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The Effects of Manufacturing Flexibility on Operational Performance; Acknowledging the Role of Innovation Capability

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Abstract- This study aims to examine the effect of manufacturing flexibility (five dimensions) on operational performance (three dimensions) and to examine the mediating effect of innovation capability (four dimensions) in the relationship between the two constructs. A cross-sectional survey design was applied involving 238 Indonesian manufacturing SMEs. The data were analyzed using covariance-based structural equations modelling. The findings indicate that manufacturing flexibility was positively associated with operational performance and innovation capability as well. The findings also indicate that each of innovation capability types mediate positively, but not equally to the operational performance. This study highlights the importance of the mediating role of innovation capability when examining the relationship between manufacturing flexibility and the operational performance of manufacturing plants. The results imply that manufacturing SMEs need to search for and utilized their manufacturing flexibility competence to enhance their innovation capability and operational performance.

Keywords: Manufacturing flexibility, innovation capability, operational performance, manufacturing SMEs.

Introduction

Recent years, many manufacturing organizations have to cope with the increased business competition and globalization market. Such a condition has put increasing pressure upon manufacturing organizations to search for new production and operation methods and strategies in order to improve their performance in term of product quality, manufacturing cost, and delivery [1], [2]. Gunday et al. [3] highlighted the potential of this operational performance function as a source of competitive advantage for a company; presuming that the operational performance would lead logically to the increase of overall company performance. One of research domain in the manufacturing flexibility literature is aimed to find out the acknowledged relationship between manufacturing flexibility and performance [4]. Scholars such as Gupta and Somers [5] and Koste and Malhotra (1999) posited that manufacturing flexibility is an important factor underlying a company's performance. Yet, studies investigating the relationship between manufacturing flexibility and performance commonly use financial-based performance measures ([5], [7]). Studies focusing on the relationship between manufacturing flexibility and operational performance are limited. In addition, prior studies widely focused on manufacturing flexibility implication on a single performance aspect [8]. In addition, prior studies provided mix-results regarding the effect of manufacturing flexibility on a company's performance, meaning that both positive and negative relationships between manufacturing flexibility and performance may emerge [9]..

Apart from the manufacturing flexibility, there is other factor that potentially affects the improvement in performance, that is, innovation capability [10]. Researchers such as Calantone et al. [11] and Hult et al. [12] assigned innovation capability with a high consideration as a tool for gaining a high performance. However, previous studies focusing on innovation and performance relationship tend to treats innovation as a single construct rather than considering all of innovation types. In addition, prior studies provided inconclusive results regarding the effect of innovation capability on a company's performance. There is still a lack of empirical research which provides a comprehensive explanation regarding innovation capability in context of SMEs ([3], [13]). Furthermore, given the importance of a greater combination of manufacturing flexibility and innovation capability to improve a company's performance, there is still a lack of research addressing how manufacturing flexibility and innovation capability work together to achieve a higher performance. Accordingly, additional studies are still needed to provide more understanding with regard to the relationship between manufacturing flexibility and innovation capability, and their implication on performance ([14], [15]).

To address these issues, this study attempt to provide empirical evidence by investigating the relationship involving manufacturing flexibility, innovation capability, and operational performance. Three different goals are pursued. First, recognizing manufacturing flexibility effects on both innovation capability and operational performance; second, obtaining more insight regarding innovation capability effects on operational performance, and third, understanding the mediating role of innovation capability in the relationship between manufacturing flexibility and operational performance. The remainder of this paper is organized as follows. Section 2 presents a review of the relevant literature that underpins the theoretical conceptualizations and the development of the research hypotheses that are put forward. This is followed by Section 3 with a description of the research methodology employed to carry out the empirical work. Section 4 comprises the results and discussions, and finally, the conclusions of the study are presented in Section 5..

Literature Review and Hypotheses Development

Manufacturing flexibility and operational performance

Manufacturing flexibility has been conceptualized in different ways. For example, manufacturing flexibility could be referenced as the ability of manufacturing organizations to adapt quickly to any changes in relevant factors such as product, process, workload, or machine failure [16]; capability to manage and utilize the existing resources effectively in response to the internal and external environmental changes [17]; or capability to produce a variety of products in response to the customers need while maintaining high performance [9]. Despite different concepts of manufacturing flexibility exist, researchers commonly agree regarding the multidimensionality of manufacturing flexibility. For example, Koste and Malhotra [6] proposed seven dimensions to reflect the multidimensionality of manufacturing flexibility, D'Souza and Williams [18] suggested four dimensions of manufacturing flexibility exist, while Sethi and Sethi [19] recommend eleven dimensions are consisted in manufacturing flexibility. For detailed reviews on manufacturing flexibility theoretical and framework this study refers to Koste and Malhotra [6] and Slack [20].

A number of studies have investigated the performance implication of manufacturing flexibility. For example, Cousens et al. [1] found that manufacturing flexibility could be intended to improve the operational performance; i.e. manufacturing lead time and cost reduction and delivery speed and reliability improvement. The study of Zhang et al. [9] reveals evidence that product flexibility is significantly associated product quality and net profit improvement, while volume flexibility positively increases the sales growth. Meanwhile, Hallgren and Olhager [8] provided evidence regarding the positive impact of volume and product flexibility on operational performance improvement. Therefore, this study formulated the first hypothesis as follows.

Hypothesis 1: Manufacturing flexibility is positively and significantly associated with operational performance of manufacturing SMEs.

Manufacturing flexibility and innovation capability

Manufacturing flexibility has been cited as a means for improving operational performance such as cost, quality, and delivery speed [21]. Manufacturing flexibility also play an important role in supporting other firm competitive criteria, e.g. innovation [15]. This study considers manufacturing flexibility and innovation capability as separate constructs and explores their relationships. In this regard, it is argued manufacturing organizations could achieve a flexibility state without having to be innovative; however, to be innovative, they need to be flexible [14].

The relationship between manufacturing flexibility and innovation has been noted in previous studies. In this regard, Oke [15] have attempt to linked mix flexibility and labor flexibility to product innovation. He confirmed that the interactive term of mix flexibility and labor flexibility is positively associated with product innovation. Meanwhile, Camison and Vilar-Lopez [14] demonstrated that manufacturing flexibility, as a construct, is positively related to product, process, and organizational innovations. Similarly, Martinez-Sanchez et al. [22] proposed that the capability of companies to innovate their product and process, in some extent, rely on the extent to which the companies seek to develop and utilize their resources to be more flexible. Based on the above discussion, this study formulated the following working hypothesis.

Hypothesis 2: Manufacturing flexibility was positively and significantly associated with innovation capability of manufacturing SMEs.

Innovation capability and performance

Literature conceptualizes innovation in different ways. For example, innovation might be referenced as the adoption of an idea of behavior that is new to the firm [10]; the introduction of new processes, products, or ideas in the organization [12]; or the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations [23]. Literature also introduces the existence of different types of innovation. For instance, innovation might be distinguished between technical and administrative innovations, incremental and radical innovations, or product and process innovations [10]. Referring to OECD [23], this study distinguished innovation into four, i.e. product, process, organizational, and marketing innovations. It is argued that distinguishing between innovation types and their differential impact on performance is a prerequisite in order to understand exactly what the relationship between innovation and performance. The premise is that there are various types of innovations have fundamentally different characteristics [24]. Damanpour and Wischnevsky [13] suggested that a company need to foster its innovation capability degree to cope with the uncertain environment and market changes. Hult et al. [12] define innovation capability as the capacity of a company to engage in innovation, that is, the capacity to introduce of some new process, product, or idea in the organization. Calantone et al. [11] considered innovation capability as a special asset of a company and assigned it with a high consideration as a tool to achieve a higher performance. Guan and Ma [25] underlined that innovation capability would provides a company with the ability to quickly introduces new products and to develops new processes.

One research domain in the area of innovation is acknowledging the relationship between innovation capability and performance [24]. However, while different types of innovation have been proposed, previous studies tend to treat innovation as a single construct rather than considering all of innovation types and appear to draw much concern with product and process innovations [3]. Previous studies commonly seemed not to have concern with organizational innovation and marketing innovation. In fact, marketing and organizational innovations are equally essential in obtaining a sustained competitive advantage and higher performance ([10], [3]). Despite of innovation types and performance is concerned; prior studies mostly suggest that innovation capability and performance are positively related. Based on the above discussion, this study formulated the following working hypothesis.

Hypothesis 3: Innovation capability was positively and significantly associated with operational performance of manufacturing SMEs.

Mediating effect of innovation capability

As have been stated above, many researchers emphasized the role of manufacturing flexibility as a driver for effective innovation capability which contributes to firm performance ([6], [18], [19]). This innovation capability, in turn, will support in obtaining high performance [26]. Raymond and St-Pierre [2] assert innovation capability was positively related to manufacturing cost reduction, product quality improvement, and service level enhancement. To examine the role that innovation capability may play in the relationship between manufacturing flexibility and operational performance, this study propose the following hypothesis.

Hypothesis 4: Innovation capability mediates the relationship between manufacturing flexibility and operational performance in manufacturing SMEs

Methodology

Sample and data collection

This study followed a survey method to collect data by using a single respondent design. Sampling frame is the listing of manufacturing companies as listed in Indonesian Manufacturing Directory 2013 provided by the Indonesia Statistical Board. A purposive sampling method was employed to select the sample. A total of 428 structured questionnaires were directly distributed to the targeted sample with 252 questionnaires among of them were received. After checking their completeness, 14 questionnaires were not utilized in the analysis due to data missing and ambiguity answers. Thus the sampled companies are 238 firms. It consisted of 32.3% of firms operating within the electrical parts, 28.2% in machining jobs, 21.0% in automotive parts, and 18.5% in plastic/paper products sectors.

Variables measurement

To address the multidimensionality of manufacturing flexibility construct, five types of manufacturing flexibility were taken into account, i.e. product flexibility, machine flexibility, volume flexibility, routing flexibility, and labor flexibility. The items including in manufacturing flexibility were derived from Das [4] and Zhang et al. [9]. A total of 24 items was utilized to assess the five dimensions of manufacturing flexibility. In the survey, respondents were asked to indicate the extent of their agreement with each of the items on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). To address the multidimensionality of innovation capability construct, this study considers four types to capture innovation capability: product, process, organizational, and marketing innovation capability. The items for four types of innovation capability were adopted from Camison and Vilar-Lopez [14] and Guan and Ma [25]. A total of 20 items was employed to capture the four dimensions. In the survey, respondents were asked to indicate the extent of their agreement with each of the items on a five-point Likert-type scale ranging from 1 (much worse) to 5 (much better). Following the literature ([27], [28], [8]), operational performance construct was measured by having respondents' perceptions of their firm operational performance in term of product quality, manufacturing cost, and delivery dependability. In the survey, respondents were requested to provide the extent of their firm performance over the past 3 years, relative to that of their principal competitor. Five-point Likert scale was applied to measure this level of performance, ranging from 1 (much worse) to 5 (much better).

Data analysis method

The variables being investigated in study were treated as latent variables consisting of a distinct set of reflective indicators. Accordingly, a structural equation modelling (SEM) was applied to assess the structural model representing the relationship among the variables. This study applied the two-stage approach [29], in analyzing the proposed model using SEM. The first stage was concerned with assessing the adequacy of the measurement model in relation to reliability, validity, and dimensionality of the scales. In hence, confirmatory factor analysis (CFA) was applied. The second stage addressed examining the proposed hypotheses on the structural relationships among industrial clustering, manufacturing flexibility, innovation capability, and operational performance. This procedure was run by using AMOS 5 with maximum likelihood estimation techniques.

Research model

Based on the literature review, this study developed a research model (Figure 1). This model highlights that manufacturing flexibility (five dimensions) have a positive direct impact on innovation capability (four dimensions) which in turn affects operational performance (three dimensions). The research model was tested empirically in the case of Indonesian manufacturing SMEs.

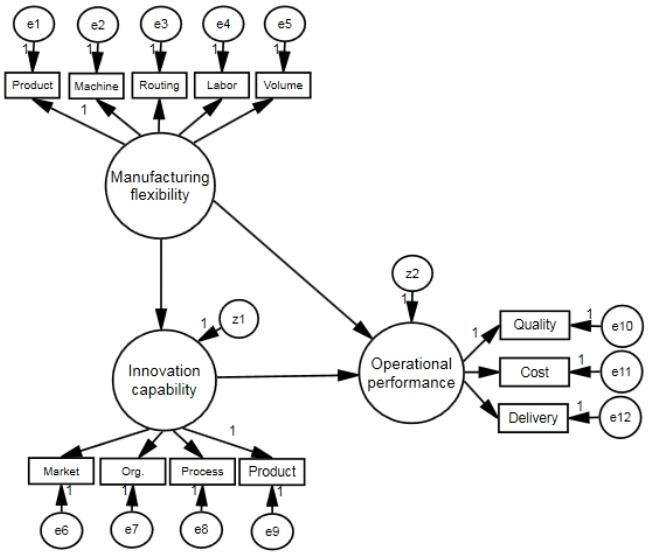

Fig. 1 Conceptual Model of This Study

Results and Discussion

Measurement model analysis

In first step, this study applied an unrotated principal component analysis (PCA) to assess to the dimensionality of each measuring scale of the latent variables being investigated. Next, this study calculated Cronbach alpha to assess internal consistency for each measuring scales. Table 1, Table 2, and Table 3 summarize the results of the test. As it emerged, the PCA generated factor loadings of ≥ 0.50 for

all measuring scales; while the reliability analysis provided Cronbach alpha of ≥ 0.70 for all constructs. Results lead to confirm the *scales validity* and reliability ([30], [31]).

TABLE 1. Validity and Reliability of Manufacturing Flexibility Scales

Dimensions	Items	Factor loading
Product flexibility (0.864)	Time required to introduce new products	0.793
	Cost of introducing new products	0.851
	Time required to accommodate minor design changes	0.827
	Cost of accommodating minor design changes	0.816
	Number of new operations required in minor design changes	0.732
Machine flexibility (0.891)	A typical machine can perform many types of operations	0.872
	A typical machine can effectively use many different tools	0.873
	Machines often become obsolete when new operations are required	0.831
	Machine set-up can be done quickly	0.843
	Machine set-ups are easy	0.750
Volume flexibility (0.876)	Operate efficiently at different levels of output	0.868
	Economically run various batch sizes	0.843
	Quickly change the quantities for our products produced	0.823
	Vary aggregate output from one period to the next	0.829
	Easily change the production volume of a manufacturing process	0.730
Routing flexibility (0.866)	A typical part operation can be routed to different machines	0.847
	A typical part can use many different routes	0.860
	The system has alternative routes in case machines break down	0.842
	Route changeovers are easy	0.833
Labor flexibility (0.862)	Workers can perform many types of operations effectively	0.874
	A typical worker can use many different tools effectively	0.799
	Cross-trained workers can perform effectively	0.811
	Workers can operate various types of machines	0.821
	Workers can be transferred easily between organizational units	0.710

TABLE 2. Validity and Reliability of Innovation Capability Scales

Dimensions	Items	Factor loading
Product IC (0.880)	Replace obsolete products	0.817
	Ability to extend the range of products	0.816
	Develop environmentally friendly products	0.824
	Improve product design	0.831
	Reduce new product development time	0.827
Process IC (0.881)	Master key manufacturing technologies	0.864
	Develop programs to reduce production costs	0.847
	Manage production facility	0.827
	Assigns resources to production department	0.898
Org. IC (0.909)	Improve employees retention	0.892
	Use inter-functional working groups	0.821
	Cooperate with suppliers	0.915
	Cooperate with customers	0.920
Marketing IC (0.912)	Introduce new products	0.869
	Develop distribution channels	0.886
	Explore new potential market	0.899
	Create promotion programs	0.903

TABLE 3. Validity and Reliability of Operational Performance Scales

Dimensions	Items	Factor loading
Cost (0.849)	Material cost reduction	0.891
	Labor cost reduction	0.899
	Overhead cost reduction	0.840
Quality (0.881)	High performance products	0.883
	Consistence quality with low deffects	0.886
	Durable products	0.860
	Working condition and safety	0.804
Delivery (0.771)	Dependable delivery	0.881
	Fast delivery	0.881

Structural model analysis

This study utilized a structural equation modeling (SEM) to assess causal relationships between manufacturing flexibility, innovation capability, and operational performance in manufacturing SMEs. In particular, this study assesses mediating effect of innovation capability through Baron and Kenny [32] method. Following these authors, this study needs to verify the significant relationship between manufacturing flexibility and innovation capability and also the significant relationship between innovation capability and operational performance. In this perspective, mediation is established if the effect of manufacturing flexibility variable on operational performance variable is reduced by innovation capability variable.

In this study, several fit indices were applied to verify the full structural models fit: Chi-Square value per degrees of freedom, the Goodness-of-fit index (GFI), the Tucker Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). In this perspective, this study needs to ensured that the Chi-Square value per degrees of freedom did not exceeded 3, the GFI value is greater than 0.90, the TLI value exceeded 0.95, and that the RMSEA value did not exceeded 0.08. Table 4 summarizes the results of the full structural models fit indices. As seen in Table 4, it was found that the model has a good adjustment to the data.

TABLE 4. Fit Indices of Model Tested

Fit indices	Level of acceptance	Model tested
X2/d.f.	≤ 3	1.44
GFI	> 0.90	0.923
TLI	> 0.90	0.955
RMSEA	< 0.08	0.060

TABLE 5. Results of Model Tested

Independent variable	Dependant variable	Standardized Estimate (β)	C.R.	P
Manufacturing flexibility	Operational performance	0.259	2.227	0.026
Manufacturing flexibility	Innovation capability	0.457	3.919	***
Innovation capability	Operational performance	0.648	6.138	***

As seen in Table 5, there is a positive relationship between manufacturing flexibility and operational performance ($\beta = 0.259$; $p < 0.05$). Therefore, H1 is supported. Results support the notion that manufacturing flexibility and firm performance are indeed positively related. A positive relationship between manufacturing flexibility and innovation capability is also established ($\beta = 0.457$; $p < 0.001$). Therefore, H2 is supported. As hypotesized in this study, there is a significantly positive relationship between innovation capability and operational performance ($\beta = 0.648$; $p < 0.001$). Therefore, H3 is supported. To test mediating effect of innovation capability in the relationship between manufacturing flexibility and operational performance, this study examined the relationship between manufacturing flexibility and innovation capability to determine if these two construct had significant relationship. Second, this study examined the relationship between manufacturing flexibility and operational performance to determine if these two construct had significant relationship. Third, this study examined the relationship between innovation capability and operational performance to determine if these two construct had significant relationship. Table 6 summarized the results of CFA for testing the mediating effect of innovation capability.

TABLE 6. The Results of CFA (Before and After Inclusion of Innovation Capability)

Independent variable	Dependent variable	Before inclusion	After inclusion
Manufacturing flexibility	Operational performance	0.529^{***}	0.259^{**}
Manufacturing flexibility	Innovation capability	0.535^{***}	0.457^{***}
Innovation capability	Operational performance	0.741^{***}	0.648^{***}

*** $p < 0.01$; ** $p < 0.05$

As seen in Table 6, manufacturing flexibility has significantly positive relationship with innovation capability. Therefore, the first condition for mediating effect of innovation capability is supported. Second, manufacturing flexibility has significantly positive relationship with operational performance. Therefore, the second condition for mediating effect of innovation capability is supported. Third, innovation capability has significantly positive relationship with operational performance. To test the third condition for mediating effect, this study examined the change in chi-square value for industrial clustering variable between before the inclusion of innovation capability variable and after the inclusion of innovation capability variable in the model. The significance of manufacturing flexibility on operational performance is reduced when innovation capability is included in the model. The results of CFA show the mediating effect of innovation capability in the relationship of manufacturing flexibility and operational performance. Therefore, H4 is supported.

The results presented in Table 6 demand manufacturing SMEs pursuing manufacturing flexibility should develop some degree of innovation capabilities to obtain the improvement in operational performance. Literature also highlighted that the adoption of flexible manufacturing system will not guarantee improvement in a company's performance. Literature also proposed manufacturing SMEs to use manufacturing flexibility to generate innovation capability in term of product, process, and marketing innovations ([9], [6], [20]). As hypothesized, results provided evidence that manufacturing flexibility is positively and significantly associated with innovation capability of manufacturing SMEs. The findings support the notion pertaining to the positive effects of manufacturing flexibility in fostering innovation capability of companies [15]. Furthermore, results indicate that innovation capability was positively and significantly associated with operational performance of manufacturing SMEs. The results confirm that manufacturing SMEs with higher capability to perform product, process, and marketing innovations are expected to have higher operational performance as measured by manufacturing cost, product quality, and delivery. The finding supported the notion regarding the positive effects of innovation capability on the firm performance ([10], [3]).

Conclusion

This study develops a conceptual model to examine the mediating role of innovation capability in the relationship between manufacturing flexibility and operational performance in manufacturing SMEs. The results show that manufacturing flexibility can positively enhance operational performance. However, if we include innovation capability as a mediator, the directly positive relationship between manufacturing flexibility and operational performance will attenuate. The results implies that manufacturing flexibility indirectly influences operational performance by influencing innovation capability. In other words, innovation capability plays a mediating role through which manufacturing flexibility benefits operational performance. This study contributes to literature on manufacturing flexibility in several ways. First, this study examines the effects of manufacturing flexibility on operational performance by utilizing five dimensions in manufacturing flexibility and three dimensions in operational performance. While the importance of manufacturing flexibility as important source for developing performance has been recognized, little is so far known as regards its effect on operational performance [8]. The results of this study contribute towards understanding about the simultaneous effects of product, machine, routing, volume, and labor flexibility on manufacturing cost, product quality, and delivery performance based on empirical data. Second, this study evaluates the effects of manufacturing flexibility on innovation capability and operational performance. Studies focusing on manufacturing flexibility and innovation are

limited [15]. In addition, previous studies mostly put a greater emphasize on the effect of manufacturing flexibility on economic-based performance [8]. The results of this study contribute towards understanding about the simultaneous effects of machine flexibility, product flexibility, volume flexibility, routing flexibility, and labor flexibility on innovation capability and operational performance as well. Third, this study evaluates the inclusion of innovation capability in the relationship of manufacturing flexibility and operational performance. The results of this study provide more insights regarding how manufacturing flexibility affects operational performance. The findings make a contribution to the manufacturing flexibility literature by clarifying the role that innovation capability plays in the relationship involving manufacturing flexibility and operational performance.

References

[1] Cousens, A., Szwejczewski, M., Sweeney, M., 2009. A process for managing manufacturing flexibility. *International Journal of Operations & Production Management*, 29(4), 357-385

[2] Raymond, L., St-Pierre, J., 2005. Antecedents and performance outcomes of advanced manufacturing systems sophistication in SMEs. *International Journal of Operations & Production Management*, 25(6), 514 – 533

[3] Gunday, G., Ulusoy, G., Kilic, K., Alpkan, L., 2011. Effects of innovation types on firm performance. *International Journal of Production Economics*, 133 (2), 662–676

[4] Das, A., 2001. Towards theory building in manufacturing flexibility. *International Journal of production research*. 39 (18), 4153-4177

[5] Gupta, P.Y., Somers, M.T., 1996. Business Strategy, Manufacturing flexibility, and organizational performance; a path analysis approach, Production and Operational Management, 5 (3), 204-233

[6] Koste, L.L., Malhotra, K.M., 1999. A theoretical framework for analyzing the dimensions of manufacturing flexibility. *Journal of Operations Management*, 18(1), 75-93

[7] Jack, P.E., Raturi, A., 2002. Sources of volume flexibility and their impact on performance. *Journal of Operations Management*, 20(5), 519-548

[8] Hallgren, M., Olhager, J., 2009. Flexibility configurations: Empirical analysis of volume and product mix flexibility. *Omega*, 37(4), 746-756

[9] Zhang, Q., Vonderembse, A.M., Lim, J.S., 2003. Manufacturing flexibility: defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management*, 21(2), 173-191

[10] Damanpour, F., Szabat, K.A., Evan, W.M., 1989. The relationship between types of innovation and organizational performance. *Journal of Management Studies*, 26(6), 587–601

[11] Calantone, J.R., Cavusgila, T.S., Zhao, Y., 2002. Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, 31, 515– 524

[12] Hult, M.T.G., Robert F. Hurley, F.R., Gary A. Knight, A.G., 2004. Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management*, 33, 429– 438

[13] Damanpour, F., Wischnevsky, D.J., 2006. Research on innovation in organizations: Distinguishing innovation-generating from innovation-adopting organizations. *Journal of Engineering and Technology Management*, 23(4), 269–291

[14] Camison, C., Vilar-Lopez, A., 2010. An examination of the relationship between manufacturing flexibility and firm performance; the mediating role of innovation. *International Journal of Operations & Production Management*, 30 (8), 853-878

[15] Oke, A., 2011. Linking manufacturing flexibility to innovation performance in manufacturing plants. *International Journal of Production Economics*, In Press, Available online 14 September 2011

[16] Tsubone, H., Horikawa, M., 1999. A Comparison between machine flexibility and routing flexibility. *The International Journal of Flexible Manufacturing System*, 11 (1), 83–101

[17] Petroni, A., Bevilacqua, M., 2002. Identifying manufacturing flexibility best practices in small and medium enterprises. *International Journal of Operations & Production Management*, 22(8), 929 – 947

[18] D'Souza, E.D., Williams, P.F., 2000. Toward a taxonomy of manufacturing flexibility dimensions. *Journal of Operations Management*, 18(5), 577-593

[19] Sethi, A.K., Sethi, S.P., 1990. Flexibility In Manufacturing: A Survey. *International Journal of Flexible Manufacturing Systems*, 2(4), 289-328

[20] Slack, N., 2005. The flexibility of manufacturing systems. *International Journal of Operations & Production Management*. 25(12), 1190 – 1200

[21] Vokurka, J.R., O'Leary-Kelly, W.S., 2000. A review of empirical research on manufacturing flexibility. *Journal of Operations Management*, 18(4), 485–501

[22] Martinez-Sanchez, A., Vela-Jimenez, J.M., de Luiz-Carnicer, P. Perez-Perez, M., 2009. Managerial perceptions of workplace flexibility and firm performance. *International Journal of Operations & Production Management*, 27(7), 714 – 734

[23] OCDE., 2005. *The Measurement of Scientific and Technological Activities. Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data*, 3rd ed. Organisation for Economic Co-operation and Development Eurostat, Paris,

[24] Subramanian, A., Nilakanta, S., 1996. Organisational innovativeness: exploring the relationship between organisational determinants of innovation, types of innovations, and measures of organisational performance. *Omega*, 24(6), 631–647

[25] Guan, J., Ma, N., 2003. Innovative capability and export performance of Chinese firms. *Technovation*, 23(9), 737–747

[26] Sher, J.P., Yang, Y.P., 2005. The effects of innovative capabilities and R&D clustering on firm performance: the evidence of Taiwan's semiconductor industry, *Technovation*, 25(1), 33-43

[27] Abdel-Maksoud, B.A., 2004. Manufacturing in the UK: contemporary characteristics and performance indicators. *Journal of Manufacturing Technology Management*, 15 (2), 155 – 171

[28] Alegre-Vidal, J., Lapiedra-Alcami, R., Chiva-Gomez, R. (2004). Linking operations strategy and product innovation: an empirical study of Spanish ceramic tile producers. *Research Policy*, 33(5), 829-839

[29] Anderson, J.C., Gerbing, D.W., 1988. Structural equation modelling in practice: a review and recommended two-step approach, *Psychology Bulletin*, 103 (3), 411–423

[30] Fornell, C. and Larcker, D.F. 1981. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, 18 (1), 39-50

[31] Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1995. *Multivariate Data Analysis with Readings*. Prentice-Hall, New York

[32] Baron, R.M. and Kenny, D.A. 1986. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Penality and Social Psychology*, 51(6), 1173-1182