The Relationship Between of Manufacturing Flexibility, Innovation Capability, and Operational Performance in Indonesian Manufacturing SMEs

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Abstract. This study examined the relationship between manufacturing flexibility competence and operational performance with technological innovation capability as mediator variables. A survey method was applied to collect data pertaining to the variables being investigated. The findings indicated that manufacturing flexibility competence is positively associated with technological innovation capability and operational performance. The findings also suggested that technological innovation capability types mediated positively to the operational performance implication of manufacturing flexibility competence. This implies that manufacturing organizations pursuing manufacturing flexibility competence need to develop technological innovation capability in obtaining a high operational performance.

Keywords: Manufacturing flexibility competence, technological innovation capability, operational performance

INTRODUCTION
The current business environment characterized by a high degree of uncertainty and intense competition, has alerted many manufacturing companies to pursue programs in order to improve their performance in term of product quality, manufacturing cost, and delivery speed ([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. Literature posited that manufacturing flexibility is a means for improving operational performance. In this line, manufacturing flexibility is defined as the capability to manage and utilize the
existing resources effectively in response to the internal and external environmental changes ([4], [5]). Likewise, there have been many studies on different types of innovation and their performance implication in the extant literature [3]. Indeed literature has often treated both manufacturing flexibility and innovation as competitive criteria. In other words, manufacturing flexibility and innovation are seen as operations performance objectives of manufacturing firms. However, researchers do not pay attention of any empirical study that has attempted to link manufacturing flexibility to innovation. In this perspective, it has been argued that while a manufacturing plant can attain flexibility state without having to be innovative, the reverse is not true [6].

Moreover, despite there are many researches focusing on the relationship between manufacturing flexibility and firm performance, few empirical studies have been realized to examine how manufacturing flexibility competence contributes to operational performance and to determine in particular mediating variables in relation to the manufacturing flexibility competence that could improve firm performance [7]. There is a need for more research examining the direct and indirect relationships involving manufacturing flexibility and performance [5]. To address these issues, this study attempt to provide empirical evidence by investigating the relationship involving manufacturing flexibility competence (MFC), technological innovation capability (TIC), and operational performance (OP). As demonstrated by Oke [6], mix and labor flexibilities have a positive effect on product innovation. Camison and Vilar- Lopez [8] suggested also that manufacturing flexibility influences product, process, and organizational innovations has a positive effect on innovation capability which in turn contributes to firm performance. As such, TIC may be a mediator variable between MFC and OP in manufacturing plant. The objective in this study is to advance the current knowledge by examining the relationships between MFC, TIC and OP within the context of the Indonesian manufacturing companies. In particular, a major objective in this study was to examine the effect of MFC on OP and the mediating effect of TIC between these variables.

**HYPOTHESES DEVELOPMENT**

Based on the extant literature, this study proposed a conceptual framework as guidelines for the conduct of data analysis and hypotheses development (Figure 1). The framework postulated that manufacturing organizations need to improve their operational performance to survive and remain competitive in the recent severe marketplace. Toward this end, they need to develop some degree of manufacturing flexibility competence and direct it to speed up innovation capability and operational performance. This study puts forward four hypotheses and will be examined in the context of Indonesian manufacturing SMEs (Table 1).

![Table 1. Hypotheses examined in this study](image)

Table 1. Hypotheses examined in this study
The first hypothesis is concerned with the relationship between MFC and OP. It is argued that manufacturing organizations need to take into account manufacturing flexibility to be able to provide customer with better products with lower cost [5]. Petroni and Bevilacqua [4] contended manufacturing flexibility enables manufacturing organizations to cope with market and environmental changes while maintaining their production and operation run efficiently. Therefore, this study proposed manufacturing organizations with a higher MFC would obtain a higher OP. The fourth hypothesis was intended to assess the relationship involving MFC and TIC. It is asserted that manufacturing flexibility could be directed towards speeding up the introduction of products, as a critical stage of the innovation process [4]. In addition, flexible manufacturing organizations tend to expose their workforce with a broad range of manufacturing tasks. This in turn would advance the workforce skills and knowledge, which can provide a greater opportunity in creating new ideas as an initial stage in an innovation process [6]. It is proposed that manufacturing flexibility associate with the ability to change: one type of ability needed by manufacturing organizations to innovate their production and operational processes [9]. Accordingly, this study proposed that the higher MFC is associated with the higher TIC. The third hypothesis was dealing with the relationship between TIC and OP. Previous studies contended innovation capability as one essential competence for manufacturing organizations to improve their performance and subsequent to obtain competitive advantage ([2], [8]). It is asserted that innovation capability positively associated with the manufacturing cost reduction and product quality improvement [2]. Accordingly, this research hypothesized TIC would provide a positive effect towards OP. The fourth hypothesis addresses the direct
and indirect effects of MFC towards OP. Literature has proposed manufacturing flexibility could be directed towards the operational performance improvement, such as cost, quality, and delivery speed ([1], [5]). Manufacturing flexibility is also linked to innovation capability enhancement ([6], [8]). Meanwhile, literature on innovation suggest that one important factor for manufacturing organizations in achieving a high operational performance is the extent to which their innovation capability ([10], [11], [12]). Thus, this research hypothesized manufacturing flexibility directly would provide a positive effect towards operational performance. At the same time, innovation capability would provide a positive effect on the relationship between manufacturing flexibility and operational performance.

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 total of 428 structured questionnaires were directly distributed to the targeted sample with 238 questionnaires among of them were utilized. It consisted of firms operating within the electrical parts, machining jobs, automotive parts, and plastic/paper products sectors.

Variables measurement
To address the multidimensionality of MFC, four types of MFC were taken into account: machine flexibility, material handling flexibility, routing flexibility, and labor flexibility. The items for four types of manufacturing flexibility were adopted from Zhang et al. [13] work. 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). This study considers two types to capture TIC construct: product and process innovation capability. The items for TIC were adopted from Camison and Vilar-Lopez [8]. 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 ([7], [14], [15]), OP 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
This study applied the two-stage approach [16], in analyzing the proposed model. 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 MFC, TIC, and OP. This procedure was run by using AMOS 5 with maximum likelihood estimation techniques.

RESULTS AND DISCUSSIONS
Measurement model analysis
Following previous studies ([13], [17]), 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. As it emerged, the PCA generated factor loadings of $\geq 0.50$ 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 ([18], [19]).

This study assessed the existence of non-response bias by examining the significant difference between the responses of early and late groups of returned surveys, presuming that the response of late respondents is representative of the response of non-respondents. This study performed an independent sample t-test on the responses of the two groups. The results indicate the early and the late responses have no significant differences in term of means and standard deviation ($p>0.05$); suggesting that non-response bias was not a problem in this study.

This study also concerned with the existence of a common method variance issue, considering that this research utilized a single respondent design [20]. Harman's one-factor test was applied to examine the existence of a common method variance. Towards this end, all items were subjected to unrotated principal component analysis (PCA) and the number of factors extracted from these items was examined [21]. The PCA provides seven factors extracted from items in MFC construct with the first factor explaining 13.38%; five factors were extracted from items comprised in TIC construct with the first factor explaining 16.11%; and two factors were extracted from items containing in OP construct with the first factor explaining 48.52%. Considering there was no single factor that emerged from the unrotated factor solutions and the first factor did not explain the majority of the variance, therefore, common method bias was not a significant concern in this study [20].

**Structural model analysis**

Existing literature often examine separately the relationship involving MFC, TIC, and OP. For this reason, this study has developed a structural model representing the simultaneous relationship involving the three constructs. Four fit indices were applied to verify the full structural models fit. In this perspective, this study needs to ensured that the Chi-Square value per degrees of freedom did not exceeded 3, the Goodness-of-fit index ($GFI$) value is greater than 0.90, the Tucker Lewis Index (TLI) value exceeded 0.95, and that the Root Mean Square Error of Approximation (RMSEA) value did not exceeded 0.06. Table 2 summarized the results of CFA for the model. As can be seen in Table 1, the factor loadings of dimensions were higher than the minimum recommended value of 0.50. Furthermore, the results provide the $X^2 = 37.886; p = 0.019$, and d.f. = 22, indicating that the structural model developed to represent the simultaneous relationship between MFC, TIC, and OP constructs fit. The three individual goodness of fit measures (the GFI = 0.936; the TLI = 0.968; and the RMSEA = 0.047) also indicate that the structural model fit.

| Table 2. Results of CFA for the relationship involving MFC, TIC, and OP |
|---------------------------------|-----------------|-----------------|
| Independent variable | Dependent variable | $\beta$ | C.R. |
| MFC | OP | 0.170** | 2.428 |
| MFC | TIC | 0.480*** | 4.794 |
| TIC | OP | 0.757*** | 8.393 |
| MFC | Machine flexibility | 0.895 | |
| | Routing flexibility | 0.802 | |
| | M. handling flexibility | 0.755 | |
| | Labor flexibility | 0.711 | |
| TIC | Product IC | 0.800 | |
| | Process IC | 0.836 | |
| OP | Manufacturing cost | 0.817 | |
| | Product quality | 0.827 | |
| | Delivery | 0.850 | |

*** $p < 0.01$; ** $p < 0.05$
The first hypothesis was concerned with the relationship between MFC and OP. The results, presented in Table 1, confirmed that MFC was positively associated with ($\beta=0.170; p<0.05$). Therefore, hypothesis 1 was supported. The second hypothesis was concerned with the relationship between MFC and TIC. The results confirmed that MFC was positively associated with TIC ($\beta=0.480; p<0.01$). Accordingly, hypothesis 2 was supported. The third hypothesis was concerned with the relationship between TIC and OP. The results presented in verified that TIC was positively associated with OP ($\beta=0.757; p<0.01$). Therefore, hypothesis 3 was supported. The fourth hypothesis dealt with the relationship between MFC and OP, with the TIC as mediating variable in the relationship. To test the hypothesis, this research particularly developed two models. Model 1 compresses two variables, namely MFC and OP. Model 1 examined the direct effects of MFC on OP. Meanwhile, Model 2 consists of three variables, namely MFC, OP, and TIC. Model 2 tested the indirect effects of MFC on OP, that is, via TIC. The results confirmed that the model to represent the direct relationship between MFC and OP fit. In this regard, the CFA provided the $X^2 = 25.836; \text{d.f.} = 13; p = 0.010$; the GFI = 0.956; the TLI=0.983; and the RMSEA = 0.012. Comparing the results of Models 1 and 2, it is found that the direct effect of MFC on OP in Model 1 ($\beta=0.532; p<0.01$) becomes lower in Model 2 ($\beta=0.170; p<0.05$). The results provide evidence that TIC mediates the relationship between MFC and OP. Therefore, hypothesis 4 was supported.

The results demand manufacturing organizations pursuing MFC should develop some degree of TIC to obtain the improvement in operational performance. The premise is that the adoption of MFC will not guarantee improvement in OP. In other words, manufacturing organizations need to adopt and use MFC to generate TIC in term of product and process innovation capability. Furthermore, results indicate that TIC was positively and significantly associated with OP. The results confirm that manufacturing organizations with higher capability to perform product and process innovations are expected to have higher OP as measured by manufacturing cost, product quality, and delivery.

CONCLUSIONS
This study develops a conceptual model to examine the mediating role of TIC in the relationship between MFC and OP. The results show that MFC can positively enhance OP. However, if we include TIC as a mediator, the directly positive relationship between MFC and OP will attenuate. The results implies that MFC indirectly influences OP by influencing TIC. In other words, TIC plays a mediating role through which MFC benefits OP. The results of this study contribute towards understanding about the simultaneous effects of MFC and TIC on OP based on empirical data: noting studies focusing on manufacturing flexibility and innovation are limited [6]. The findings make a contribution to the literature by clarifying the role that TIC plays in the relationship involving MFC and OP.

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