AMT Jani Nyoman Togar

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Critical Success Factor of Advanced Manufacturing Technology Implementation on Small Medium Enterprise in Indonesia

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ABSTRACT

The study discusses the factors which influence the implementation of advanced manufacturing technology (AMT) on small medium enterprises (SMEs) of food, beverage and herb which located in Indonesia. It was also discussing on the effect of the implementation of AMT on the SMEs performance. The respondents of this research are the owner of the enterprise. Tests and analysis of the research model were performed using SmartPLS™ program. The research result shows that the characteristics of the organization, monitoring, and strategic alliances affect the implementation of AMT, and also the implementation of the AMT affects the SMEs performance.

Keywords: Advanced Manufacturing Technology, Small Medium Enterprise, Indonesia.

INTRODUCTION

The implementation of advanced manufacturing technology (AMT) in small and medium enterprises (SMEs) has garnered significant research interest. One notable study explored the relationship and modeling of AMT implementation strategies aimed at enhancing SME performance. This research aimed to produce a theoretical framework and hypotheses suggesting a connection between AMT implementation and SME performance. Additionally, it identified several factors influencing AMT implementation: technological characteristics, critical success factors, strategic alliances, and monitoring (Jonsson, 2000). These factors were derived from comprehensive literature reviews of books and journal studies related to AMT implementation and company performance. However, previous studies offered only a theoretical framework, necessitating further research to understand the real-world situation of SMEs that have adopted AMT.

This study is conducted from the perspective of SME owners, specifically those involved in the food, beverage, and herbal industries in Surabaya. The food, beverage, and herbal industries in Indonesia are not solely dominated by large enterprises; SMEs also play a significant role, with their market share extending to export levels and within Indonesia (GAPMMI, 2014). Data indicates that large enterprises in the food and beverage sector constitute only 0.5% compared to SMEs. However, this proportion is not reflected in competitiveness, where the majority of SMEs struggle to compete against large enterprises and imported products. The herbal industry faces similar challenges.

SMEs encounter intense competition in the globalization era and continue to struggle in terms of quality, cost, and delivery (Ministry of Industry of the Republic of Indonesia, 2013). The competitiveness of SMEs in the food and beverage industry, in particular, is hindered by their limited ability to match the quality and efficiency of larger enterprises and imported goods. The problems faced by these SMEs highlight the need for strategic implementation of AMT to enhance their performance and competitiveness.

Research by Rahardjo et al. (2015) serves as a critical reference for this study. It focuses on SMEs that have already implemented AMT, aiming to determine if there is a significant relationship between AMT implementation and SME performance post-implementation. Additionally, the study examines the relationship between the factors influencing AMT implementation to identify critical success factors that significantly affect AMT adoption. This dual focus allows for a comprehensive understanding of both the direct impact of AMT on SME performance and the contextual factors that facilitate successful AMT integration.

The present research aims to fill the gap in empirical data regarding the real-world application of AMT in SMEs, particularly in the Indonesian context. By focusing on SMEs in the food, beverage, and herbal industries in Surabaya, this study provides valuable insights into how AMT can be effectively implemented to improve competitiveness and performance. The findings are expected to contribute to the development of more effective AMT implementation strategies, ultimately supporting the growth and sustainability of SMEs in a highly competitive global market.

2. AMT

Advanced Manufacturing Technology (AMT) is an integrated manufacturing system designed to manage people, machines, and tools for planning and controlling the production process. AMT encompasses everything from purchasing raw materials to product delivery and customer service. According to Jonsson (2000), AMT refers to a variety of technologies that use computers to control or monitor manufacturing processes. Research by Rahardjo et al. (2015) on AMT implementation strategies for improving SME performance identified key variables affecting AMT implementation: organizational characteristics, strategic alliances, and monitoring.

RELATIONSHIP AMONG VARIABLES

3.1. Impact of AMT Implementation on Company Performance

The implementation of AMT has been extensively studied in operations management and organizational studies, with a focus on its impact on company performance. Various studies have examined performance metrics such as lead time, quality, cost, efficiency, and productivity (Rahman and Bennett, 2009), as well as forecasting, production planning, and administration (Esteves, 2009), and AMT investment levels (Monge et al., 2006). Baldwin and Sabourin (2002) noted that adopting advanced technologies leads to greater labor productivity and market share growth. Firms that adopt AMT early often experience higher market share and productivity growth. Raymond and Croteau (2005), Koc and Bozdag (2009), and Boyer and Pagge (2005) found that AMT implementation positively impacts company performance. However, Cagliano and Spina (2000) revealed that these benefits are often limited to specific performance areas, such as reduced manufacturing lead time due to robotics in product assembly.

3.2. Relationship between Organizational Characteristics and AMT Implementation

The relationship between technology implementation and organizational practices has been extensively explored. Research has examined various settings such as organizational structure (Ghani and Jayabalan, 2000), practices (Challis et al., 2005), size (Gupta and Whitehouse, 2001), and operational context (Sohal et al., 1992). Ghani and Jayabalan (2000) found that low productivity after several years of AMT implementation was due to an incompatible mechanistic organizational structure. Challis et al. (2005) investigated the relationship between AMT implementation and organizational practices, finding significant associations with planning, team structure, and human

resource management. Gupta and Whitehouse (2001) concluded that smaller firms often achieve better performance from technology implementation, indicating a correlation between firm size and AMT strategy. Sohal et al. (1992) highlighted that the operational context does not directly affect AMT adoption but can act as a surrogate variable.

3.3. Effect of Strategic Alliances on AMT Implementation

The dynamic business environment necessitates collaborations, especially for emerging market technologies. Given the high capital investment and uncertainty associated with AMT, collaboration with appropriate partners and selecting suitable suppliers can mitigate risks. Burgess (1998) found that buyers often seek collaborative relationships with suppliers for soft technology implementation. Fulton and Hon (2010) confirmed that stakeholder involvement influences AMT implementation. Rahman (2008) emphasized the importance of Buyer-Supplier Relationships (BSR) in AMT acquisition. Ming et al. (2008) revealed that effective collaboration among customers, developers, suppliers, and manufacturers throughout the product lifecycle is crucial for competitiveness. Similarly, Sohal et al. (2006) concluded that AMT progress depends on the transfer of AMT ideas among networks of firms, suppliers, industry associations, and government.

3.4. Effect of Monitoring on the Success of AMT Implementation

AMT's complexity in terms of techno-ware, human-ware, info-ware, and orga-ware requires monitoring the employees involved in each phase. Chung (1996) found that employing skilled, knowledgeable, and capable workers is crucial during the installation phase but not as much during the start-up phase. Without qualified workers during installation, the overall success of AMT implementation may be jeopardized. Marri et al. (2007) confirmed the necessity of controlling the type of workers at the earliest stages of AMT planning and implementation to ensure peak performance. Based on these empirical findings, a hypothesis is formulated regarding the critical role of monitoring in AMT implementation success.

4. RESEARCH METHODS

4.1. Structural Equation Modelling (SEM)

SEM is a statistical technique that analysis the pattern of relationship between latent constructs and indicators, latent constructs with one another, as well as measurement error directly. SEM allows the analysis of multiple dependent and independent variables directly (Hair et al., 2006). The variables were used in SEM is a latent variable, manifest variables/indicators, and variable error. Latent variables are variables that require a variable number of manifest or latent variable indicators that can be measured. Manifest or indicator variable is a variable that is used to describe/measure latent variables (Santoso, 2014).

4.2. Selection of Respondents

The respondent oh this research are SMEs owner in industry sector of food, beverages and herbs that already implemented the AMT. Type of ownership of SMEs is divided into individual, family, other people, and the combined bank and its subsidiaries. The results showed that the type of ownership of the respondents only individuals and families. Proprietorship amounted to 65%, or about 41 respondents. Type of family ownership amounted to 35% or 22 respondents. The number of SMEs that have 50-500 million of assets is 89% or 56 respondents. SMEs with assets of >500 million is 11%. Base on employees, 28% or 18 SMEs have 5-19, 48% of SMEs have 20-99 and 24% of SMEs have more than 99. Based on the long-established, showed that majority of respondents had stood between 5 and 10

years (41% or 26 SMEs), 25% have stood ≤5 years, and 18% have stood 10-15 years, and only 16% that stood more than 15 years.

4.3. Convergent Validity Test

Convergent validity test conducted with respect to the value of the loading factor that must be >0.5. Values higher loading factor indicates the stronger or invalid data have been generated (Hair et al., 2006). Loading indicator has a score of <0.5 should be ignored because they were invalid (cannot represent the relationship between indicators and variables). While in Figure 1 shows the loading factor value generated by each indicator. Indicators that have a value smaller (<) of 0.5 will be removed from the model baseline. Indicators that have a value <0.5 is (−0.031), of (0.216), inform (−0.187), trust (0.486) and finance (0.149).

4.4. Discriminant Validity Test

Discriminant validity test is done by taking into account the value average variance extracted (AVE). Table 1 indicating the value of each variable AVE. AVE value of a variable must be >0.5 (Ghozali, 2008). According to the Table 2 all grades AVE variables >0.5. Validity discriminant test based on AVE value showed that all variable has discriminant validity.

4.5. Composite Reliability Testing

Reliability testing research model can be known through the value of composite reliability. Variables are said to fulfil composite reliability if the value obtained is >0.7. This demonstrates the accuracy, consistency, and determination of a measuring instrument to perform a measurement (Ananda, 2015). Table 1 also shows the value of each variable composite reliability. According to the Table 1 in mind that each variable has a value above 0.7 composite variable (>0.7) with variable composite highest value is 0.9567 which is the variable characteristics of the organization. Table 1 indicate that all variables in the model of the research is to be reliable.

5. DATA ANALYSIS

5.1. Analysis of the Structural Model

Analysis model of research done by the application SmartPLS. SmartPLS useful to describe the influence or relationship between the indicator variables and the other variables. Tests using SmartPLS will go through three stages, namely the outer analysis models, analysis models and analysis inner hypothesis (Ananda, 2015).

Figure 2 shows a model of the initial research model. The variable characteristics of the organization has a cultural indicator, strategy and organizational structure. Indicators for monitoring variable is the HR (human resource), OS (organization support) and OF (organization facility). Indicators for the variable of the strategic alliances are a business alliance strategy, information, know and trust. Indicators in AMT implementation is improvement, OpKon (operation and control) and PerDen (planning and design). Performance indicators for the variable SMEs are finance, customer, PBI (internal business process) and PP (learning and growth).

5.2. Analysis of Outer Model

Analysis of outer model is used to ensure that the measurements made are valid and reliable. Test the validity of the model is done in two ways, namely by convergent validity and discriminant validity test. Convergent validity test known with regard to the value loading factor, while discriminant validity test

of the value AVE (average variance extracted) and the value of cross loading. Reliability test models done by considering the value of composite reliability.

5.3. Inner Model Analysis

Inner structural model to see the percentage of variance explained by looking R^2 dan predictive relevance (Q^2).

Table 2 shows the R^2 value of the variable AMT implementation and performance of SMEs. R^2 shows the extent to which a variable can be explained by research or a model (Ananda, 2015). R^2 results can be seen in rated R^2 for the implementation of AMT obtained at 0.9358, this means that the AMT implementation can be explained the characteristics of the organization, monitoring and strategic alliances at 93.58%. R^2 on SME performance variable is equal to 0.5168, this means that SMEs can explained by performance of 51.68% by the variable implementation of AMT. Predictive relevance (Q^2) showed how well the observed values indicated by the model. It also shows that the value of the variable redundancy AMT implementation and performance of SMEs is >0, i.e., 0.3567 and 0.3169. It is indicated that the model generated in research fit to the data.

5.4. Hypothesis Testing and Analysis

Hypothesis testing is done by first testing the validity and reliabilities research model. Hypothesis testing is done by comparing the t-statistic model obtained by the t-statistic theory, namely 1.96 with 5% alpha. The hypothesis would be acceptable if the value of t-statistic larger models of the t-statistic theory, namely (t-statistic > 1.96).

Figure 3 shows a new research model after passing through the analysis stage outer inert models and analysis models. The new model is obtained after eliminating some of the indicators that are not valid and reliable in the initial research model.

The initial hypothesis (H):

H1: Implementation AMT significant impact on the company's performance.

H2: Organizational characteristics have a significant impact on the implementation of AMT.

H3: Monitoring significantly affect the implementation of the AMT.

H4: The strategic alliance significantly affects the implementation of the AMT.

Significance of the causal relationship can be found from Table 3. The first hypothesis is the implementation AMT significant impact on the performance of SMEs. It shown that the value of t-statistic is 10.36 and >1.96. This is in line with previous researches by Burcher et al. (1999) and Thomas et al. (2007). Implementation of AMT business unit (enterprise and SMEs) will bring important tangible and intangible benefits. The benefits are the improved quality, improved corporate image, a process of reduction and improvement of the working environment.

A second hypothesis is the organizational characteristics significant impact on the implementation of AMT. It shows that the value of t-statistic variable correlation characteristics of the organization and implementation of the AMT is equal to 4.80 and >1.96 (4.80 > 1.96). The value of t-statistics show that the second hypothesis is acceptable, i. e. organizational characteristics significantly influence the AMT implementation. The second hypothesis research results in line with previous researches that says the organization's characteristics affect the implementation of AMT that conducted by Ghani (2000) and Thomas et al. (2007).

The third hypothesis is monitoring a significant impact on the implementation of AMT. The value of t-statistic monitoring and implementation of variable correlation of 4.50 and >1.96. The third hypothesis can be accepted. This study was consistent with previous studies conducted by Thomas et al. (2007) and Sohal et al. (2006). Last, the fourth hypothesis is a strategic alliance significantly influence the implementation of AMT. The value of t-statistic monitoring and implementation of variable correlation of 3.75 and >1.96. The fourth hypothesis can be accepted and consistent with previous studies conducted by Sohal et al. (2006) and Ghani (2000).

Table 1: AVE and composite realiability value

Variable	AVE	Composite reliability
AMT implementation	0.6296	0.8323
Organization characteristic	0.9172	0.9567
SME performance	0.6333	0.8317
Monitoring	0.6114	0.7556
Strategic alliances	0.6339	0.7729

Figure 1: Loading factor of each indicator and path coefficient between variables

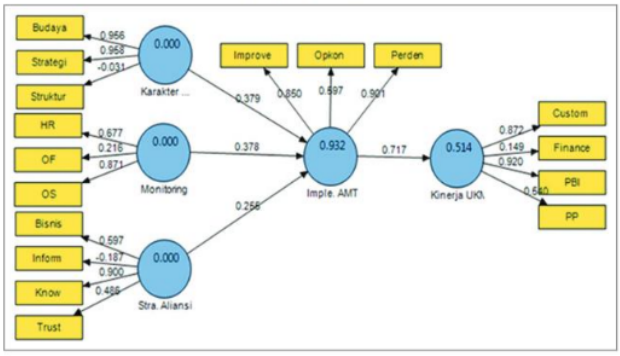


Figure 2: The initial of the research model

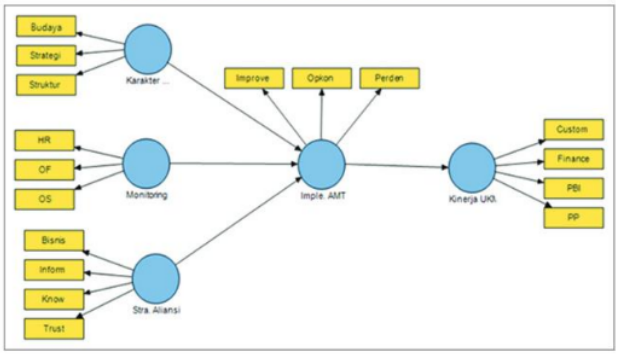


Table 2: Value of R^2 dan redundancy

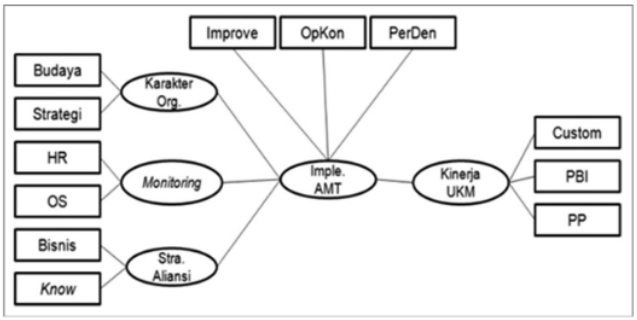
Variable	R^2	Redundancy
AMT implementation	0.9358	0.3567
Organisaton characteristic	-	-
SME performance	0.5168	0.3193
Monitoring	-	-
Strategic alliances	-	-

AMT: Advanced manufacturing technology, SMEs: Small medium enterprises

Table 3: Path coefficient among variables

Causal relathionsip between variables	Path coefficient	t-statistics
AMT Implementation→Performance of SMEs	0.717	10.36
Orgnization Charateristic→AMT Implementation	0.790	4.80
Monitoring→AMT Implementation	0.378	4.50
Strategic Alliances→AMT Implementation	0.256	3.75

Figure 3: Research model



6. CONCLUSION

The results of this study indicate that the implementation of AMT in particular SMEs in the business of food, beverages and herbs have a significant impact on company performance. It can be seen from the results were obtained in this study. In addition, this study also shows that there are factors that affect the implementation of AMT that is characteristic of the organization, monitoring and strategic alliances. These three factors significantly influence the implementation of AMT.

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