian SME manufacturers to diversify. Studies by Corradini et al. [3] and Rahuman et al. [30] mentioned about the firms' current capabilities as the core factor for firms to

diversify its technology base. Suzuki and Kodama [4] and Teece et al. [28] on the other hand demonstrated that the factors of economies of scope as being the causing factor for firms to diversify multiple technologies or products in the most economical way possible. In addition to this, the factor of growth of sales and specialized engineers were also supported by these authors. The lowest ranked factors that were identified such as foreign workers, government projects and venture capitalists indicate that Malaysian SME manufacturers are moving away from the dependency of labour or foreign workers and government projects. These factors were however less or unknown in any of the previous studies.

In conclusion, this study has provided an initial understanding of the requirement needed for SME's to diversify their technologies at the product level. It could act as a basic guide on the necessary steps for SME's to look in before diversifying to a new product or project. More importantly for the SME's is to identify their own capabilities and strengths for them to diversify into technologies that are related to their core competencies as suggested by Corradini et al. [3]. This study could also benefit non-SME's as well as other researchers into improving the requirements of the diversification before adopting to a new technology. In future studies, more determinants could also be explored to provide a more holistic approach in the study of diversification in technologies at the product level in the Malaysian context.

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