STRATEGIC TECHNOLOGY ALLIANCES, TECHNOLOGY TRANSFER AND THE PERFORMANCE OF MALAYSIAN MANUFACTURERS

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ABSTRACT

Organizations are realizing the strategic importance of technology alliances to enhance and maintain their competitive advantage. The turbulent business environment compels firms to adopt appropriate technologies for effective and efficient operations. While many firms are inclined to source external technology or form alliances, there are various considerations that can affect the success of such initiatives. This study examines the relationship between factors enabling strategic technology alliances (STAs), technology transfer and organizational performance. Based on three theories namely: Resource-based View (RBV); Organizational Learning Theory (OLT); and Technology Acceptance Model (TAM), this paper presents a model on the antecedent and outcomes of STA that is analyzed using structural equation modeling (SEM). The findings depict that absorptive capacity, type of alliances; relative advantage and perceived ease of technology implementation affect the alliance, which in turn determine organizational performance. Further tests show that technology transfer only partially mediates the relationship between STA and organizational performance. This research provides platforms and consideration for the implementation of new technologies and capabilities in manufacturing firms in a developing nation.

KEYWORDS*: Strategic technology alliances, technology transfer, firm performance, Malaysian manufacturing*

1.0 INTRODUCTION

Production success and survival are becoming more unpredictable with the emergence of new markets and competitive products. The transformation of technology and innovation has significantly impacted many manufacturing businesses in terms of their operations and strategy in the global marketplace (White and Bruton, 2007). One area of concern facing manufacturing organizations is the pressure to effectively manage their technology and decide whether to innovate internally or acquire external knowledge and technological capabilities from other local or foreign firms (Di Benedetto *et. al.,* 2003), (Lee and Tan, 2006), (Majumdar, 2009). There are various benefits which organizations can gain from undertaking internal innovations; such as radically changing their business goals, technologies, products and processes (McKeown, 2008). However, internal innovation requires the knowledge and technical expertise, that can be costly, time consuming and susceptible to failure (White and Bruton, 2007). Furthermore, there are also risks of first-mover advantages and swift competition. In order to overcome such uncertainties, many firms are increasingly forming alliances with local and foreign companies to acquire external technology (Guan *et. al.,* 2006), (Kumar *et. al.,* 1999).

It is well acknowledged in the literature that developing countries generally lack the resources and capabilities to implement their own R&D activities (Erensal and Albayrak, 2008); and many organizations view technology transfer as a strategy to stay abreast (Kristinsson and Rao, 2008). To facilitate effective technology transfer, organizations from developing countries tend to form alliances to acquire the latest technologies for their manufacturing (Ju *et. al.,* 2005), (Schaan and Kelly, 2006). This is evident in Malaysia, where the government has sanctioned for international collaboration in up-scaling the manufacturing industry towards higher value-adding activities and in upgrading the industry's technological capabilities. The aim is to transform industrial businesses into strong knowledge-intensive and value-creating entities capable of producing their own technologies (The Economic Planning Unit, 2006). By combining resources with other firms, these organizations can access the latest production technologies (Pateli, 2009), (Verspagen and Duysters, 2004) and innovative processes that are beneficial and easily utilized (Di Benedetto *et. al.,* 2003) to enhance their technological capabilities.

An increasing number of alliances have been formed globally, indicating the significant efforts by organisations around the world to augment their technical capabilities (Hagedoorn and Sedaitis, 1998), (Norman, 2004). Usually, studies on alliances in high-technology organisations have been limited to developed countries - for example, studies on STAs have been conducted mainly in the US (Hagedoorn *et. al.,* 2001), (Norman, 2004), (Rothaermel and Deeds, 2006), (Soh and Roberts, 2005), (Ybarra and Turk, 2009). Studies on STAs have also been conducted in Finland (Vilkamo and Keil, 2003), Italy (Colombo *et. al.,* 2006), Greece (Pateli, 2009) and in transition economies such as Russia (Hagedoorn and Sedaitis, 1998). Currently, research on STAs is increasing in developing countries such as Taiwan (Ju *et. al.,* 2005), (Tsai and Wang, 2009) and China (Chen and Wang, 2009). Generally, however, developing countries are lacking in resources and capabilities to embark on R&D activities to produce their own technologies (Lee and Tan, 2006). This deficiency encourages developing countries to find suitable strategies to acquire and adopt external technology through STAs to compete in the global market (Abdul Wahab *et. al.*, 2009). Apparently, it is felt that there is still limited research conducted on STAs in developing countries (Abdul Wahab *et. al.*, 2009).

This study extends existing knowledge by examining the factors that enable STAs, technology transfer and organizational performance in Malaysian manufacturers. It draws on four theories: Resource-based View (RBV); Organizational Learning Theory (OLT); and Technology Acceptance Model (TAM) to develop a framework to analyze the antecedents of STAs and the impact on organizational performance of manufacturing firms in a developing economy. Having an integrated approach from various perspectives can provide cumulating efforts within the field of interest and lead to better discernment with greater explanatory power.

2.0 LITERATURE REVIEW

2.1 Resource availability

The resource-based view (RBV) regards firms as collections of resources that include tangible assets and intangible capabilities (Barney, 1991), (Grant, 1991), (Peteraf, 1993), (Peteraf, 1984). This collection of resources must be simultaneously *valuable, rare, imperfectly imitable, and non-substitutable* (sometimes referred to as VRIN) (Barney, 1991); and are also the firm's source of sustainable competitive advantage (Das and Teng, 2000). Firms will engage in STAs when there is a need for additional resources, specifically involving technology that are expensive and difficult to replicate in a certain timeframe (Eisenhardt and Schoonhoven, 1996); and can enhance the value of their existing resources (Das and Teng, 2000). From this perspective, firms adopt alliances as a means to extend resources, specifically involving technology that are expensive and difficult to replicate in a certain timeframe (Eisenhardt and Schoonhoven, 1996); and can enhance the value of their existing resources (Das and Teng, 2000). From this perspective, firms adopt alliances as a means to extend their collection of value-creating resources, which are otherwise unattainable independently. Hence this study defines resource availability as the organization's tangible assets as well as intangible assets which include technology and knowledge embedded in product material, physical assets, processes and production, and management capabilities.

Firms are constantly seeking alliance partners who possess the critical resources desired (Gulati *et. al.,* 2000). Such resources are usually specific, rare and not obtainable from others (Barney, 1991), such as tacit knowledge of the technology (Nagarajan and Mitchell, 1998), managerial skills (McGee *et. al.,* 1995) and local market knowledge (Zhan *et. al.,* 2009). Firms that are in a vulnerable strategic position tend to view large firms as potential valuable partners (Eisenhardt and Schoonhoven, 1996) because they generally possess the latest technologies and skills which smaller firms cannot acquire by themselves (Colombo, 1995), (Santoro and Chakrabarti, 2002), (Stuart, 2000). Furthermore, the literature reinforces that organizations seek complementary resources when forming alliances (Chung *et. al.,* 2000), (Colombo *et. al.,* 2006) or aim to broaden their knowledge and learning skills (Hamel, 1991), (Kogut, 1988), (Nagarajan and Mitchell, 1998). The acquisition of new knowledge through alliances is known to enable firms to combine and internalize their partner's knowledge to develop technological competencies (Colombo *et. al.,* 2006). It can be established that firms lacking complementary resources would have higher tendencies to form STAs in order to access the resources they desire. Hence the following hypothesis is posited:

H1: The organization's resource availability is negatively related to the formation of a strategic technology alliance.

2.2 Organizational learning

The literature establishes that organizational learning is an important means for competitive advantage (Drejer, 2000) as this type of learning involves tacit knowledge transfer (Lane and Lubatkin, 1998), (Mowery *et. al.,* 1996). In manufacturing and technology alliances, this trait is conducive for two-way learning where production knowledge, skills and expertise can be exchanged. Organizations from developing nations benefit from learning new methods and processes to develop technological capabilities, whereas organizations from more developed markets are more interested in knowledge of the local market and their partners' unique capabilities (Hitt *et. al.,* 2000). Learning through the experience of partners is found to be an effective form of collaboration (Dussauge *et. al.,* 2000).

Cohen and Levintal (1990) define absorptive capacity as the utilization of a firm's previous knowledge to identify and value new external information while incorporating and applying the knowledge for the firms' commercial advantage. These authors suggest that learning abilities are influenced by the organization's environment. When there are similarities between alliance partners (e.g. in terms of organizational culture, technology, resources and experience) there will be higher absorptive capacity for more effective learning and knowledge transfer (Cohen and Levinthal, 1989, 1990). The information and knowledge transferred are usually tacit and socially complex and the ingenuity to exploit these could result in better performance and higher revenues. Moreover, organizations that are competent in learning and acquiring valuable resources will tend to be more successful in technological alliances. Therefore it is hypothesized that:

H2a: The organization's absorptive capacity is positively related to the formation of a strategic technology alliance.

Learning in alliances is also influenced by the alliance characteristics. The study by Dussauge *et. al.,* (2000) reveals that learning outcomes depend on the type of alliances, coupled with the opportunities they bring. The type of alliances can enhance or impair learning objectives – for instance, various authors acknowledge greater learning opportunities in joint ventures and equity alliances, as compared to non-equity alliances (Anand and Khanna, 2000), (Shenkar and Li, 1999), (Simonin, 2004). Empirical findings depict that firms in equity-based collaborations ensure that they reap effective learning and profitable investments; while other studies illustrate that international joint ventures do not always lead to enhanced firm performance (Hastings, 1999), (Peek *et. al.,* 1999). However this type of collaboration can create new knowledge and competencies that will eventually lead to innovation and competitive advantage (Bakerma *et. al.,* 1997), (Tsang, 2002). In relation to this, Anand and Khanna (2000) emphasize the value creation through learning in joint ventures compared to licensing agreements; where joint ventures are more complex and deal with higher ambiguity. Additionally Anand and Khanna (2000) also indicate that the impacts of learning are especially stronger in R&D joint ventures when compared to other forms of joint ventures. This signifies that the form of alliance can impact the realization of organizational goals. We argue that firms with high-technological uncertainty will need to reconsider the nature and form of technology alliances. Consequently, this study hypothesizes that:

H2b: The type of alliance is positively related to the formation of a strategic technology alliance.

Continuous organizational learning enables adapting to changes in the business environment while improving existing business practices, through effective allocation of resources, enhancing employee skills and learning potential, and implementing a sound corporate strategy (Gupta and Thomas, 2001). This indicates the importance of an encouraging learning environment to ensure successful organization learning through alliances. Simonin's study (2004) establishes that the learning intent may be impaired by alliance partner's knowledge protectiveness and the ambiguity surrounding the learning environment. Norman (2004) emphasizes the importance of learning and trust for knowledge sharing and transfer. Firms tend to be more protective of their knowledge when partners have high learning intent, however they will lower their guard with trusted partners. These discussions illustrate that the environment surrounding a firm is an important factor influencing the intention to form alliances and at the same time can influence learning outcomes of alliances formed. The term 'environment' in this study may include alliance network (Gulati, 1999), relationship between partners (that includes trust) (Norman, 2004), adjusting to the local environment (Bakerma *et. al.,* 1996), and other factors that may influence the alliance outcomes. Therefore it is hypothesized that:

H3c: The organization's learning environment is positively related to the formation of a strategic technology alliance.

2.3 Innovation adoption

Organizations constantly need to stay abreast with the rapidly changing technological environment, and as an alternative to internally developing new innovations, an expeditious means to implement new manufacturing solutions is to acquire technology from external sources through collaborative agreements. Results from Hung and Tang (2008) depict that technological relevance is positively related to the formation of joint ventures; where the technological relevance is perceived to be greater by both transferor and transferee, the likelihood of firms forming joint ventures to acquire the technology will also increase. Consistent to this, Chau and Lai's (2003) study found that Internet banking customers would like more integrated services after the perceived usefulness of such services has been realized. The perceived ease of use was found to be the most vital reason affecting the decision to adopt the new Internet banking technology (Chau and Lai 2003).

Based on the technology acceptance model (TAM), this study proposes that the perceived relative advantage and perceived ease of use will determine the decision to adopt a certain innovation. Relative advantage is generally the principal motivation for technology adoption through STAs. Higher levels of complexity would infer more time and effort to understand and implement the technology. Therefore a technology that is relatively easy to use is more attractive. As a result, this study demonstrates that:

H3a: The perceived level of relative advantage of an innovation is positively related to the formation of a strategic technology alliance.

H3b: The perceived level of ease of use of an innovation is positively related to the formation of a strategic technology alliance.

2.4 Organizational performance

There are various performance measures used to assess the outcomes of alliances. This is because research on alliance performance is complex as collaborations are based on multifaceted objectives (Evans, 2001). Past studies indicate that firms forming alliances will experience superior performance in terms of new product development (Lee, 2007); return on assets and investments (Goerzen, 2007); level of efficiency and learning (Nielsen, 2007); alliance partner satisfaction (Judge and Dooley, 2006); product, market and financial performance (Jones *et. al.,* 2000); profitability (Hagedoorn and Schakenraad, 1994); and innovation (Ahuja, 2000). Therefore it is hypothesized that:

H4: Strategic technology alliances will lead to positive organizational performance.

2.5 Technology transfer

Technology acquisition is a strategy for acquiring the most current manufacturing methods, processes, applications, equipment and machinery; and to overcome obsolescence due to rapid technological progress. This is practiced by manufacturing organizations in developing countries to stay competitive (Kristinsson and Rao, 2008), (Majumdar, 2009) and ensure long-term economic performance (Erensal and Albayrak, 2008). Successful technology transfer occurs when the technology transferred is significant to the organization's technological knowledge (Pisano, 1990), (Yasuda, 2006), and this is commonly done through STAs (Abdul Wahab *et. al.,* 2009). Based on this argument the following is posited:

H5: Strategic technology alliances will lead to positive technology transfer.

Technology transfer can attain outcomes such as avoiding the costs of internal innovation (Noori, 1990), attaining rapid growth (Granstrand *et. al.*, 1992), accessing the latest technology (Jones *et. al.*, 2000) and satisfying market demand. This also enhances technological knowledge (Cohen and Levinthal, 1989), (Huber, 1991), capabilities (Jonash, 1996) and organizational performance as a result. Technology acquisition through alliances also transfers partners' technological and manufacturing capabilities, firms hence increasing their competitive advantage (Mowery *et. al.,* 1996). Vanhaverbeke, Beerkens and Duysters (2004) suggest that STAs result in greater innovative outcomes. Therefore based on the literature, it is demonstrated that technology acquisition through STAs positively affects organizational performance. The study hypothesizes that:

H6: Technology transferred through strategic technology alliances will lead to improved organizational performance.

Organizations possessing advanced technologies, knowledge and competencies will perform significantly better and have higher innovative abilities compared to firms that lag in technology (McEvily *et. al.,* 2004). External technology acquisition enables firm to stay abreast with technology developments with lesser time and costs incurred

(Vanhaverbeke *et. al.,* 2002), and achieve sustained organizational performance (Henderson and Cockburn, 1996), (Montoya *et. al.,* 2007). Therefore it is argued that technology acquisition is an innovation strategy for both large and small organizations to improve organizational performance. Accordingly, the study hypothesizes that:

H7: Technology transfer significantly mediates the relationship between strategic technology alliances and organizational performance.

3.0 THEORETICAL FRAMEWORK

Based on the literature, we formed a theoretical framework for the antecedents and outcomes of STAs for Malaysian manufacturing organizations. STAs' success is influenced by six exogenous variables. Firms choose to embark on technological collaborations when they are lacking in resources, in need of new knowledge, and considering adopting a certain innovation. The seven exogenous variables hypothesized factors affecting organizations forming STA while STA is predicted to lead to the transfer of technology. Hence, the endogenous variables are represented by Strategic Technology Alliances and Technology Transfer. Additionally, technology transfer is also a mediating variable where the direct relationship between STA and organizational performance is mediated by technology transfer. Finally, organizational performance is the ultimate endogenous variable. Figure 1 illustrates the framework for this study.

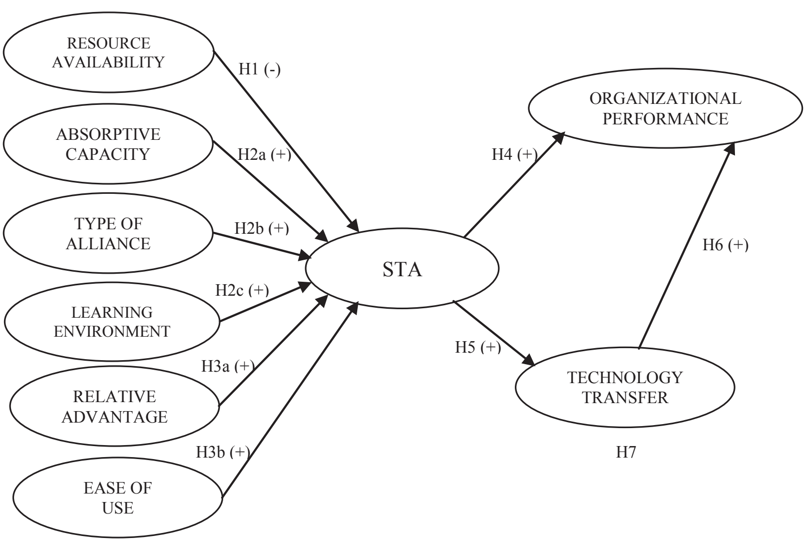


Figure 1 Theoretical framework

4.0 RESEARCH METHODOLOGY

4.1 Participants

Participants of this research were sourced from the 2008 Federation of Malaysian Manufacturers directory. A random sample of 2,500 organizations was contacted through letters and emails inviting them to participate in this study. The key respondents targeted for this study are chief executive officers, managing directors, managers and senior engineers from manufacturing organizations that have experience and knowledge of STAs. The process yielded 569 executives agreeing to participate, and emails were subsequently sent for them to complete an online survey with assigned password and restricted access, based on their best performing STAs. A major concern in survey research is the degree to which the validity of results may be compromised due to non-response by the subjects when the information is not obtained from some elements of the population that were selected for inclusion in the sample (Churchill, 1999).

Table 1 Frequency of respondents by manufacturing sector

Manufacturing	Respondents		Population	
	Frequency	Percentage	Frequency	Percentage
Basic Metal Product	24	7.2	175	7.0
Electrical and Electronics products	109	32.5	850	34.0
Engineering Supporting	176	52.5	1380	55.2
Others	26	7.8	95	3.8
Total	335	100	2500	100

A total of 343 completed surveys were received yielding a 13.72 percent response rate, and 335 (13.40 percent) were found usable for this study. Table 1 indicates the various manufacturing sectors of the respondents and population. This table indicates that there are relative similarities in the distribution of sample respondents as compared to the total population.

The characteristics of the firm are explained by the firm size and the type of industry. Firms in this study were divided into three categories i.e. small organizations with less than 50 employees, medium-sized organizations with 51 to 149 employees, and large organizations with more than 150 employees (Department of Statistics Malaysia, 2009). Respondents in this study comprise 137 small organizations, 51 medium-sized organizations and 147 large organizations. The majority of respondents were from the engineering supporting sector (which provides support to manufacturing).

Table 2 Distribution of respondents by firm size and industry type

Industry/No. of employees	Less than 50	50 to 149	More than 150	Total
Basic metal	13	5	6	24
Electrical and electronics products	49	9	51	109
Engineering supporting	69	28	79	176
Others	6	9	11	26
Total	137	51	147	335

4.2 Pilot study

A survey was designed based on an extensive literature review to generate the items to be tested. Consequently a pilot study was conducted to test the reliability of the instrument and to assess the length as well as the readability of the questionnaire. Two consecutive rounds of pre-testing were conducted in order to ensure that respondents understood the questions. First, the questionnaire was reviewed by three academic researchers experienced in questionnaire design and then piloted with four managers from manufacturing organizations. This was pursued with face to face interviews. The conclusion drawn from the interviews was that the questionnaire was too long, and the terms used were 'too academic'. The final questionnaire was shortened and reworded while retaining its original meaning.

4.3 Measures

This study examines the theoretical constructs or latent variables (Byrne, 2010) to generate scale items or multiple scale items to measure these variables in a quantitative sense. Most of the items are adapted from existing studies, which have been tested for scale validity. However, a number of items were modified for this study based on variable definitions. The 43-item questionnaire comprises ten subscales namely, Resource Availability (e.g. "Our organization has a considerable amount of patents"), Absorptive Capacity (e.g. "Our organization is highly experienced in terms of forming alliances"), Type of Alliance (e.g. "Our organization believes that it is important to choose the right type of alliances for effective learning outcomes"), Learning Environment (e.g. "Our organization shares more information with our trusted partners"), Relative Advantage (e.g. "The technology/process increases our organization's productivity"), Ease of Use (e.g. "The technology/process is easily implemented by our employees"), Strategic Technology Alliance (three items utilizing an ordinal scale asking the number of alliances formed in the past three years), Organizational Performance (e.g. "Our organization has increased in profit as a result of STA"), and Technology Transfer (e.g. "Our organization has been able to develop new technology or processes as a result"). Participants respondent to the 40 items (excluding the ordinal scale) by indicating their support on each statement on each statement on a 7-point Likert scale ranging from 1 *strongly disagree* to 7 *strongly agree*.

4.4 Statistical analysis

Data were divided into two groups for calibration and validation and to implement the two-stage process for establishing factorial validity as recommended by Jöreskorg (1993). The calibration sample consists of 135 respondents and the remaining 200 respondents were the validation sample. The calibration sample (n=135) was utilized in model generating models that are exploratory in nature. These models were examined using exploratory factor analysis (EFA) to reduce the data set to a more manageable size while retaining as much of the original information as possible. Subsequently, the validation sample (n=200) was then utilized to conduct a series one-factor congeneric models for each construct to test the unidimensionality of items. During this process, changes were made to the model one step at a time until the data fit the model well. Following this, a full measurement model employing the full dataset (N=335) was specified and analyzed using confirmatory factor analysis (CFA) to cross-validate the model derived from the model generating stage and analyze the hypothesized relationships in this study.

4.5 Analysis Procedure

Data were analyzed using PASW 17.0 and AMOS 17.0. EFA was conducted using principal axis factoring and direct oblimin rotation. Maximum Likelihood (ML) was utilized in the CFA and structural equation modeling (SEM) analyses which assume multivariate normality and continuity of the data being analyzed. Model evaluations were examined using the chi-square (χ^2) test statistic that has an associated significance test. Hence a model may be assessed for model fit by evaluating the *p* value under the normal theory χ^2 test, or the Bollen-Stine bootstrap *p* when data are non-normal ($p > .05$ indicating consistency between data and the model). Goodness-of-fit indices reported are the standardized root mean square residual (SRMR), the goodness-of-fit index (GFI) and the root mean square error of approximation (RMSEA), normed fit index (NFI), Tucker Lewis index (TLI), and comparative fit index (CFI). Data fit the model well based on the following criteria: χ^2 probability $p>.05$, Bollen-Stine bootstrap $p>.05$ (Bollen and Stine, 1992), SRMR<.05 (Diamantopoulos and Siguaw, 2000), GFI>.90 (Schumacker and Lomax, 2004), RMSEA<.08 (Browne and Cudeck, 1993), NFI>.90, TLI>.90, and CFI>.90 (Hu and Bentler, 1999).

To overcome the non-normality nature of data, we adopted item parceling to form composite scores of items measuring the same construct (Little et al., 2002). Prior to this, the unidimensionality of items measuring the same constructs was examined using EFA and one-factor congeneric CFA models. Furthermore the regression coefficient and measurement error variance for the items were specified using Munck's (1979) formula.

4.6 Measurement Model Analysis

A CFA was conducted on the full-measurement model using the full dataset (N = 335) comprising both exogenous and endogenous variables. At first, the data did not fit the model well, $\chi^2\,(df = 735, N = 335) = 1482.72$, $p < .001$. Therefore a bootstrapping procedure was performed resulting in an adjusted chi-square *p* value (i.e. Bollen-Stine *p*) of .05, indicating the data fit the model well. Other fit indices are as follow: SRMR = .04, GFI = .90, TLI = .90, NFI = .90, CFI = .90, RMSEA= .07.

5.0 RESULTS

5.1 Missing values, outliers and normality

In the first stage of analysis, data were examined for missing values, outliers and normality (Tabachnick and Fidell, 2007). A non-significant value of Little's MCAR (Missing Completely At Random) chi-square (χ^2) statistics indicates that data are missing at random. The missing value range was from .5% to .7% for items of Resource Availability and Learning

Environment. A total of 335 cases were utilized for further analyses. The missing values were imputed using expectation-maximization (EM) algorithm within the missing value analysis in PASW 17.0.

5.2 Realiability and validity

Once there are more than three items measuring a construct, the reliability of that construct should be evaluated through examining the Cronbach's α value. Reliability measures the extent to which a group of different items are consistent with one another and whether every measure is measurement error free (Leech *et. al.,* 2005). It is assumed that each item comprised of a true score measuring an underlying construct. Based on the recommendation from Garver and Mentzer (1999), this study calculates three estimates of reliability for each construct: Cronbach's α, composite reliability, and average variance extracted (AVE). Table 4 indicates the Cronbach's alpha, composite reliability and AVE values achieving the requirements. Table 3 also illustrates that the scales utilized in this study have substantially higher AVE values compared to their correlation with other constructs, providing evidence of discriminant validity (Fornell & Larker, 1981).

Table 3 Discriminant validity test

Construct	*M*	*SD*	Res	EU	RA	LE	TA	AC	STA	TT	OP
Res	5.99	1.12	.82								
EU	5.62	1.10	.69	.85							
RA	5.78	1.10	.68	.70	.92						
LE	5.19	1.30	.44	.41	.54	.79					
TA	5.48	1.08	.70	.70	.75	.46	.79				
AC	5.58	0.97	.63	.60	.61	.72	.69	.79			
STA	2.08	1.12	.61	.69	.73	.45	.74	.67	.82		
TT	4.43	1.12	.11	.12	.13	.08	.13	.12	.18	.77	
OP	6.10	1.02	.52	.58	.61	.58	.62	.56	.72	.57	.77

Note: Res=Resource availability, EU=Ease of use, RA=Relative advantage, LE=Learning environment, TA=type of alliance, AC=Absorptive capacity, TT=Technology transfer, OP=Organizational performance

5.3 Measurement invariance

Measurement invariance is examined using the multi-group CFA analysis to test whether there is a difference across the groups in the sample when predicting the relationship between the latent variable its indicator (Byrne *et. al.,* 1989). The dataset was split into groups of small and large firms where organizations with less than 150 employees are considered small and firms with more than 150 employees are considered large (Department of Statistics Malaysia, 2009). For this study, invariance testing was conducted between small firms (*n*= 188) and large firms (*n*= 147) to ascertain if the constructs of this study have different meanings between them. Establishing the differences between the two groups would subsequently invalidate any mean comparisons between them.

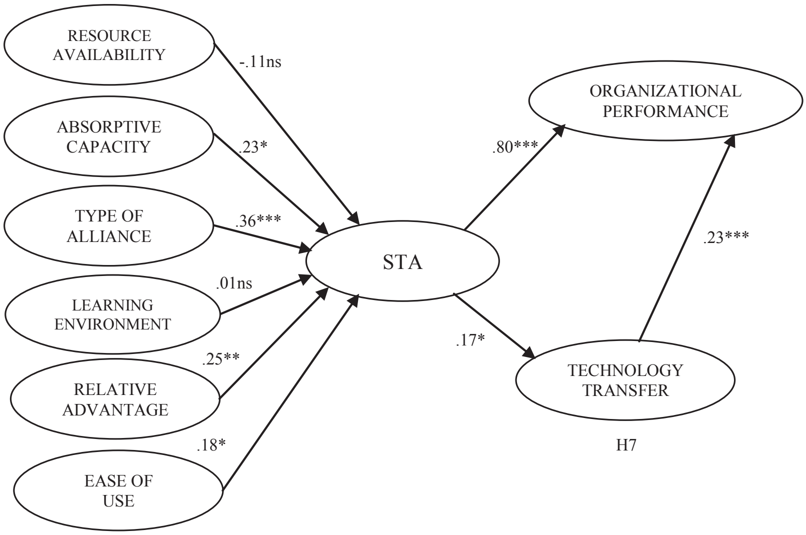
Byrne *et. al.,* (1989) classified invariance tests as the tests of measurement or structural invariance. As a general rule, the relationship between latent variables and the indicators should be similar with any group to ensure meaningful comparisons to be carried out (Widaman and Reise, 1997). The omnibus test of equivalence is performed to test for measurement invariance between the groups. This is the primary test conducted before any further invariance test is deemed necessary (Vandenberg and Lance, 2000). The multi-group omnibus test is a chi-square difference test conducted to examine if the sample variances and covariances for each group come from the same population. This is conducted by comparing two models: unconstrained model and constrained model. In the constrained model, the variance and covariances are set to be equal across both groups (see Table 4). In the unconstrained model, the variances and covariances are free to vary. The result signified that the chi-square difference ($\Delta\chi2$) test is not significant, indicating that the variance-covariance matrices are equivalent across groups. Therefore the model has structural invariance for both small and large firms. Hence no further tests need to be conducted (Vandenberg and Lance, 2000).

Table 4 Result of multi-group analysis

Model	χ^2	*df*	***p*-value**
Unconstrained	0.00	0	-
Constrained (Structural covariances)	40.84	28	.06
Chi-square difference ($\Delta\chi^2$)	40.84	28	.06

5.4 Structural model analysis

Figure 2 illustrates the SEM with standardized parameter estimates where the regression coefficients and measurement error variances of the ten single indicators for both exogenous and endogenous variables were specified to the composite scale prior to the analysis. The data did fit the model well, χ^2 (df = 12, n = 335) = 19.04, p = .08.



Note: *p<.05; ** p<.01; ***p<.001.

Figure 2 Structural model with path coefficients

The findings provide support for the structural model, where only two hypotheses were found not significant (Figure 2). Contrary to prediction for Hypothesis 1, the negative relationship between resource availability and STA formation was not supported. As predicted by Hypothesis 2a, absorptive capacity is positively related to the formation of STA where this relationship is found to be significant. The result also indicated support for Hypothesis 2b, proving that type of alliance has a positive impact on the formation of STAs. The relationship predicted by Hypotheses 2c was not supported where this result indicates that learning environment did not have a positive impact on STA formation. Consistent with Hypotheses 3a and 3b, results indicate that relative advantage and ease of use positively influenced the STA formation. Additionally, the results also support Hypotheses 4 and 5 where STA formed by organizations leads to positive organizational performance and technology transfer. Furthermore technology transfer will also lead to a positive organizational performance indicating support for Hypothesis 6. These relationships are summarized in Table 5.

Table 5 Hypotheses and results

Predictor variables	Criterion variables	*t*-value	*p*-value	Hypotheses	Results
Resource availability	Strategic technology alliance	-1.39	.16	*H1*	Not supported
Absorptive capacity	Strategic technology alliance	2.51	.01*	*H3a*	Supported
Type of alliance	Strategic technology alliance	3.54	***	*H3b*	Supported
Learning environment	Strategic technology alliance	0.11	.91	*H3c*	Not supported
Relative advantage	Strategic technology alliance	2.80	.005**	*H4a*	Supported
Ease of use	Strategic technology alliance	2.28	.02*	*H4b*	Supported
Strategic technology alliance	Organizational performance	17.96	***	*H5*	Supported
Strategic technology alliance	Technology transfer	2.55	.01*	*H6*	Supported
Technology transfer	Organizational performance	4.73	***	*H7*	Supported

The effect of STA on organizational performance may be mediated by technology transfer; hence this relationship is further examined by conducting nested model comparisons. First, Model 1 (partially mediated model) is tested with the presence of all direct and indirect pathways to organizational performance. Model 1 did fit the model well, χ^2 (df = 12, n = 335) = 19.04, p = .08 (see Table 8). In this model, STA is a significant predictor of technology transfer (β = .10, $p < 0.05$), and technology transfer is a significant predictor of organizational performance (β = .36, $p < 0.001$), and STA is also a significant predictor of organizational performance (β = .71, $p < 0.001$).

Secondly, Model 2 (fully mediated model) was tested with the pathway from STA to organizational performance constrained to be zero. The data did not fit Model 2 well, χ^2 (df = 13, n = 335) = 248.92, $p < .001$. A bootstrapping procedure was performed and the data still did not fit the model well with Bollen-Stine p = .001. Other fit indices include: SRMR = .16, GFI = .89, TLI = .61, NFI = .86, CFI = .86, RMSEA= .23 (see Table 8). The relationships between STA and technology transfer (β = .19, p < 0.001) as well as technology transfer and organizational performance (β = .76, p < 0.001) are both significant. Model 2 testing the fully mediated model of STA to organizational performance, lead to a significant χ^2 difference when compared to Model 1 ($\Delta\chi^2$ = 229.88 (1) p < .001) suggesting that the partial mediated model is a better fit to the data.

Thirdly, Model 3 tests for no mediation relationship with the pathway from STA to technology transfer constrained to be zero. The data did not fit Model 3 well χ^2 (df = 13, n = 335) = 25.45, p = .02. A bootstrapping procedure was performed and the data fit the model well with Bollen-Stine p = .32. Other fit indices include: SRMR = .06, GFI = .98, TLI = .98, NFI = .99, CFI = .99, RMSEA= .05. The relationships between STA and organizational performance (β = .72, p < 0.001) as well as technology transfer and organizational performance (β = .38, p < 0.001) are both significant. Model 3 tested for no mediation between STA and organizational performance, lead to a significant χ^2 difference when compared to Model 1 ($\Delta\chi^2$ = 6.41 (1) p = .01) suggesting that the partial mediated model is still a better fit to the data. Based on the nested model comparison, the results indicate that technology transfer only partially mediates STA and organizational performance (see Table 6). Therefore these results did not provide support for Hypothesis 7.

Table 6 Result of multi-model analysis: Nested model comparisons to test for mediating relationship

Paths	Model 1 Partial mediation			Model 2 Full mediation			Model 3 No mediation		
	χ^2	df	β	χ^2	df	β	χ^2	df	β
STA → OP			.71***			0			.72***
STA → TT	19.04	12	.10*	248.92	13	.19***	25.45	13	0
TT → OP			.36***			.76***			.38***
Chi-square	χ^2 = 33.22, p < .01			χ^2 = 229.88 (1) p < .001			χ^2 = 6.41 (1) p = .01		
Goodness-of-fit measures									
p-value		.08			.00			.00	
Bollen-Stine p		n/a			.00			.32	
SRMR		.03			.16			.06	
GFI		.99			.89			.98	
TLI		.99			.61			.98	
NFI		.99			.86			.99	
CFI		1.00			.86			.99	
RMSEA		.04			.23			.05	

6.0 DISCUSSION AND CONCLUSION

6.1 Implications for theory

The investigation of alliances has been approached from various theoretical viewpoints. For instance, empirical studies have adopted RBV (Das and Teng, 2000; Hung and Tang, 2008), and organizational learning (Colombo, 2003), (Pucik, 1988). While some studies have merged some factors from these theories into a single study; not many researchers have successfully embodied these theories together with the technology acceptance model (TAM) into an integrated model (Gottschalk and Solli-Sæther, 2005), (Tiwana and Bush, 2007). Furthermore, TAM although pertinent in technology alliances, has received very little attention in such studies. This research identifies the antecedents considerable for the implementation of new technologies and capabilities in manufacturing firms in a developing nation in their quest for strategic alliances. Our findings support the literature on absorptive capacity as enabling higher levels of knowledge exploitation in technology collaborations, as well as TAM, where relative advantage and perceived ease of technology implementation will affect decisions in alliance formation. Pursuant to Geringer and Hebert's (1991) work, this research also ascertains the improvements in market share, profits, sales and manufacturing capabilities as a result of technology alliances.

This research contributes to the literature on alliances from the perspective of a developing nation. Developing countries play a significant role in the global economy with the growing number of manufacturing facilities and operations set up by well known multinational firms from industrialized nations, who capitalize on abundant resources and cheaper labor costs. On the other hand, firms from developing countries are also consistently reinforcing manufacturing technology development as a means of industrialization and staying abreast with more advanced economies. The economic performance of these countries lies in their ability to acquire, adapt and innovate new technologies. It is evident that such countries tend to focus on collaborations with more advanced countries to accelerate their economic growth.

6.2 Implications for management

One existing problem facing Malaysian manufacturers is the lack of indigenous capabilities. This can be possibly mitigated by forming alliances with multi-national corporations (MNCs) and foreign organizations, where production techniques, new technology and knowledge are utilized to build desired manufacturing capabilities (Li et al., 2007), (Majumdar, 2009) and internalized in local firms. Despite the onset of successful alliance formation and technology transfer, it appears that these firms will still need to invest substantially in developing employee skills and their learning ability to maximize the full potential of newly industrialized manufacturing design. For instance, if an organization is largely immersed in their existing technology or process while STAs offers radical changes, employees may be resistant to accepting and learning new methods of production. This investment would be vital in increasing the technical competence, production methods, processes and consequently organizational performance.

The creation, transfer and absorption of technology and knowledge also depend on the learning context and environment. In ensuring successful learning between alliance partners, the new technology needs to be easily understood and compatible with business culture, operational priorities, business objectives and strategic resources. The role of management is to ensure positive learning environments as well as employee motivation and commitment in the organization. To enable this, various human resource development programs such as skills development initiatives, profit sharing schemes or incentives can be implemented to ensure that technological knowledge is continuously accumulated into human resources that are involved in production activities. Organizations will also need to establish formalized processes to internalize newly developed innovations and knowledge spillovers.

Correspondingly, such organizations will require more resources in terms of funding, expertise, and technological equipment specifically to promote internal innovative activities. All things considered, an overall technology development strategy needs to be linked to the business strategy in terms of technology acquisition, diffusion and application. Furthermore new and alternative organizational forms (such as loosely coupled systems, modular structures and open systems) can facilitate new and advanced manufacturing techniques. It is proposed that managers envision flexible and emergent strategies so that organizations can be more adept at responding to technological progress, dynamic markets, competition, and opportunistic developments.

6.3 Implications for public sector engagement

The public sector plays a vital role in promoting technology development, especially in achieving Malaysia's vision of becoming an industrialized nation and bridging the technological gap between other developed and developing countries (Bhattacharya, 2002), (Jegathesan *et. al.,* 1997). Currently, there are various initiatives undertaken by government agencies to strengthen the technological competitiveness of the manufacturing industry and to assist organizations in acquiring new technologies. We advocate for continuous and widespread support to ensure that Malaysia will not lag behind other developing countries such as China, Singapore, and Korea (Narayanan and Wah, 2000). For instance, policy makers and government agencies could further promote skills development, and fiscal and monetary policy mechanisms to enhance the competitiveness of the manufacturing industry. As innovation is a prominent objective of the national agenda, the provision of R&D facilities, financial grants and other incentives could strengthen manufacturing development and growth in the national economy.

7.0 LIMITATIONS

The findings presented in this study must be understood in the context of the following limitations: firstly, a more effective sampling technique such as stratified random sampling could have been adopted, as it was difficult to identify organizations with some form of technology alliances. Additionally, the sample from this study was attained from the FMM directory, thereby limiting the population to only organizations registered in this database. We suggest that subsequent research in Malaysia should include other sources for a more robust population sampling.

Secondly, respondents who participated in the survey were required to consider their best alliance partner in order to evaluate organizational learning and outcomes. These analyses and results should be understood as applied to successful STAs that may not necessarily have resulted in technology transfer. Thirdly, since data were collected only from manufacturers in Malaysia, the findings and conclusions cannot be generalized to STAs formed by manufacturers from other countries. We believe that future comparative studies on STAs formed by manufacturers from other countries or other industries may be beneficial to further understand the model proposed in this study.

8.0 SCOPE FOR FUTURE RESEARCH

This study has developed a model based on various theories to evaluate the antecedents of STAs formed by manufacturing organizations. It is imperative that the model be validated with samples from other countries to confirm its applicability in different business cultures and economic environments. Additionally, attention should be placed on the general applicability of the findings in this study with other studies. Future studies could focus on specific types of alliance to gain in-depth results. More interesting findings could also be gained by conducting comparative studies and replicating the research design with other types of firms, such as those in the service industry, as cross-industry comparisons could enhance the generalization of findings of this research.

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