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Technology adoption decision among food manufacturers: What are the critical factors?

(Keputusan mengguna pakai teknologi dalam kalangan pengilang makanan: Apakah faktor kritikal?)

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Keywords: technology adoption decision, innovation, factor analyses, food manufacturers

Abstract

Technology is one of the enablers that can help firms improve their performance. Firms with high technology adoption will have a huge competitive advantage over their competitors. Among the advantages of using technology are improve product quality, gain more productivity, slash production error and boost profit. Most of the SMEs are well aware about these advantages. However, the adoption rate among the SMEs in Malaysia is still below the target, hence the technology usage among them must be increased. This study was conducted with the aim to identify the critical factors that affect technology adoption decision. The SMEs food manufacturers formed the entire samples of this study. Primary data was collected from 124 firms through face-to-face interview. The data was analysed using descriptive and factor analysis. The results obtained suggest that technology adoption decision among the firms surveyed is influenced by four factors namely readiness and information availability, support instrument, financial and perception.

Introduction

Competition is a common issue in the business world. The increase in competition has always been viewed as one of the challenges where a firm needs to strive for excellence in order to maintain their sales, market shares and customers. Sometimes this effort is seen so difficult with the emergence of the recent global economic concept which stresses more on the firm's ability to innovate, to capture global level of manufacturing efficiency and to understand international marketing and the diversity of the world's market (Rockart and Short 1989). The pattern of economic competition has changed drastically. Before this, production factors were the main things that need to be focused by a firm. However, now a firm needs to struggle more because their performance is not only depends on capital or workers, but may also be influenced by several other factors such as technologies used, product range, market penetration as well as its management practices. Among these key elements, technology has greater impact towards the firm sustainability and

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competitiveness (Syahida 2008). Technology can be considered as a core element in the manufacturing industry. Firms with high technology adoption would have a greater competitive advantage over their counterparts with lesser technology usage. Improving product quality, gaining higher productivity, slashing production error and boosting profit are the advantages of technology adoption (Norani et al. 2008).

When talking about technology adoption, some firms may have certain perception. Most commonly, they perceived that using technology will be incurred with certain cost. As such, they need to allocate certain amount of money in order to acquire the technology. This is true because some technologies may need high investment and of course firm should have enough capital to position themself as 'hi-tech firm'. In most cases, investment of new technology not only incurs cost, but also demands for specially trained resources (Murzidah and John 2011). Those firms with stable financial condition will have no problem taking this challenge, but to those who are unable to cope will stay with their factory operations, keep using the traditional way or relying intensively on labour workers. Consequently, they are unable to compete effectively or grasp the opportunity as being offered by the economy. This is usually happen among the micro enterprises so called backyard company. Unfortunately, the biggest number of Small and Medium Enterprises (SMEs) still cannot overtake the record made by the large company (LC) in term of productivity level. The difference of productivity levels between SMEs and LC is so obvious where the average productivity of SMEs is around RM47,000 which is about one third (RM148,000) of the productivity by LC (SME Master Plan 2012 – 2020).

In term of the awareness, Zaya (2005) founds that most of the manufacturing companies are well aware of a wide range of technology that available to them. However, only few technologies are adopted as stated by Asgary and Wong (2007). This probably happen due to certain factors. Among the external factors ever cited include customer demand and supplier perspective (Burca et al. 2005), competitors, suppliers and customers (Scupola 2003), competitive pressure, external support and incentive (Sadowski et al. 2002) as well as market condition and competitor (Chengalur-Smith and Duchessi 1999). Similarly, Murzidah and John (2011) found that customers, competitors, government regulation and economy are the factors that hinder technology adoption among manufacturers in Malaysia. In agricultural sector, farmers perception toward technology, age of farmers and farmer experience are the main reasons for not adopting technology (Truong and Ryuichi 2002). Study on information communication technology (ICT) shows that the level of ICT adoption among SMEs owners in Malaysia is lower than the expected level. One of the reasons that contributes to this situation is lack of skill and knowledge in ICT (Junaidah 2007). Mirmahdi and Khairuzzaman (2012) suggest 10 factors that are grouped into three dimensions namely environmental context, organisational context and technological context. The identified factors were external pressure, supplier support and financial resources; organisational structure, organisational culture, manufacturing strategy, human resource practice and top management; perceived benefits and technology-in-use. Findings by Kumlachew (2015), variables such as firm size, certification, competition, employee technical skill, financial resources and government supports were identified as the factors influencing technology adoption decision among manufacturing firms. Our study is more specific where the objective of this study is to determine the critical factors affecting technology adoption decision among SMEs in food manufacturing.

Food manufacturing industry

The Malaysian food manufacturing industry is dominated by SMEs which represent

80% of total establishment in processed food segment. This industry comprises of a variety of processing activities covering cocoa and cocoa preparations, prepared cereals and flour preparation, fisheries, livestock and dairy products, vegetables and fruits, and other segments (Suwardi et al. 2012). Currently, the industry's key growth areas are functional food, health food, convenience food, food ingredients and halal food. Due to the interruption by external factors such as rising production costs, technological developments and shifting demand patterns, this industry has already going through numerous changes (Kartinah and Rabaah 2013).

The SMEs food manufacturers have certain characteristic which differentiated them from the large scale. They are organised as a family business and operate under a simple organisation structure. The location of the firms tends to be scattered. Usually they are found in both rural and urban areas, although some have been relocated in industrial areas (Ghani 1995). Despite the great potential for expansion in the food industry, they have some difficulties which restricted the SMEs food manufacturers from tapping this opportunity. They are facing micro and macro challenges as the industry deals with various stakeholders along the food chain starting from farmers, suppliers, policy makers, manufacturers, transportation services, retailers, wholesalers and finally the consumers. Insufficient supply of good quality raw material, low level of technology, lack of skill labour, management problem and difficulty in securing finance are the major challenges faced by them (Suwardi 2013).

What is technology?

The term technology is universal. In fact it has various definitions. Technology can be defined as the ability to carry out productive transformation which includes the ability to act, competency to perform and transform materials, energy and information for value added purposes (Metcalfe 1995). A practical definition of technology related with a system of knowledge, techniques, skills and expertise used to produce, commercialise and utilise goods and services that satisfy economic and social demands. However, in simple words, technology means a powerful tool in gaining competitive advantage (Twiss and Goodridge 1989). Technology can be recognised and observed through the creation of a tangible product like machinery, equipment, vehicle and others. However, there are also some technologies which are intangible in nature like information, knowledge, skill and expertise. Considering that characteristic, both types of technology will be focused in this study.

The adoption of technologies will contribute efficiently and effectively towards the development of competitive Malaysian industries (Ninth Malaysia Plan 2006). SMEs that have the abilities to utilise technology can render their competitiveness and sustainability (Kuan and Chau 2001). However, the adoption rate among the SMEs needs to be increased (Abdullah 2002). Despite having the policy pertaining to technology adoption, the trend continues to focus on encouraging innovation and not on the diffusion of technology, while managing the process of technology diffusion is imperative to ensure the implementation of technology (Rogers 2003). However, the situation shows that the adoption of technology among the SMEs is very small even though they are aware of the potential benefits of using it (Rosnah et al. 2005).

Diffusion of innovation

Diffusion of innovation refers to the process by which an innovation is adopted by members of a certain community. It has been popularised by Rogers (2003). He explains how the innovation is adopted through four major theories namely (1) innovation decision process theory, (2) individual innovativeness theory, (3) rate of adoption theory, and (4) theory of perceived attributes.

Innovation decision process theory

Innovation decision process is the process which an individual (or other decision making unit) passes through from first knowledge of an innovation, to form an attitude toward the innovation, to a decision to adopt or reject, to implement the new idea and to confirm this decision. There are five stages in the process namely knowledge, persuasion, decision, implementation and confirmation. Knowledge occurs when an individual is exposed to the innovation's existence and gains some understanding on how it functions. Persuasion (attitude formation) occurs when an individual forms a favorable or unfavorable attitude towards the innovation. Decision occurs when an individual engages in activities that require him to choose whether to adopt or reject the innovation. Implementation occurs when an individual puts an innovation into use and confirmation occurs when an individual seeks reinforcement of an innovation decision already made, but he or she may reverse the previous decision if exposed to some conflicting messages about the innovation. According to this theory, it will take longer time to adopt certain technology because the user needs to go through each stage in order to search, verify and built confidence towards the technology. This is the reality that happens among the SMEs.

Individual innovativeness theory

This is about who adopts the technology and when. The adopters can be differentiated by five categories namely innovators, early adopters, early majority, late majority and laggards. There are risk-takers and pioneers who lead the way. They are willing to adopt that technology despite their awareness about the uncertainty during the adoption time and also willing to accept an occasional setback when the innovation fails. This characteristic refers to innovators. Early adopters refer to those who explore the new ideas and spread the word about the innovation to others. The third category is early majority where they are influenced by innovators and early adopters. Their innovation decision period usually takes longer time than the first two. The fourth group called late majority where they are very cautious toward innovation. They will adopt the technology after others have done so. The last group is called laggards and this group was highly skeptical and resists adopting until absolutely necessary. The percentage of individuals who adopt an innovation can be illustrated using bell shaped curve (*Figure 1*).

The rate of adoption theory

The rate of adoption is the relative speed with which an innovation is adopted by members of a social system, measured as the number of individuals who adopt a new technology in a specified period. The rate of adoption is influenced by perceived attribute of innovations, type of innovation decision, communication channel, social system and change agents. Perceived attribute consists of five attributes namely relative advantage, compatibility,

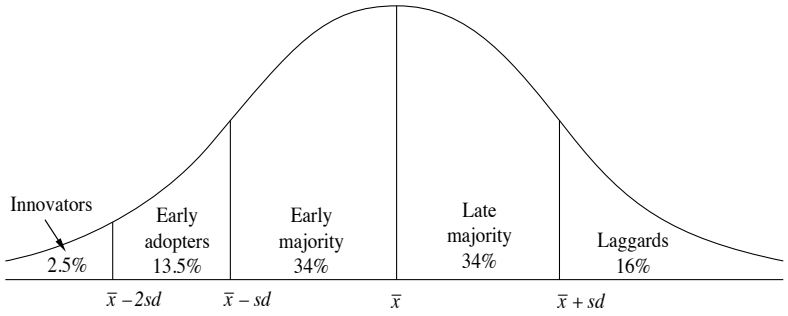

Figure 1. Categories of adopters

complexity, trialability and observability. Innovation decision means how fast certain technology will be adopted. Suggesting few individuals involved in decision making will speed up the adoption process. The three types of decision are optional, collective and authority. Communication channel can be mass media or interpersonal, and need to use appropriate communication channel to boost up the adoption rate depending on the degree of complexity of innovation. Norms, degree of network and interconnectedness are the natures of the social system that play an important role toward the adoption rate. High promotion effort by change agents also can increase the adoption rate of certain technology.

Theory of perceived attributes

This theory suggests that technology will be adopted if it has the certain attributes that acquired by the adopters. Technology also must have some relative advantage over an existing technology or status quo, and technology must be compatible with the existing values, past experience and practices of the potential adopters. Technology also cannot be too complex or perceived as difficult to understand, must have trialability (where it can be tested for a limited time without adoption) and must offer observable results.

Materials and method

This study used both primary and secondary data sources. The primary data were gathered through face-to-face interviews using structured questionnaires. The questionnaires were developed based on previous studies and contained the variables pertaining to the respondents' background, firms' characteristic and a set of 15 statements which was used to measure how far each obstacle will influence the respondent's decision in adopting technology. As for measuring purposes, a Likert Scale of 1 to 5 (1 representing no influence and 5 representing high influence) was used. The sample was selected randomly from MARDI's entrepreneur list which contains SMEs food manufacturers. In term of the factory operation, some of them already have semi-automated or automated lines, while some of them still use small equipment. They have different demographic backgrounds and company profiles. Referring to the food processing technology, normally they will approach MARDI for advice and suggestion. As for this study, a total of 124 companies were surveyed.

Data captured were analysed using both descriptive and factor analysis. Variables such as respondents' demographic and company profile were described using descriptive analysis, while factor analysis was performed in order to determine the underlying factors that might influence respondents' technology adoption decision. The factor analysis was conducted using the principal component method. Relevant factors were extracted by varimax method. The criterion for the number of factors to be extracted was that the eigenvalue of each factor had to be equal or greater than one.

Result and discussion

Respondent background and firms' characteristic

Majority of the respondents surveyed are Malays (88.7%) followed by Chinese (6.5%) and others (4.8%). About 53.2% of the respondents are male and majority of them (34.1%) are in the age group of 46 and 55 years. More than half of the respondents (56.3%) are involved in food processing activities for ten years and below while some of them (17.7%) exceeded 21 years. This indicated that majority of the respondents had some experiences in their businesses. In term of the educational level, about 45.2% claimed that they had tertiary education followed by secondary education (47.6%) and primary education (4.0%). Most of the respondents (47.6%) stated that they are responsible in suggesting, identifying and making decision in adopting certain technology (*Table 1*).

In term of firms' characteristic, this study revealed that most of the firms

Table 1. Demographic data of the respondents (n = 124)

	Percentage
Race	
Malay	88.7
Chinese	6.5
Others	4.8
Gender	
Male	53.2
Female	46.8
Age (year)	
<25	4.9
26 – 35	20.3
36 – 45	29.3
46 – 55	34.1
>55	11.4
Experience (year)	
<5	28.6
6 – 10	27.7
11 – 15	16.8
16 – 20	8.4
>20	18.5
Education	
Primary	4.1
Secondary	48.0
Tertiary	47.9
Responsibility (regarding technology adoption)	
None	0.8
Give suggestion	4.1
Give suggestion and identify technology	25.2
Make decision and approval	22.0
Give suggestion, identify technology, make decision and approval	48.0

Table 2. Firm characteristic (n = 124)

	Percentage
Form of business	
Sole proprietorship	44.4
Partnership	12.1
Private limited	43.5
Firm age (year)	
<5	10.2
6 – 10	38.1
11 – 15	22.0
16 – 20	13.6
>20	16.1
Annual sale value (RM)	
<500,000	50.8
500,001 – 1,000,000	18.0
1,000,001 – 1,500,000	7.4
1,500,001 – 2,000,000	5.7
>2,000,000	18.0
Investment (RM)	
<100,000	23.7
100,001 – 500,000	45.8
500,001 – 1,000,000	13.6
1,000,001 – 1,500,000	2.5
>1,500,000	14.4
Workers	
<10	43.9
11 – 20	23.6
21 – 30	10.6
31 – 40	8.1
>40	13.8

(38.1%) are operated between 6 and 10 years. Only 16.1% of the firms are operated for 21 years and above (*Table 2*). The annual sales value of the firms ranged between RM12,000 and RM23 million, with an average of RM1,641,852. Majority of the firms (50.8%) had annual sales value of RM500,000 and below, while another 18.0% of the firms recorded annual sales value for more than RM2 million. Based on the annual sales value, it can be assumed that some of the firms surveyed do have stable financial condition. Referring to capital distribution, about 16.9% firms have current investment over RM1 million. As usual, higher investment always associated with firm capability in term of technology usage. This study also revealed that majority of the firms (43.9%) have 10 workers and below while 13.8% employ more than 40 workers. Sole proprietorship and private limited are common types of business entity where both accounted for 44.4% and 43.5% respectively.

Classification of workers

Workers are the asset of a firm. *Table 3* highlights the distribution of workers in several classifications. As for management and administrative positions, majority of the firms have less than five workers while for important positions that are related to technology such as technical and semi technical, majority of the firms do not have any worker for this position. However, there are other 4.1% and 1.6% of

Table 3. Percentage of workers classification (n = 124)

	Percentage
Management	
<5	95.1
>5	4.9
Administrative	
<5	90.2
>5	9.8
Technical	
0	76.4
1 – 2	19.5
3 – 4	4.1
Semi technical	
0	80.5
1 – 2	17.9
3 – 4	1.6
Operator	
<10	68.2
11 – 20	21.8
>20	10.0

the firms which had three to four workers for technical and semitechnical respectively.

Factor affecting technology adoption decision among the respondent

Prior to running factor analysis, the Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) test were performed on the statement to confirm sampling adequacy and the appropriateness of conducting factor analysis. The KMO test value for the set of predetermined variables obtained was 0.763 (*Table 4*) which indicates that the sampling adequacy and factor analysis can be carried out using the 15 statements stated earlier.

As shown in *Appendix 1,* technology adoption decision among the respondents was affected by four latent factors. These factors had the eigenvalues greater than unity while total variance explained was 58.324%. Each of the factors is named based on the variables loaded within the factor as follows:

i. Readiness and information availability

This factor consists of four variables and had a total variance of 27.730%. The workers acceptance toward the technology have the highest factor loading (0.755), then followed by qualified and skilled workers (0.747), information regarding the technology to be used (0.681) and firm planning and strategy (0.638). The result for this factor suggests internal environment as the main determinant of technology adoption decision and their decision would be directly affected by worker as well as information availability pertaining the particular technology.

Table 4. Kaiser-Meyer-Olkin and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy	0.763
Bartlett's test of sphericity	522.367
Significance	0.000

ii. Support instrument

This factor had a total variance of 12.130% and record significant loading on three variables namely bank interest rate as the highest loading (0.808). This is followed by bank financing facility (0.776) and tax rebate (0.631). This factor shows that apart from internal concern, external situation would also be another factor that influence the firms' decision. Most of the SMEs were micro-based and they rely heavily on availability of the financial facilities or incentive provided.

iii. Financial

This factor comprises of three variables with total variance of 10.247%. The highest loading recorded on the cost to use the technology (0.844), assumption of economic risk (0.738) and firm financial capability (0.602). For most of the technology being identified, the SMEs evaluated the cost of that particular technology and compared with their financial capability. Sometimes they also make projection in order to predict the viability of the technology based on current economic situation.

iv. Perception

This factor had a total variance of 8.216% and consists of two variables namely suppliers view and suggestion (0.755) and perception toward the technology to be used (0.646). In some circumstance, awareness and decision toward certain technology was affected by outsiders such as suppliers that dealt closely with them and the perception toward the advantage of particular technology that would determine their decision.

Conclusion

The exploratory factor analysis helps to identify the critical factors that affect technology adoption decision among the respondents surveyed. From the results obtained, it can be concluded that the SMEs food manufacturers' decision towards technology adoption were affected by four factors namely readiness and information availability, support instrument, financial and perception. Surprisingly, readiness and information availability factors are found as the more critical factors compared to the financial factor which is ranked as the third in this study. The possible reason for this situation could be the characteristic of the firm itself, where majority of the firms had no workers in charged for technical and semi technical position. Generally, technical people are required, especially for the firms that are using machinery and equipment in their factory operations. Machinery may have operators, however their tasks only involved day to day operation, not to troubleshoot problems. Hence, this would be a challenge for the SMEs food manufacturers, particularly to those who have intention to adopt technology. Besides that, decision on technology adoption also influenced by availability of information in the market. As for this situation, each of the technology producer and SMEs must be aggressively promotes and search information.

The second and third factors are describing similar thing which is financial. Regarding this aspect, government involvements in introducing and facilitating various programmes through various agencies are needed to assist SMEs. The agencies are responsible to disseminate and communicate with the SMEs about what they have as well as their roles and functions. This effort must be carried out continuously so that more SMEs will be benefited. This is because some of the SMEs out there are still not familiar with the agencies' latest programmes. The same goes to financial institutions which are responsible as financial providers. They should facilitate the SMEs and not to burden them with too much rules, term and condition. Hence, their service policy must be adjustable and the product offered should also be up-to-date and relevant with current situation. Other thing that can be done is to promote internal R&D among the SMEs and nurture it as a corporate culture. The R&D institution can help them by establishing research collaboration. This type of engagement can help them use technology that suits with their requirement witch lesser cost. Since Malaysia has implemented the goods and services tax (GST) on consumers, all expenses need to be considered including firms' capital expenditure.

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Abstrak
Teknologi merupakan salah satu pemangkin yang boleh membantu meningkatkan prestasi firma. Firma yang mengguna pakai teknologi tinggi mempunyai kelebihan persaingan yang besar berbanding dengan pesaing mereka. Antara kelebihan menggunakan teknologi adalah meningkatkan kualiti produk dan produktiviti, mengurangkan kecacatan produk dan merangsang keuntungan. Kebanyakan PKS menyedari semua kelebihan ini. Walau bagaimanapun, kadar penggunaan teknologi dalam kalangan PKS di Malaysia masih di bawah sasaran. Ini bermakna penggunaan teknologi dalam kalangan mereka perlu ditingkatkan. Kajian ini dijalankan dengan tujuan untuk mengenal pasti faktor kritikal yang mempengaruhi keputusan mengguna pakai teknologi. Pengilang makanan PKS membentuk keseluruhan sampel kajian ini. Data primer dikumpul daripada 124 firma melalui temu bual bersemuka. Data dianalisis dengan menggunakan analisis deskriptif dan analisis faktor. Hasil kajian yang diperoleh mencadangkan keputusan mengguna pakai teknologi dalam kalangan firma dipengaruhi oleh empat faktor iaitu kesediaan dan kedapatan maklumat, instrumen sokongan, kewangan dan persepsi.

Appendix 1. Result of the factor analyses

	Factor loading			
	F1	F2	F3	F4
Readiness and information availability				
• Worker acceptance toward the technology	0.755			
• Qualified and skilled worker	0.747			
• Information regarding the technology to be used	0.681			
• Firm planning and strategy	0.638			
% of variance explained	27.730			
Support instrument				
• Bank interest rate		0.808		
• Bank financing facility		0.776		
• Tax rebate		0.631		
% of variance explained		12.130		
Financial				
• Cost to use the technology			0.844	
• Assumption of economic risk			0.738	
• Firm financial capability			0.602	
% of variance explained			10.247	
Perception				
• Supplier view and suggestion				0.755
• Perception toward the technology to be used				0.646
% of variance explained				8.216
Total variance explained (%)				58.324