**Technology Adoption Readiness and AMT Implementation in Manufacturing SMEs**

Murzidah Ahmad Murad1, Hafini Suhana Ithnin2, and Juhaini Jabar3

1,2,3 Faculty of Technology Management and Technopreneurship, University Technical Malaysia Melaka, Jalan Hang Tuah, 75300 Melaka, Malaysia

**ABSTRACT**

Implementing advance technology within the organization plays a vital rules for speedy the production part and accomplish the customer demand. However, for small company especially SMEs it is hard to be achieve cause of many obstacles including lack of resources, expert manpower and knowledge. The aims for this study was to validate the technology readiness index (TRI) for AMT implementation among manufacturing SMEs. The four technology readiness dimensions, optimism, innovativeness, insecurity and discomfort were replicated in this study. Total of 120 questionnaires were collected among Southern region in Malaysia embraced Melaka, Johor and Negeri Sembilan. The questionnaire were developed based on Parasuraman (2000) previous study. Then the raw data were analysed using Statistical Package for Social Science (SPSS) software examine the two main components which are Exploratory Factor Analysis (EFA) and regression. From the results indicated that innovativeness present the strongest unique contribution (0.338) for the standardized coefficient value.

*Keywords: Manufacturing SMEs, Technology Readiness Index (TRI), SPSS*

**INTRODUCTION**

Many years since independence, Malaysian economy has been mainstay by agricultural sectors. In this era, Malaysia is one of the best establishment in oil palm and cocoa which is contribute about 50% in current GDP (Ahmad & Sunthralingam, 2009). Starting in the mid of 1970’s, due to many investment in service sector together with acceleration in industrialization, agricultural sector become decline. Manufacturing sectors is fully overtook the agriculture begin in 1987 and become the main contribution to the Malaysian economic. This transformation cause the big impact for Malaysian changes from low income country to middle income county starting 1992 until now (Epu, 2015). Manufacturing sector still become domain to the Malaysian economic because of its higher contribution in gross domestic product (GDP) for about 23.0% (Epu, 2015).

In this manufacturing sector, small and medium enterprises (SMEs) are seen as a huge potential for the Malaysian economic due to their development in providing employments, exports and contributions to the GDP. SMEs regarded as the backbone for many developing countries listed as the larger contributor to their GDP (Kee-luen et al., 2013; Jabar, 2012; Khalid, 2012;Cheungsuvadee, 2006**;** Saleh & Ndubisi, 2006**;** Rosnah & Osman, 2004). Moreover, SMEs become the main agenda for developing countries cause of their capabilities in offering job opportunities and also as catalyst for new entrepreneur to started new business.

SMEs can be defined as its major sectors which is manufacturing, service and others. According to (SMEs Corp, 2016) manufacturing can be viewed as sales turnover not exceeding RM50 million or full-time employees not exceeding 200 workers while service and other sectors is clarified to sales turnover not exceeding RM20 million or full-time employees not exceeding 75 workers. Besides that, definition of SMEs can be determined based on its size of operation. It includes small and medium categories. For small manufacturing viewed as sales turnover from RM300, 000 to less than RM15 million or full-time employees from 5 to less than 75 whereas medium manufacturing is when the sales turnover from Rm15 million to not exceeding RM50 million or full-time employees 75 to not exceeding 200. Compared to manufacturing, small service and other sectors defined as sales turnover from RM300, 000 to less than RM3 million or full-time employees from 5 to less than 30 though medium categorize clarified as sales turnover from RM3 million to not exceeding RM20 million or full-time employees from 30 to not exceeding 75.

Growing of manufacturing sector either in huge nor small firms accelerate the use of high technology machineries to support the technical part and also management section. Adoption of technology is more significant towards business operation today. Nowadays technology change has become mode of operation for business community (Afzal *et al*., 2013; Murad & Thomson, 2011) There are many existing technologies that related to the manufacturing sectors. Closed with it is advance manufacturing technology (AMT). Advanced manufacturing technology (AMT) is type of high technology that very useful for production part. Producing bulk of products plus maintaining the standard of product quality required high machinery usage. Adopting AMT is synonym with manufacturing. Its benefits towards production, time taken and energy reduces become a savior to achieve competitive advantage (Jabar & Soosay, 2010).

Adopting high technology might not be a big problem for huge firm but for small firm this is hard to handle. Plus, there are study that indicate more failure in implementing AMT had lower down the intention to adopt it (Murad, 2016; Koc & Bozdag, 2009) The situation is more critical to small and medium enterprise (SME) which is the focus study in this research. Most of them have the intention and strive to adapt with AMT changes but lack of certain information and resources force them ignoring the desire. AMT can be defined as technologies that connected with application of mechanical, electronic, and computer- based systems to operate and control production (Jabar et al., 2017; Koc & Bozdag, 2009). It applied to be one of the key strategies for long term competitiveness. Evidently, it not just a well said. Implementing AMT required high knowledge and crystal clear about the organizational capabilities, technology accessibility and employees availability. Lacking of it will cause huge trouble. Some studies indicates that implementing AMT not fully give benefits to those firm which adopt it. Some may stick cause of the system capabilities (Jabar et al., 2015; Small & Yasin, 1997).

From the above illustration, it may be concerned that this study aims to understand the technology readiness factors that influencing implementation of AMT within manufacturing SMEs. Technology Readiness Index (TRI) was used to utilized the dimensions for implementation include optimism, innovativeness, insecurity and discomfort. The objectives of this research is to explore the readiness factors that contribute to implementation of AMT among manufacturing SMEs due to many SMEs are to do so. Besides, from this four dimensions built up after TRI theory which dimension accounted strongest relationship towards AMT adoption.

**LITERATURE REVIEW**

TRI was used in this study to examine the individual perception towards AMT adoption (Parasuraman, 2000). Within TRI concept it consists of 36 statements that illustrate the hindering or facilitate of technology readiness. Technology readiness is closely related with people behaviour to accept and interact the existing or new types of technologies. Their intention seriously can give high impact towards organization decision process whether to implement or not. This behaviours can be different depends on each individual perception. It can be positive and negative technologies related believe. For this situation in Technology Readiness Index (TRI) Parasuraman (2000) categorized this believe into four dimensions which are optimism, innovativeness, discomfort and insecurity (see [Table 1](file:///C:\Users\user\AppData\Local\Temp\TABLE%20AND%20FIGURE.docx)).

Based on this four dimensions optimism and innovativeness is contributed to the positive implementation technology. Highly tendency towards these two dimensions will result overall agreed and technology readiness closely happens. Besides, for discomfort and insecurity, they act as inhibitors to the technology readiness. Highly score of it will cause failure and technology readiness seems like hard to be happen.

TRI was adopted in many study. Some of the study conducted by Ithnin et al. (2015) and Demirci et al. (2008) observe the customer perception towards the technology adoption and usage. Based on this study technology cannot be accepted if the customer is not fully ready with it. As the result, four dimension that exist in original theory had extend to five dimensions include interactions. It conclude that male are more interest to use the technology while older people are tend to technology refusing.

Some other research was exploring in different cultural issue for adopting technology. In a study conducted by Elliott & Hall (2008) diverse of cultural that exist in American and Chinese student give variant dimension towards technology acceptance. This study come out when the problem arise that Chinese student ere more comfortable to study within their area compare to foreign universities. Later on, the results indicates that Chines student are feeling discomfort and insecurity to technology acceptance while less innovate and optimism.

From this two previous study, it can be conclude that technology readiness is significant to be investigate due to the acceptance of technology are strongly depend on the way people interact and think about the new technology. Moreover, people is also main subject that will make decision whether to accept or deny with technology acceptance. This is why this four dimension of technology readiness index being study in this research. This four individual dimensions presented the independent variables towards readiness factors for implementation of AMT as dependent variables (see [Figure 1](file:///C:\Users\user\AppData\Local\Temp\TABLE%20AND%20FIGURE.docx)).

**METHODOLOGY**

This research deployed quantitative method for data collection that will be used survey instrument obtain from the selected respondent. The questionnaire developed from identified variable in the literature review. Linkert scale technique will be used to measure the items effectiveness. One to five scale will indicate each items in independent and dependent variables. All of the items were developed using the previous study conducted by Parasuraman (2000).

*Population and Sampling*

The level of analysis for this study is on SMEs in Malaysia focusing in only one sector which is manufacturing SMEs. The population of manufacturing SMEs were determined from SMEs Corp (2016). It stated about 37, 861 SMEs are all over Malaysian region. This study was conducted only three main countries located in southern Malaysia included Johor, Melaka and Negeri Sembilan. According to the statistics from SMEs Corp (2016) total of 7, 430 manufacturing SMEs detect within this region. Sampling technique was examine based on Krejcie and Morgan table. Total of 120 questionnaire were managed to collect. This indicates that 33% of response rate were achieved. All the data were recorded in excel program which later the file was transferred into SPSS to conduct the analyses.

**RESULT**

*Extracting and Determining Number of Components*

Total of 120 responses across four variables were extracted to minimize number of components. There are several criteria that need to examine during extracting the number of components. First is Kaiser-Meyer-Olkin (KMO) value with the index range is above 0.6 is a good consider accepted (Tabachnick & Fidell, 2007). Second is the items with low factor loading (< 0.4) and not clump with others components were deleted.

*Undimessionality- People*

From the PCA results, it compute that four components are representing the independent construct actual from the theoretical framework with factor loading as expected. There are two items were deleted (BPS1-when it is called a business, I prefer to talk to a person rather than machines) and (BPO4-i feel confident that machines will follow through with what I instructed them to do) due to unloaded in any group. The results of PCA for TRI dimensions (see [Table 2](file:///C:\Users\user\AppData\Local\Temp\TABLE%20AND%20FIGURE.docx)).

Component 1 reflects to be measuring items for ‘*Discomfort’* factor. Specifically, this item explain the unwillingness to accept the technology. It more feeling like unease, trouble, difficulty and inconvenience with existing of the new technology. One item from another factor which is Insecurity was found to cross-load in Component 1. The item was BPS2 (If I provide information to a machines, I can never be sure it really gets to the right place). However this item was retained. This is because if only one item was combine together in same group it still can consider accepted and the domain items are representing that group. The items in this component show loading from 0.591 to 0.768.

Component 2 composed of item that measure the willingness to try a new technology. Items in this group explain the positive behaviour towards implementing the new technology. Tendency to adapt with technology is high due to characteristic of imaginativeness, creativity and ingenuity. They can see the opportunities while sustain with technology advantages. Items in this group presenting the ‘*Innovativeness’* with the loading received from 0.520 to 0.831.

Component 3 appears to be measure the item that combine together the characteristics to deny the technology acceptance which are discomfort and insecurity. The reason discomfort items merged with insecurity items could be because it illustrated the anxious behaviour and unsure about the technology capabilities. This also can be seen as negative side. In addition, this characteristic feel like standing between two feeling which are to accept or decline the technology. That trait is not convenient with technology availability. Hence, this component has been labelled as ‘*Anxiety’* with item loadings ranged from 0.527 to 0.844.

Component 4 representing items with received loading from 0.618 to 0.819 and the component was labelled as ‘*Optimism’.* Behaviour in this component describe hopefulness and confidence about the future or the successful outcome of something. This could be interpreted of the result of positive contribution and confident with the benefits that promise by technology effectiveness.

*Evaluating Each of TRI Dimensions (Regression)*

In this step determined which variables within this research contributed to dependent variable. It is important to check the standardized coefficient because the value appear of independent variables had been converted to the same scale and this will make it easy to compare each of them. Other than that, this step also evaluating the most significant factors that influence the dependent variable preferable Sig. value is less than 0.05 (0.01, 0.0001, etc.). This test can be done by checking the significant column (see [Table 3](file:///C:\Users\user\AppData\Local\Temp\TABLE%20AND%20FIGURE.docx)).

Innovativeness factor contribute the largest score in beta column which is 0.338. This can be concluded that *Innovativeness* present the strongest unique contribution towards Readiness Factor. Beta value for *Discomfort, Anxiety* and *Optimism* were slightly lower (0.89, 0.96 and 0.151) indicated that they made less of unique contribution.

Next is significant column. From above result *Innovativeness* indicated statistically significant to the Readiness Factors with scored 0.000. Others included *Discomfort, Anxiety* and *Optimism* showed the values greater than 0.05 which means this three factors were not making a significant unique contribution to the Technology Readiness factors. It may due to overlap with other factors in the same independent variable.

**DISCUSSION**

This study centralized on technology readiness factors which according to Parasuraman (2000) can be developed from four main dimensions which are optimism, innovativeness, insecurity and discomfort. The researcher claims that adoption of new ideas and intervention are closely related with the individual perception towards any changes making. Based on this four dimensions from this theory, the main purpose of this study is to examine the readiness factors that contribute to AMT implementation for manufacturing SMEs focuses on the individual insight. Using an abbreviated 16-item of TR scale a set of questionnaire had been prepared and distributed among 120 respondents within manufacturing SMEs in Southern Malaysia.

According to the result, that four dimensions were initially tested through exploratory factor analysis (EFA) using SPSS software. The main purpose of EFA test is too eliminate those items which are not clamping into exact group and reducing those items to form smaller coherent subscales (Pallant, 2011). Other than that is to reduce a large number of related variables to a more manageable number. This step is essential before regression take place. Within this study, EFA result indicates that all the items grouped into four main components but slightly different with the initial framework. Two items known as (BPS1-when it is called a business, I prefer to talk to a person rather than machines) and (BPO4-i feel confident that machines will follow through with what I instructed them to do) were terminated due to unloaded in any group.

Based on EFA result, the main four new components were utilized named *Discomfort, Innovativeness, Anxiety and Optimism. Anxiety* was a new named replacing *Insecurity* component. This happen when the items within *Insecurity* and *Discomfort* components were merged and illustrated the contrast term and definition of individual perception. *Anxiety* viewed as individual perception that standing in the middle of technology adoption. Means that people with this behaviour tend to accept as well as rejected the new upcoming technology.

After the data were screening in EFA analysis then it is ready to be tested using multiple regression. Regression will explain how much the independent variables explained the uniqueness variance in the dependent variable (Pallant, 2011). Constructed on regression outcome, *Innovativeness* loaded onto factor one followed by *Optimism, Anxiety* and lastly *Discomfort.* Since *Innovativeness* reflects to level of how that personal perceives them as the innovators with availability of new technology, in this context, this suggest that implementing AMT for manufacturing SMEs are tend to grab attention implementer that eager to explore new ideas and invention.

Second is *Optimism* which indicated the belief that technology provided potential adopter with increased control, flexibility and efficiency. Accordance with this study framework, people are considering relative advantages of AMT usage compared to traditional forms of production. Clearly, this consistent with previous research by Godoe & Johansen (2012), *Optimism* and *Innovativeness* slightly give impact to perceived usefulness and perceived ease of use. This can be conclude that individual with optimistic about technology will found easy to accept adoption rather than someone less optimistic.

Next is *Anxiety* and followed by *Discomfort.* Having said that, *Anxiety* and *Discomfort* are the two dimensions that shows as the inhibitor to the implementing of advance technology. This is a line with TRI theory that adoption of new technology inclusive both favourable and unfavourable believe (Parasuraman, 2000). In this instance *Innovativeness* and *Optimism* appear more dominants and contribute to greater effect towards AMT implementation compared to this two inhibitor dimensions. Overall, these results, therefore provide an indication that this four dimension developed by Parasuraman (2000) are applicable and useful in term of examining the readiness factors for AMT implementation among manufacturing SMEs.

**CONCLUSION**

As a conclusion, this study aim to examine the technology readiness factors that influencing the implementation of AMT among manufacturing SMEs. Using the TRI theory by Parasuraman (2000), four individual perceptions were tested include optimism, innovativeness, insecurity and also discomfort. From the results found that people with innovativeness are more tendency to adopt with advance manufacturing. This show that, this implementer are eager to be a pioneer with high level of leadership personality. Even though others factors also give impact to AMT implementation but innovativeness contribute domain cause of advance technology adoption.

This study is very significant to the manufacturing SMEs for making due diligence with adopting advance technology. Organization members especially top management team need to explore this characteristics towards others employees perception to accept the new technology embedded into their firms.

**REFERENCES**

Afzal, F., Shakir, M. A., Syed, G., Raza, M., & Muhammad, S. (2013). Motivation of Employees towards the Adaptation of Technology. *European Journal of Business and Management*, *5*(5), 158–165.

Ahmad, T. M. A. T., & Sunthralingam, C. (2009). Transformation and economic growth of the Malaysian agricultural sector. *Economic and Technology Management*, *4*, 1–10.

Cheungsuvadee, K. (2006). Business Adaption Strategies Used By Small And Medium Retailers in an Increasingly Competitive Environment : A Study of Ubon Ratchathani, (December).

Demirci, A., Ersoy, N., van Raaij, E. M., & Schepers, J. J. L. (2008). Technology readiness for innovative high-tech products: how consumers perceive and adopt new technologies. *The Business Review*, 1–9.

Elliott, K. M., & Hall, M. C. (2008). Student Technology Readiness And Its Impact On Cultural Competency, *4*(6), 11–22.

Epu, J. P. M. (2015). *Rancangan Malaysia ke-11 (2016-2020)*. *Unit Perancang Ekonomi, Jabatan Perdana Menteri*.

Godoe, P., & Johansen, T. S. (2012). Understanding adoption of new technologies: Technology readiness and technology acceptance as an integrated concept. *Journal of European Psychology Students*, *3*, 38–52. http://doi.org/10.5334/jeps.aq

Ithnin, H.F., Murad, M. A, & Jabar, J. (2015), Conceptual study of readiness factors for AMT implementation in manufacturing SMEs. International Conference on Technology Management and Tehnopreneurship (IC-TMT 2015)

Jabar, J. (2012). Strategic Technology Alliances, Technology Transfer and the Performance of Malaysian Manufacturers. *Journal of Engineering and Technology (JET)*, *3*, 69-98.

Jabar, J., & Soosay, C. (2010, June). An assessment of technology transfer in Malaysian manufacturers and the impact on performance and innovativeness. In *Management of Innovation and Technology (ICMIT), 2010 IEEE International Conference on* (pp. 983-989). IEEE.

Jabar, J., Karim, M. H. A., Yusof, S. W. M., Murad, M. A., & Khalid, F. A. (2017). Adoption attitude towards the usage of pusher box technology in the rubber industry. *Advances in Social Sciences Research Journal*, *4*(4).

Jabar, J., Soosay, C., Khalid, F. A., Musa, H., & Othm, N. A. (2015). The Role of Strategic Technology Alliances (STA) Towards Organizational Performance in Manufacturing Industry: The Perspective of Developing Countries. *Asian Social Science*, *11*(16), 38.

Kee-luen, W., Thiam-yong, K., & Seng-fook, O. (2013). Strategic Planning and Business Performance : A Study of SMEs in Malaysia Proceedings of 3rd Asia-Pacific Business Research Conference, (February).

Khalid, F. A. (2012). An Empirical Analysis into the Underlying Components Impacting Upon Business Incubation Performance of Malaysian ICT Incubators. *Thesis*, (April).

Koc, T., & Bozdag, E. (2009). The impact of AMT practices on firm performance in manufacturing SMEs. *Robotics and Computer-Integrated Manufacturing*, *25*(2), 303–313. http://doi.org/10.1016/j.rcim.2007.12.004

Murad, M.A. and Thomson, J.D., (2011). The importance of technology diffusion in Malaysian Manufacturing SMEs. 3rd International Conference on Information and Financial Engineering.

Murad, M.A., 2016. *Industrial manufacturing technology diffusion of Malaysian manufacturing Small and Medium Enterprises (SMEs)* (Doctoral dissertation, RMIT University).

Pallant, J. (2011). *SPSS Survival Manual: A Step By Step Guide To Data Analysis Using SPSS* (4th Editio). Australia: Allen&Unwin.

Parasuraman, a. (2000). Technology Readiness Index (Tri): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research*, *2*(4), 307–320. http://doi.org/10.1177/109467050024001

Rosnah, M. Y., & Osman, M. R. (2004). Barriers To Advanced Manufacturing Technologies Implementation In The Small And Medium Scales Industries Of A Developing Country, *1*(1), 39–46.

Saleh, A. S., & Ndubisi, N. O. (2006). An Evaluation of SME Development in Malaysia, *2*(1), 1–14.

Small, M. H., & Yasin, M. M. (1997). Advanced manufacturing technology: Implementation policy and performance. *Journal of Operations Management*, *15*(4), 349–370. http://doi.org/10.1016/S0272-6963(97)00013-2

SMEs Corp. (2016). No Title. Retrieved April 2, 2016, from http://www.smecorp.gov.my/index.php/en/

Tabachnick, B. G., & Fidell, L. S. (2007). *Using Multivariate Statistics*. *PsycCRITIQUES* (Vol. 28). http://doi.org/10.1037/022267

**APPENDICES**

TABLE 1

Technology Readiness Index (TRI) Dimensions

|  |  |
| --- | --- |
| Dimensions | Explanation |
| Optimism | Captured a positive view of technology. They believe that technology provided people flexibility, efficiency and increased control in their daily live (Parasuraman, 2000) |
| Innovativeness | Its liability towards leader characteristics and eager becoming a technology pioneer (Parasuraman, 2000). Level of how that personal perceives them as the innovators with availability of new technology are measure in this dimension. |
| Discomfort | A perceived lack of control over technology and a feeling of being overwhelmed by it. In this dimension the individual feel fear with technology adoption based of previous experiences. |
| Insecurity | Distrust of technology and scepticism about its ability to work properly. The adopter feels hesitation whether this new technology gives bad or good impact. |

TABLE 2

The results of PCA for TRI dimensions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Selection TRI items** | **Component** | | | |
| 1 | 2 | 3 | 4 |
| BPD3-There is no such things as a manual for high-tech product or service that is written in plain language | .768 |  |  |  |
| BPD4-It is embarrassing when i have trouble with a high-tech gadget while people are watching | .638 |  |  |  |
| BPS2-If I provide information to a machines, I can never be sure it really gets to the right place | .591 |  |  |  |
| BPI4-I keep up with the latest technological developments in my areas of interest | .450 | .831 |  |  |
| BPI2-In general, I am among the first in my circle of friends to acquire new technology when it appears |  | .767 |  |  |
| BPI3- I can usually figure out new high-tech products and services without help from others |  | .754 |  |  |
| BPI1-Other people come to me for advice on new technologies | .484 | .520 |  |  |
| BPD2-Sometimes, I think that technology systems are not designed for use by ordinary people |  |  | .844 |  |
| BPD1-Technical support lines are not helpful because they do not explain things in terms that I understand |  |  | .680 | .382 |
| BPS3- Something gets automated, I need to check carefully that the machines or computer is not making mistakes |  |  | .610 |  |
| BPS4-I feel less confident doing production with a place that covered with only high tech machines | .343 |  | .527 |  |
| BPO3-I prefer to use the most advanced technology available |  |  |  | .819 |
| BPO2-Products and services that use the newest technologies are much more convenient to use |  |  |  | .764 |
| BPO1-Technology gives people more control over their daily lives | .415 |  |  | .618 |

TABLE 3

Regression Result

|  |  |  |
| --- | --- | --- |
| Factors | Standardized Coefficients | Sig. |
|  | Beta | Upper Bound |
| (Constant) |  | .001 |
| Discomfort | .089 | .407 |
| Innovativeness | .338 | .000 |
| Anxiety | .096 | .322 |
| Optimism | .151 | .131 |

FIGURE 1

Theoretical Framework

AMT Readiness of Manufacturing SMEs

Discomfort

Insecurity

Innovativeness

Optimism