The impact of new product flexibility (NPF) on operational performance: evidence from Jordanian manufacturing companies

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Abstract
The study investigated the impact of new product flexibility (NPF) on operational performance of manufacturing companies in Jordan. The results indicated that NPF positively affects operational performance by improving quality, increasing productivity, decreasing cost and lead-time. Directions for future research for managers are included in this study.

Keywords: new product flexibility, quality, and operational performance.

Introduction
New product flexibility (NPF) is the ability of a firm to launch new parts and products into the market in response to changing business environment. It is master key for maintaining and developing the competitive advantage. Manufacturing flexibility is viewed as a strategic capability and competitive priority that should be considered to compete on quality, quick delivery, cost, and responsiveness since the popular strategies of cost saving and quality improvement are no longer sufficient to win the competitive battles. To win a battle(s) companies should create and dominate new markets by developing new products (Ozer, 1999). However, NPF strategy combines operations strategy with marketing strategy to improve and sustain competitive advantage by responding to changes in customer’s needs and expectations. Therefore, NPF is strategically linked to a firm’s survival and success, in particular, if a firm has the ability to thrive in a turbulent or uncertain business environment.

Literature
Flexibility is characterized as a multi-dimensional construct (Sethi and Sethi, 1990). Literature on flexibility (i.e. Sethi and Sethi, 1990; Narasimhan and Das, 2000) shows it is classified into different dimensions such as market flexibility, machine flexibility, labor flexibility, supply chain flexibility, NPF, process flexibility, volume flexibility, expansion flexibility, modification flexibility, etc., where each dimension has main jobs to do. Manufacturing flexibility is the ability of the organization to manage production resources and uncertainty to meet various customers’ requests (Zhang et al., 2003). This means that the main job of flexibility is coping with uncertainty to respond effectively and efficiently to changes result from uncertain business environment. NPF is a strategic dimension of manufacturing flexibility (Narasimhan and Das, 2000) because it positively affects organizational performance in the short and long run since it is the ability of a manufacturing system to introduce and manufacture new parts and products (Das, 2001). NPF strategic importance comes from different jobs and functions. First, it is highly correlated with other dimensions of flexibility like product mix flexibility and modification flexibility (Chang et al, 2002). Second, NPF contributes to customer satisfaction and enables organizations to adopt customization strategy (Narasimhan and Das, 1999). Third, NPF has a positive relationship with new product performance (Larso, 2004), as it can reduce costs. Finally, it is required for firms that compete on innovation and customization (Das, 2001).
Despite of the strategic importance of NPF for organization’s growth and survival, flexibility is limited by the product development process, available technology, labor skills, job design, and materials management. Coordination between these activities is critical for developing products and manufacturing them (Rogers, 2008). To overcome these limitations, new product development (NPD) flexibility should be increased by managing three main variables: technology; development process; and competences (Buganza et al., 2010). In this context, Anderson (2008) suggests the following key contributors for NPD success: Commitment from senior management; clear delegated authority to improve NPD management; and good cooperation and communication across the key internal stakeholders involved.

In general, the main driving force behind NPD projects is change and uncertainty. Therefore, one of the central problems that face organizations is how to cope with the uncertainties arising from the globalization of economics; internationalization of competition; increasing pressures to innovate; short life cycles of products, brands, and technology. Cousens et al. (2009) point out that NPD is one of the best ways to manage demand in response to uncertainty that may be caused by market, innovation, competitors’ behavior, seasonality, customers, supply chain management, planning and control. They indicate that the external drivers of the need for flexibility are the expectations of customers for both reductions in their suppliers’ delivery lead time and an increasing number of new product introductions. This means that NPF is always needed for response to changes in customers’ expectations and preferences. Similarly, Eng and Quaia (2009) indicate that NPD in uncertain environments is volatile in terms of constant changes in technology, customer needs, competition, legislation and political environments. Firms operating in such uncertain environments are faced with an intense competitive pressure to innovate and a high risk of NPD failure. In the same vein, Narasimhan and Das (2000) characterize the NPF as a strategic capability that enables organizations to respond to new cycle of the product.

Based on the above argument, it could be concluded that launching new products is critical to long-term survival and success of a firm in today’s globally competitive environment (Song and Noh, 2006). This means that measuring strategic and operational performance is dependent to some extent on NPD strategy. The strategic objective of managing product life cycle is to maximize the product’s value and profitability at each stage. Thrassou et al., (2012) suggest that value lies at the heart of the innovation, as it responds to any change in consumer behavior and shapes the strategic role of marketing. As a result, practices and activities of NPD can be done in response to changes related to the stages of product life cycle. This means that different functional strategies and techniques should be implemented during the various stages of the product life cycle in order to enhance firm performance (Slack et al., 2001).

In summary, NPF is required and needed for coping with the turbulence of today’s business environment to respond to the changes attributed to short product life cycles, demand for product customization, pressures of globalization, technological innovation, dramatic changes in customer expectations, competition, and technology (Arsis and Zhang, 2002; Zhang et al., 2003).

**Operational Performance**

Organizational performance is one of the most important constructs in management research where all functions in the organization (marketing, operations, human resources, and strategy) are ultimately judged by their contribution to organizational performance (Richard et al., 2009). This means that operations strategy and other functional strategies are evaluated and judged based on their contribution to organizational performance. Therefore, it is believed that the success of NPD should be linked to organizational performance to determine how the performance is improved in recognition to pre-determined standards in terms of quantity and quality. Operational performance rather than organizational performance was considered in this study since it is believed that the outcomes of operational performance can be noted and measured directly in the short and long run by linking them to planned objectives. Operational performance refers to the measurable aspects of the outcomes of an organization’s processes, such as reliability, production cycle time, and inventory turns. Operational performance in turn affects business performance measures such as market share and customer satisfaction (Voss et al., 1997). Therefore, it is expected that NPF contributes to operational performance by reducing cost and lead-time and improving quality. In the empirical work done by Larso (2004) the author argues that the performance of new
product is determined based on internal factors including quality, cost, time to market, and lead-time; and external factors that represent the financial measures including sales performance measured by total sales, market share, and sales growth; besides to profitability measures including both the level of profits and profits against planned objectives.

However, this study was undertaken to:

- To examine the extent that Jordanian manufacturing companies perform well on each of the operational performance criteria including quality, productivity, cycle time, and cost efficiency.
- To identify the causal relationship between NPF and operational performance.

However, the logic behind linking NPF to operational performance is the fact that organizational performance is the ultimate dependent variable of interest for researchers concerned with any area of management (Richard et al., 2009).

**Population and Sample**

The entire population that comprises all manufacturing companies listed in Amman stock exchange market was chosen as the sample of this study. This population includes 93 industrial companies according to the report of Amman Stock Exchange for the year 2009. The respondents of this study are executives with titles of operations manager, head of operations department, marketing manager, and head of marketing department. The targeted population was chosen because the industrial sector is more relevant and clearly reflects the constructs of this research since its variables are related to manufacturing rather than services. A total of 320 questionnaires were distributed. 230 questionnaires were returned, of which 218 completed questionnaires were returned.

**Research Model and Hypothesis**

The research model seen in Figure 1 is designed to predict the causal relationships between NPF and operational performance of a firm.

![Figure 1: The theoretical research model](image)

Structural equation modeling through the EQS 6.1 software was utilized to test the model. Figure 2 represents the structural research model.
Based on the above model, the main hypothesis of this research is formulated as follows:

**HI:** *NPF positively contributes to operational performance of a firm.*

This main hypothesis suggests that NPF based on dimensions of range, mobility, and uniformity positively affects operational performance by improving quality, increasing productivity, decreasing cycle time, and decreasing cost.

**Data Collection Methods and Measurement of the Research Constructs**

Data collection consisted of a questionnaire designed to test the model. The measurement scales used in this study are adapted from previous empirical research conducted in the fields of organizational performance, NPD, and NPF. These measurements are validated with respect to the results of exploratory factor analysis and confirmed in recognition of the results of confirmatory factor analysis (CFA) that emerged from data analysis in this study.

**Measurement of Operational Performance Construct**

The operational performance construct was measured with referring to measurement scales in the previous work of Voss et al., 1997; Parajogo, 2007; and Bayraktar et al., 2009. Respondents were asked to indicate on a 5-point scale, ranging from “strongly disagree” (1) to "strongly agree" (5) on how their business had performed over the last 3 years relative to their major competitors on each of the operational performance criteria displayed in Table 3. It was noted that the operational performance construct was divided into four dimensions including quality, productivity, cycle time, and cost efficiency. This was done with respect to the results emerged from factor analysis.

**Measurement of NPF Construct**

In this study, NPF was measured depending on the measurement scales and indicators that were used in the previous empirical work of Gupta and Somers, 1996; Koste et al., 2004; Rogers, 2008). Respondents were asked to indicate on a 5-point scale, ranging from “strongly disagree” (1) to "strongly agree" (5) the extent that their companies can use the different dimensions of NPF in launching new products into the market.

**Data Analysis, Hypothesis Testing, and Discussion**

**Exploratory Factor Analysis (EFA)**
The initial factor analysis indicated the existence of dimensions (four-factor solution) of operational performance construct. These dimensions (sub-constructs) are named as quality, productivity, cycle time, and cost efficiency. This result is considered in consistency with the literature on organizational (Voss et al., 1997). Loadings for the four factors were greater than .50, ranging from range from 0.59 to 0.93.

NPF construct is divided into three sub-constructs as the items determined for measuring the main construct are loaded on three factors which are named and labeled as follows: NPF based on range dimension (NPF_R). NPF based on mobility dimension (NPF-M). NPF based on uniformity dimension (NPF_U).

The literature on manufacturing flexibility (e.g. Slack, 1987) supports the idea that each type of manufacturing flexibility has three distinct attributes: range/variety, mobility/responsiveness, and uniformity).

Reliability and Validity
A reliability test was carried out using Cronbach’s alpha, which measures the internal consistency of a construct. The results can be seen in Table 3 and 4. In this study, the survey instrument was checked with executives and academic experts who were asked to review the questionnaire for readability, ambiguity, completeness, and to evaluate whether individual items appeared to be appropriate measures of their respective constructs (Dillman, 1978). This process led to several minor changes, which were made prior to generating the final version of questionnaire, though the items were drawn from previous studies having validated survey instruments. In addition, the constructs of this study were conceptually defined based on reviewing the literature and previous empirical studies. This procedure ensures that the factors’ scales are considered to have face validity (Hair et al., 2009). Construct validity was considered to insure that each item measures only the particular construct it is designed to measure. It was determined through principal components factor analysis and item-to-scale correlation analysis. Tables 3 and 4 contain the results of factor analysis and indicate the items that represent the expected construct. The results of factor analysis presented in section 5.1 give the evidence that all these criteria are met, indicating that the convergent validity is ensured.

Confirmatory Factor Analysis (CFA)
Structural equation modeling (SEM) was utilized to test the relationships between NPF (independent variable) and operational performance (dependent variable). This study used EQS 6.1 for data analysis. The main hypothesis of this study is formulated to investigate and examine the effect of NPF on the operational performance of a firm. To ensure that the hypothesized model is fit, the goodness-of-fit measures recommended by Hair et al. (2009) were used in this study. These measures include: Absolute fit measures (AFM) including Chi-square $X^2$ accompanied by the model’s degrees of freedom and its probability, goodness of fit index (GFI), and the root mean square error of approximation (RMSEA). These measures assess the overall model fit (both structural and measurement model collectively); and Incremental fit measures (IFM) including indices such as Tucker-Lewis index (TLI) and comparative fit index (CFI). According to Chau (1997), the recommended value of Chi-square $X^2$ accompanied by the model’s degrees of freedom and its probability is ≤ 3.0 and $P \geq 0.05$, and the recommended values of GFI; RMSEA; TLI; and CFI are $\geq 0.90$; $\leq 0.10$; $\geq 0.90$; and $\leq 0.90$ respectively.

Figure 3 shows the structural model of the relationship between NPF and operational performance (OP) and all the goodness-of-fit measures exceeded the recommended cut-off values (Chi-square = 12.5, $P = 0.33$; GFI = 0.96; RMSEA = 0.04; TLI = 0.98; and CFI = 0.99), and the path loadings were significant. In other words, Figure 3 shows that the structural model was estimated with two latent variables (NPF and OP) and one path. The review of the hypothesized model revealed that (beta=0.52, t-value =2.56) of the completely standardized coefficient of NPF $\rightarrow$ PO regression path is significant. The coefficient of determination $R^2$ of the (regression path: NPF $\rightarrow$ PO) = 0.266. This means that 26.6% of the total variance in the (OP: operational performance) was accounted for by the NPF. These results support the findings that emerged from EFA. The findings of structural equation model revealed that hypothesis $H_1$, which predicts a direct positive relationship between NPF and operational performance was accepted. This conclusion implies that NPF positively affects operational performance in several ways: Improving quality; increasing productivity; decreasing lead-time; and minimizing cost.
This study has found a positive relationship between NPF and operational performance. This result is expected since flexibility as a whole concept is needed to respond effectively and efficiently to changing business environment. Therefore, the NPF as a strategic flexibility is needed for coping with uncertain business environments that characterized by rapid changes, shorter product life cycles, increasing of competitors’ threats, and rapid pace of technological innovation. The results of this study are also consistent with the literature on NPD and NPF in which the success of NPD projects depends to the large extent on the ability of a firm to cope with uncertainties in the business environment. In this vein, Mullins and Sutherland (1998) identify three levels of uncertainty that confront firms operating in rapidly changing markets. First, potential customers cannot easily articulate needs that a new technology may fulfill. Second, NPD managers are uncertain about how to turn the new technologies into products that meet customer needs. Finally, senior management faces uncertainty about how much capital to invest in pursuit of rapidly changing markets as well as when to invest. To this end, it could be said that NPF has a main job to do. Its job is giving a firm the ability to launch new products quickly. By linking the above three levels of uncertainty mentioned by Mullins and Sutherland (1998) to the NPF’s job, it could be concluded that NPF can act as a facilitator that enables a firm to overcome the difficulties, constraints, impediments, and barriers that confront firms when planning for NPD projects. This conclusion means that a firm can check its NPF status by examining the ability of its manufacturing systems to: produce a large number of new product prototypes, make extensions of new existing product lines, produce new innovative products, increase the variety of new products, reduce the time required to develop and introduce new products, minimize the production cost, increasing productivity rate and output, increase and improve operational performance, and engender competitive advantage by proving products that meet or exceed customer needs and expectations. Consequently, if a firm can meet the above abilities, NPD managers are more able to launch new products successfully, and more confident to cope with uncertainties caused by changes in marketing and manufacturing issues such as the changes in customers’ expectations, product innovation, customized products, intense competition, and new communication technologies. In this sense, Mullins and Sutherland (1998) argue that uncertainty arises from managers’ difficulties in translating technological advancements into product features and benefits. Thus, it is the NPF that enables NPD mangers to cope with these uncertainties by launching new products into the current markets or entering new ones. The results of this study are also supported by other results emerged from previous empirical work. For instance, Das (2001) found significant relationship between NPF and each of customization responsiveness performance, reduction of new product time introduction, and purchasing competence. He also found that companies competing on innovation and customization should focus on developing NPF. The results of this study consistently agree with Chang et al. (2002) who have found a positive relationship between NPF and sales growth. In the same vein Larso (2004) found that NPF has a positive relationship with new product performance measured by cost, delivery, quality, and market success. In addition, it was found that NPF and process flexibility are related to performance in

Figure 3: The hypothesized model of the relationship between NPF and operational performance
the work done by Rogers (2008) who has found that manufacturing flexibility and advanced manufacturing technology contribute to organizational performance. In summary, NPF is a competitive priority that enhances operational performance of a firm. This conclusion is in line with the argument present by Corrêa, (1992) who suggests that manufacturing companies should strategically address the following main competitive priorities: cost: to produce and manufacture at lower rates of cost; cost dependability: to meet the required or intended costs; productivity: to achieve the best utilization ratio of process technology, labor and material resources; product quality: to manufacture products with high performance and conformance to standards; range of products: to launch new products with a broad range; innovativeness: to introduce new parts, products or processes; delivery speed: to react quickly to customer orders; delivery dependability: to meet delivery schedules or promises; and flexibility: to respond effectively and efficiently to changing circumstances in business environments.

Conclusions and Managerial Implications

It was found a direct positive relationship between NPF and operational performance. This conclusion implies that NPF contribute to the achievement of operational performance by: improving quality; increasing productivity; decreasing lead-time; and, minimizing cost.

The findings of this research have the following practical implications for managers: organizations should eliminate the non-profitable products over the product life cycle by positioning new products to replace them instead of the moribund products. NPF is a dynamic capability that enables a firm to deal with competitors’ actions and their abilities to launch new products and impacts on the strategic decisions of entry to or exit from the markets. Organizations need to have NPF to enhance their organizational performance through rapid entry to new product markets or penetrating new market segmentations. Organizations need to plan and implement their operations and marketing strategies to respond effectively and efficiently to shortened product life cycles by focusing on NPD and NPF.

Limitations and Further Directions for Future Research

It should be noted that the study was not without limitations. Measures of NPF are subjective and situational, i.e. lack generality and the sample was limited to the Jordanian manufacturing companies listed in Amman Stock Exchange Market as public industrial shareholding companies. Thus, it is not representative of all manufacturing companies and therefore the findings are not generalisable to global industry. In addition, the decision was made to adopt the positivistic approach to test the research model, which made the choice of methodology limited to one method of data collection (the cross-sectional survey). Therefore, the findings of this research must be treated with caution due to the limitations related to the positivistic paradigm. These limitations should be viewed as opportunities for future research. As a result, this study suggests the following directions for future research: conducting more empirical investigations about the role of NPF in enhancing, improving, and sustaining the competitive advantage of a firm; researchers are encouraged to take into consideration the relationship between NPF and the competitive priorities that include: quality, cost, delivery, and flexibility; conducting empirical studies to investigate the impact of NPF on strategic performance of a firm.

References


