



THE MEDIATING ROLE OF SUPPLY CHAIN MANAGEMENT PRACTICES IN THE RELATIONSHIP BETWEEN MANUFACTURING FLEXIBILITY AND MANUFACTURING PERFORMANCE

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Abstract

Purpose: The current study is interested in exploring the nexus between manufacturing flexibility supply chain practices and manufacturing performance of Indonesian manufacturing firms. Multidimensionality of manufacturing flexibility within the function of manufacturing is generally accepted by past researchers and its importance honoured.

Methodology: Employing the survey-based methodology, the SEM-PLS technique is used to test the hypothesized relationships. So, the current study has used SEM-PLS as a statistical tool to answer the research questions raised in this study and research objectives envisaged in the current study.

Results: The complexity of manufacturing flexibility has made this concept difficult to comprehend yet delimit. To date, agreement on how to practice this concept has not yet been resolved. The findings of the study have provided support to the theoretical foundation and proposed hypothesis of the current study. Current study will be helpful for policymakers and practitioners in understanding the issues related to supply chain risk, supply chain integration and supply chain agility. In the author's knowledge this is among very few pioneering studies on this issue.

Keywords: *supply chain, flexibility manufacturing performance, Indonesia*

INTRODUCTION

In modern day, rapidly evolving business environments that are full of changes and uncertainty led to the need for flexibility. The increase of customers' expectations on the speed to fulfil their requirements have forced many organizations to act and respond faster, and to be more flexible to changes (Agus, 2011). Traditional manufacturing approaches are no longer sufficient for a firm to secure competitive advantage in this drastically changing environment (González-Benito, 2007; Nxumalo and Naidoo, 2018; Obeid and Awad, 2018). Concurrently, rapid changes in the world's technology has shortened the life cycle of the product; with customer demand for more innovative products with higher value, creating a flexible organization becomes essential to cope for rapid changes (Judi and Beach, 2008); Decreasing of profit margins, increasing inventory levels to cope with uncertainty, increasing global competition, and increasing the speed of technological changes (Judi and Beach, 2008) have further amplified the need for flexibility. As a result, organizations must find better ways to meet these challenges. Since manufacturing flexibility enhances the ability of a firm to respond to customer needs that are highly diversified, it is generally accepted that incorporating manufacturing flexibility within the manufacturing function will help the organization to respond to such changes and customer needs in a faster and better way (Kaur and Singh, 2016).

Many organizations tend to solve problems using conventional way, where internal factors that are within the organization are focused even though the problems may be caused by external factors. However, negligence of external factors such as suppliers, distributors, and customers did affect an organization's ability to fulfil customer expectations and their survivability in uncertainty (Jabbour *et al.*, 2017). Various manufacturing practices such as lean manufacturing, world class manufacturing, knowledge management, organization learning, total quality management (TQM), quick response program (QRM), efficient consumer response (ECR), systems dynamics, business process re-engineering, mass customization, manufacturing flexibility, total productive maintenance and benchmarking of best practices are proposed to help the organizations in enhancing their performance especially the manufacturing functions (Shibin *et al.*, 2017; Obi and Okekeokosisi, 2018; Obiero, 2018). With respect to the production system, due to lacking of understanding of the synergy within the manufacturing system, many firms have implemented the manufacturing flexibility in an incomplete way. Loss of the synergistic benefits have made the implementation of manufacturing flexibility being considered as a fail subject, as performance does not improve as expected (Dubey *et al.*, 2017).

Manufacturing flexibility can provide an organization the ability to handle the rapidly changing business conditions with more dynamic options and act more effectively to dynamic competitive business environment. As flexibility becomes important and its potentials are recognized by managers around the world, it has been proclaimed as the —next competitive battle to improve organizations survivability in this ever changing yet volatile business environment (Dubey *et al.*, 2017). Impacts of flexibility in the value chain are substantial in many areas including development of new products, manufacturing systems, and logistics. For example, flexibility allowed a firm to improve performance by reducing

manufacturing lead time, introduce new products in a timely manner and reduce manufacturing costs (He *et al.*, 2014; Basheer *et al.*, 2019).

LITERATURE REVIEW

Manufacturing sector is a constantly changing and upgrading sector that needs reforms for its sustainability. The manufacturing sector needs to be flexible in dealing with increasing competition in the market and customer demands that are getting complex. Flexibility is now emerging as one of the key competitive priorities in manufacturing environment that prioritized products variety, ability to varied production volumes, short product life cycle and time-based competition. Thus, flexibility is seen as an important attribute of the manufacturing system that is capable of fulfilling the challenges posed by uncertain business environment (Fayezi *et al.*, 2017). A great deal of research in attempting to identify various types of flexibilities in manufacturing has been carried out over the past few decades. Nevertheless, there is no general agreement on how to define flexibility. According to (Brettel *et al.*, 2016), flexibility can be the capability to cope with environmental ambiguity and variation. (Khanchanapong *et al.*, 2014) defined flexibility as a way to solve problems arising from assortments of situations. According to (Hartini and Ciptomulyono, 2015) flexibility is the capability to react effectively to frequent changing of state of affairs. (Karim and Arif-Uz-Zaman, 2013) noted that flexibility is the capability to adjust with little drawback in performance, time, cost and effort. Flexibility's role is to serve as the response to different types and categories of problems, where numerous choices of responses are available.

For an organization, flexibility means generating choices at various stages in the firm, creating methods and also reasons of change across various choices and providing freedom of choice to numerous players in the organization for enabling this transformation to materialize with slightest effort and time. (Karim and Arif-Uz-Zaman, 2013) stated that flexibility is a polymorphism that its definition may change from one state to another state of affair, "implying stability, sustainable advantage, and capabilities that may evolve over time". Meanwhile, (Hafeez *et al.*, 2018) defined flexibility as an attribute that enables a production technology to accommodate greater variation in output. He also stated that flexibility is an attribute that enables firms to respond to uncertainty, in terms of fluctuations in demand and market imperfection. In the same (Hafeez *et al.*, 2018) defined flexibility in a similar way as —property of the system to be changed easily. In addition, (Belekoukias *et al.*, 2014) defined flexibility in manufacturing system as —nature of change the production system can accommodate". While (Heizer *et al.*, 2017) claimed flexibility as the absorber of environmental ambiguity and variability. Last but not least, (Ojha *et al.*, 2013) described flexibility as —ability of the system to change status within an existing configuration.

With reference to the preceding definitions, it is reasonable to conclude that the concept of flexibility is a complex term. It carries different meanings in different contexts and implies adaption to environmental changes, sensitivity to changes, adaptability of actions and capability to tackle unforeseen event through non-rigid solution (Al-jawazneh, 2012). Flexibility is a multidimensional construct and various responses exist to meet different flexibility challenges. Utmost importantly, flexibility is acting as the medium, which enables the existence of choices and options to handle unexpected circumstances.

Many benefits of adopting flexibility have been reported in various case studies and empirical studies. Some of the benefits include reduction of time in new product design and new product introduction; improve performance of products without sacrificing key performance indicator such as product quality, time to delivery and manufacturing cost (Heizer *et al.*, 2017). On the other hand, better financial performance, bigger market share, reduction of rework cost, reduce of raw material cost and cost to manufacture, increase throughput, reduce machine setup time, increase efficiency, inventory reduction, increase productivity, better customer satisfaction are also part of the benefits reported by past studies (Al-jawazneh, 2012; Ojha *et al.*, 2013; Heizer *et al.*, 2017; Hafeez *et al.*, 2018). Outcomes and benefits of flexibility to organization are uncountable and diverse in different situation (Camison and Villar López, 2010) as flexibility allowed delay of decision making or judgement to a later time, where information may be more accessible. According to (Alamro, 2014), flexibility can be active or passive. Passive flexibility improves firm's awareness and response to uncertainties active flexibility allowed a firm to shape the market and control the uncertainties. As an example, passive flexibility enables a firm to defend against customer expectations that are increasingly demanding, which include but not limited to faster response time and frequent change of order quantities. Passive flexibility is reactive in nature and acts after customer demand. On the other hand, active flexibility is the ability to tap the opportunity exists whenever it happens and shapes the buying pattern of the customers, it also served as the capability to foresee and foretold what customer need and prepared against it. Typically, firms with higher flexibility has higher chance of surviving through volatile market environment that are temperamental yet changing at a fast pace (Sawhney, 2013). This is further supported by the fact that competitors will keep on improving and those do not improve will find themselves unable to survive.

As stated by (Sawhney, 2013) flexibility in management introduces a new way of competitiveness for an organization and creates organizational and managerial effectiveness; stimulate exceptional business performance, with enlightenment, freedom and inspiration. According to the author, flexibility is the blend of speed and versatility. Speed is the time-based ability to change course to obtain benefits when opportunity arrived or step aside when a threat present to mitigate the risk. Versatility is the ability to do things in a different way and the ability to do many different things. In sum, flexibility enables an organization to embrace innovation, improve speed and reduce response time to market needs. As flexibility

allowed an organization's products and services as well as the ways of doing business to evolve more rapidly than their contenders, it has become the cradle of competitive advantage (Nawanir *et al.*, 2013). On the other point of view, (Belekoukias *et al.*, 2014) noted the needs of flexibility is aroused when price and quality are no longer the decisive authority in determining customer satisfaction, as customers nowadays not only demand product with cheap price and high quality, but also variety of products to choose from (Nawanir *et al.*, 2013). Tastes of customers are unpredictable and keep on changing, which make the market is to be viewed as comprising of multiple niches. This promotes the needs to be flexible, to tackle the various niche markets exist in the global market. In sum, flexibility has been seen as a source to promote competitive advantage by various researchers (Pinilla and Prinz, 2003). Manufacturing flexibility, as an extension of flexibility is burden with the same expectations by various researchers and industry practitioners (Pinilla and Prinz, 2003).

Concept of manufacturing flexibility is increasingly complicated and confusing when certain manufacturing system features that have nothing to do with manufacturing flexibility are associated with the concept. For example, the term —manufacturing flexibility| and —flexible manufacturing system| (FMS) are used interchangeably. FMS is a specialized manufacturing technology involving computer-based control and the usage of fully automated machine that operates with minimal staffs and minimal supervision; in order to enable the organization to carry out fully automated production without the need for a more skilled workforce. According to this definition, an organization will be considered to have a flexible manufacturing system, although it uses equipment that are very specific and inflexible. When FMS is used interchangeably with "manufacturing flexibility", such term usage may again result in confusion in the literature and practical applications. The lack of consensus on the definition of manufacturing flexibility and its components have created problems for researchers to further investigate the link between manufacturing flexibility and firm's performance (Hafeez *et al.*, 2018). Confusion about what is manufacturing flexibility and what constitutes it has made the selection of instrument(s) to assess the concept become difficult. To mitigate the problem, a common definition of manufacturing flexibility and its components are indeed necessary. For the purpose of this study, manufacturing flexibility is defined as a multidimensional construct that represents the overall ability of the manufacturing system to adapt to both external changes and internal. In other words, manufacturing flexibility is the specific characteristics of a manufacturing system.

Supply Chain Management Practices

A set of different activities, which an organization conducts for increasing effectiveness of its supply chain is referred as SCM practices. The current developments in the practices of Supply Chain Management have been described by (Karim and Arif-Uz-Zaman, 2013) such as outsourcing, maintaining customer relations, quality and purchasing, flow of information, process flow and partnership with suppliers. For representing SCM practices, customer relations, quality, and purchasing have been used by Tan *et al.* in their research study.

The core competencies, and inter-organizational systems including reduction or elimination of excess level of inventories, EDI have been included by (Hafeez *et al.*, 2018) in SCM practices concentration the reduction of inventory levels can be done by delaying the customizations to the supply chain end. Six perspectives of SCM practices have been identified by (Kaur and Singh, 2016) by use of factor analysis. These aspects include information sharing, integration of supply chain, customer relation management, Just in Time approach and geographical proximity. For measuring supplier-buyer relation, supplier base reduction, communication, long term relationship and cross-functional teams along with involvement of suppliers have been used by (Judi and Beach, 2008) in the similar way, goals, visions, information sharing, integration of process, supply chain leadership, risk sharing, cooperation, etc. have been used by (Hartini and Ciptomulyono, 2015) for analysing the concept of SCM.

SCM and its practices have been demonstrated from different perspectives in literature. However, the common goal or purpose of SCM practices is to improve organizational performance. Five different aspects such as customer relationship, strategic supplier partnership, information sharing level, postponement and quality of information sharing are used in the literature review for the measurement of SCM practices. The upstream and downstream sides of supply chain i.e. supplier relationships and customer relationship are covered by these five constructs. These constructs include flow of information across the supply chain, level and quality of information sharing, internal process of supply chain and postponement.

The main perspectives of Supply Chain Management are involved in the above-mentioned dimensions; however, these cannot be considered complete. Several other aspects such as Just in Time or lean factor (Kaur and Singh, 2016), integration of logistics (Judi and Beach, 2008), geographical proximity, shared goals, visions, and leadership of supply chain (Khanchanapong *et al.*, 2014) are important to be considered in the literature. These dimensions are of great value and recognition, but these are not involved because of the survey length and parsimony of instruments of measurement.

The current research study defines SCM practices to be a concept with different dimensions. These different dimensions are listed in Table 1 as supported by literature. Following is a detailed view on these dimensions

The Impact of Manufacturing Flexibility on Manufacturing Performance

Various past researches about manufacturing flexibility that shown positive and significant effects (at $\alpha = 0.05$) on manufacturing performance are depicted in Table 2.10. Based on the table, specific manufacturing flexibility component has significant influence on certain manufacturing performance measures. Manufacturing flexibility at aggregated level

also showed similar results. Nevertheless, further examination revealed that the number of studies at the aggregated level is relatively scarce. Impacts of manufacturing flexibility on product quality have been stressed by a number of past studies. For instance, research by (Funnell and Rogers, 2011) showed that new product flexibility has positive and significant impact on the quality of the product. Another study related to product quality was conducted by (Sekaran and Bougie, 2013) and found 88 that labor, routing and volume flexibility have positive and significant impact on scrap and rework cost, which is highly correlates with product quality.

The effect of mix flexibility on manufacturing cost reduction was empirically proven by research done by (Belekoukias *et al.*, 2014). In the same vein, mix flexibility has positive impact towards cost reduction and this has been supported by (Shibin *et al.*, 2017). Meanwhile, (Sekaran and Bougie, 2013) has concluded that labor flexibility has positive and significant impact on cost reduction. Furthermore, research done by (Brettel *et al.*, 2016) have link three flexibility types (i.e. mix, new product and volume flexibilities) to the success of cost reduction in manufacturing systems. On the other hand, (Nawanir *et al.*, 2013) study has confirmed that resource flexibility (the mixture of machine and labor flexibility) has a positive impact on manufacturing performance (cost reduction) with α at 0.067. In the term of lead time reduction, impact on mix flexibility towards lead time reduction has been studied by (Khanchanapong *et al.*, 2014) and positive relationships have been observed. (Alamro, 2014) also has touched upon the impact of new product flexibility towards lead time reduction in his research and the outcome is positive and significant. (Belekoukias *et al.*, 2014) has link three flexibility dimensions (labor, routing and volume flexibility) on lead time reduction with positive and significant effect on it. Meanwhile, lead time reduction has positive relationship with routing flexibility.

Rogers (Dubey *et al.*, 2017) has discussed about how labor flexibility, routing flexibility and volume flexibility impacted productivity. Besides that, research done by (Alamro, 2014) on new product flexibility also stated that new product flexibility can help to increase productivity. On the other hand, study by (Sawhney, 2013) on 74 PCB plant has concluded that labor flexibility (measure using (i) usage of multi skills workers; (ii) workers used for multiple jobs; (iii) workers used to increase profits) has significant effect on plant performance (in terms of cost and work-in-process inventory). Effect of manufacturing flexibility on inventory minimization has been discussed by (Dubey *et al.*, 2017) especially on mix flexibility, labor flexibility, routing flexibility, and volume flexibility. According to (Dubey *et al.*, 2017), these four flexibility dimensions have positive and significant impact on inventory minimization effort, that mean the higher the capability of these flexibilities, the higher the effectiveness of inventory minimization can be achieved. In the sense of aggregate manufacturing flexibility, its impact on elements of manufacturing performance is supported by various past studies (Funnell and Rogers, 2011). Specifically, according to (Rogers, 2008), aggregate manufacturing flexibility affecting four elements of manufacturing performance. Basing on the literature reviewed the current study has formulated the following hypothesis.

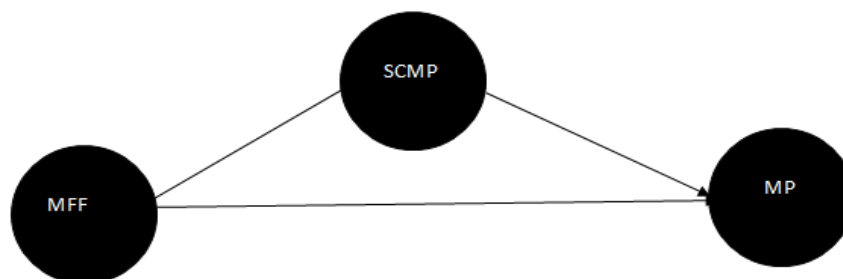


Figure 1: Conceptual Framework

- H1:** Manufacturing flexibility is in significant relationship with manufacturing performance of Indonesian firms.
- H2:** Manufacturing flexibility is in significant relationship with Supply chain management practices of Indonesian firms.
- H3:** Supply chain management practices are in significant relationship with manufacturing performance of Indonesian firms.
- H4:** Supply chain management practices mediates the relationship between manufacturing flexibility and manufacturing performance of Indonesian firms.

METHODOLOGY

For the purpose of data analyses, the Statistical Package for the Social Sciences (SPSS) version 22.0 was employed. Data collected was analysed using descriptive analysis, where the percentage and the mean value for specific variable(s) were calculated. In addition, correlation analysis, regression analysis and mediation tests were conducted to investigate the relationship between the variables of interest (i.e. manufacturing flexibility, manufacturing performance and business performance). Besides, the hypotheses developed for this study were tested. Detail descriptions of each of the analytical methods are presented in the following subsections.

Face validity examining whether the items that are intended to measure a concept, on the face of them, reads as if they truly measure what they are supposed to measure. Content validity is referring to whether the measures included are adequate and representative to tap the concept of interest In order to warrant the face validity, content validity, as well as

readability and conciseness of the questionnaire, the instrument in the questionnaire was pre-tested and reviewed by three academicians from the field of operations management and three industry practitioners. According to (Saraph *et al.*, 1989) sample size is preferred to be at least 5 times more than the number of independent variables in the relationship study. Sample sizes larger than 30 but not more than 500 is appropriate for most of the research. Sample size larger than 500 is not desirable as statistical significance can be identified even with only weak relationships (correlation of 0.10 or less) exist among them.

RESULTS

According to (Hair *et al.*, 2013) although correlation coefficient r indicates the strength of the relationship between any two variables, however, it does not tell how much variation in the dependent variable being explained by multiple independent variables which are hypothesized to concurrently affect it. Subsequently, multiple regression analysis was carried out with the aimed to measure the simultaneous effects of multiple independent variables on a single dependent variable (Cooper and Schindler, 2003) The regression analysis may provide further understanding and information about the relationships among the variables. This analysis tests the null hypothesis that the amount of variation in the dependent variable explained by the regression model (R^2) does not differ significantly from zero.

In this study, regression analyses were employed to assess the relationship between manufacturing flexibility components (independent variables) and each manufacturing performance measure (dependent variables), between manufacturing flexibility components (independent variables) and each business performance measure (dependent variables), and between manufacturing performance measures (independent variables) and each business performance measure (dependent variables). In other words, the analyses determine the contribution of manufacturing flexibility components to both manufacturing performance measures and business performance measures and also the contribution of manufacturing performance measures to business performance measures. In addition, principal components analysis and simple regression were applied to handle the multicollinearity problems that existed among the independent variables in the multiple regression models. Specifically, one simple regression model was developed to measure the contribution of manufacturing flexibility components (collectively) to each manufacturing performance measure, while the second simple regression model was developed to find out the contribution of manufacturing flexibility components (collectively) to each business performance measure. Meanwhile, another simple regression model was developed to determine the contribution of manufacturing performance measures (collectively) to each business performance measure.

The importance of validity and reliability of measurement instrument have been stressed by many researchers asserting that researchers have to know the validity (do they measure what are intended to be measured) and reliability (consistency of measurement results) of their instruments. 3 types of validity generally considered are: (1) content validity; (2) criterion-related validity; (3) construct validity items have high factor loadings and reliability, validity test was performed. The ability of an item to estimate what it should estimate is referred as validity.

Table 1: Reliability

	CR	AVE	Cronbach Alpha
MFF	0.925	0.872	0.985
SCMP	0.702	0.777	0.924
MP	0.920	0.821	0.873

This study also intended to investigate the interrelationship between manufacturing flexibility, manufacturing performance and supply chain practices. To examine the mediating roles of manufacturing performance, the procedure as proposed by (Saraph *et al.*, 1989) was adopted. In supplement to (Baron and Kenny, 1986) method, bootstrapping was also used to test the significance of the mediating effect and confirming the mediation relationship Past researches shown that bootstrapping is one of the powerful tools to test mediating variable effects (Hayes and Scharkow, 2013). Bootstrapping makes inference based on an estimate of the indirect effect itself and makes no assumptions about the shape of the sampling distribution of the indirect effect. Besides, standard error for the indirect effect is not needed to make the inference, eliminating the argument on the best way to estimate the standard error. Additionally, bootstrapping is a very general method that can be used to test the indirect effects in any mediating variable model, even if the model is complex with numerous paths between the dependent variable and the independent variable. The bootstrapping method provides indirect effect estimates and confidence intervals to allow researchers to assess the significance or non-significance of a mediation effect (Preacher and Kelley, 2011; Obodo and Anigbata, 2018; Okon, 2018; Okoroma, 2018). For testing the mediation effect, (Saraph *et al.*, 1989) provided a macro with the name —PROCESSI, which is available at www.processmacro.org that calculates bootstrapping directly within SPSS.

Table 2: Direct Effect

	(β)	SD	T-value	P-Values
H1	0.211	0.135	3.211	0.000
H2	0.357	0.152	3.678	0.000

H3	0.321	0.178	3.321	0.000
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CONCLUSION

Concept of manufacturing flexibility is increasingly complicated and confusing when certain manufacturing system features that have nothing to do with manufacturing flexibility are associated with the concept. For example, the term —manufacturing flexibility and —flexible manufacturing system (FMS) are used interchangeably. A great deal of research in attempting to identify various types of flexibilities in manufacturing has been carried out over the past few decades. Nevertheless, there is no general agreement on how to define flexibility. The current study is interested in exploring the nexus between manufacturing flexibility supply chain practices and manufacturing performance of Indonesian manufacturing firms. multidimensionality of manufacturing flexibility within the function of manufacturing is generally accepted by past researchers and its importance honoured. The complexity of manufacturing flexibility has made this concept difficult to comprehend yet delimit.

To date, agreement on how to practice this concept has not yet been resolved. Employing the survey-based methodology, the SEM-PLS technique is used to test the hypothesized relationships. So, the current study has used SEM-PLS as a statistical tool to answer the research questions raised in this study and research objectives envisaged in the current study. The findings of the study have provided support to the theoretical foundation and proposed hypothesis of the current study.

Current study will be helpful for policymakers and practitioners in understanding the issues related to supply chain risk, supply chain integration and supply chain agility. In the author's knowledge this is among very few pioneering studies on this issue of flexibility in manufacturing, The study revealed the fact that for an organization, flexibility means generating choices at various stages in the firm, creating methods and also reasons of change across various choices and providing freedom of choice to numerous players in the organization for enabling this transformation to materialize with slightest effort and time.

The Mediation effect is shown in table 3

Table 4: Indirect Effect

	(β)	SD	T-value	P-Values
H4	0.211	0.135	3.211	0.000

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