IMPACT OF PLATFORM-BASED STRATEGY ON PRODUCT DEVELOPMENT PERFORMANCE

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ABSTRACT

Product development performance has become a critical-to-success aspect in this age of globalization and international competition. Platform-based strategy could be used to enhance and support the efficiency and effectiveness of product development performance, as this paper suggests. This paper explores the impact of platform-based strategy on product development flexibility, product development leanness and product development performance. Five key hypotheses are presented based on the notion that use of the platform-based strategy could enhance product development performance. Although this paper is presented as a conceptual paper at this point in time, it is hoped that data collection and analysis based on the suggested model will find all the stated hypotheses and relationships to hold true.

INTRODUCTION

In today’s age of globalization and diversified demands, the competition among manufacturing companies is intense. This requires companies to use available resources efficiently and effectively, and offer high quality products in a timely manner [11] [35]. To achieve these objectives, a faster and more efficient product development process is necessary. A well-organized and efficiently designed product development process could facilitate shorter and more cost-effective manufacturing cycles and quicker delivery times [39] [41].

Product development has gained prominence over the last two decades in industry and academia alike. In academic research, there are several detailed studies about product development. [6] [9][16] [19]. These studies researched different aspects of product development, including the characteristics of product development, the success factors for product development, the relationship between product development and other managerial issues, and the impact of product development on firm performance. Among the various types of product development strategies, combining the platform-based strategy concerns, platform-based product development has been the most popular since this facilitates product variety in a cost-effective way [24] [27] [28] [29] [31] [34] [46].

Platform-based product development has many benefits such as improved product quality, faster development process, less cost and less man-hours. Specifically, the implementation of platform-based product development facilitates leanness (or elimination of waste from the process) and product development flexibility.

Platform-based product development has become widely accepted in some sections of industry as an effective method to enhance product development performance.
However, there has not been a significant amount of research validating the impact of platform based strategy on manufacturing effectiveness in general. This study attempts to fill this gap.

THEORY AND HYPOTHESES DEVELOPMENT

Figure 1 shows the research framework for this paper. This paper explains the impact of platform-based product development on product development flexibility and leanness, both of which in turn impact product development performance.

FIGURE 1: CONCEPTUAL FRAMEWORK WITH HYPOTHESIS

1. Platform-based product development

Platform based product development is the reflection of platform-based strategy in product development context, it provides for product variety by enabling easy changeover from one product manufacture to another. However, having too many product s to work on at any given time (excessive product variety) could complicate the changeover process. This paradox has been explored in earlier research [10] [20] [33].

A platform could be defined as a manufacturing base catering to a large set of product components that are physically connected as stable sub-assemblies, and are common to different variations of the base product [29]. From a broader perspective, platform can be considered a collection of assets shared by a set of products. Based on the concept of platform, and its characteristics, the platform approach has the following benefits:

1. Speed: Since platforms would be used not for just one, but for a variety of similar products, changeover for manufacture of different products would take lesser time resulting in greater speed
2. Cost: Due to reuse of platforms, components, tools and fixtures for multiple costs, overall costs will be significantly low
3. Design quality: Platform based thinking allows firms to save significantly in the design, manufacturing, operating, and marketing costs of new products by simplifying designs for components and providing for component interchangeability.
4. Reference ability: Sawhney [37] discusses the idea that customers buying products made on one
platform may buy related products made on the same platform. This line of thinking helps organizations to increase their customer base by focusing marketing efforts along non-routine paths.

Using a platform approach, companies can develop a series of differentiated products from one single platform very effectively at a reasonable cost level [27] [46]. From the production and manufacturing perspective, implementation of platform concept makes it possible to share production tools, equipment, assembly lines and other infrastructure. Moreover, it could result in enhanced productivity, capital investment reduction, market share improvement and lead time reduction. A review of practitioner literature shows that implementation of platform strategies have indeed yielded such benefits.

Aside from the above mentioned benefits, other benefits pertaining to the incorporation of platform strategy in the product development process have been documented [27] [28] [29] [31] [34] [46]. First of these is the reduction in prototype building and testing time, which translates to considerable cost savings in the product development process. Secondly, a reduction in the overall development lead time of up to 30% has been reported in research literature [17]. Thirdly, the time to market could be reduced due to the fact that products made on the same platform would have almost the same base features and concepts (in other words, the same core architecture and design modularity).

However there are also some drawbacks of platform-based product development: it may be unsuitable for all product types [24]. There is also a fear in industry that due to the capital expenditure associated with implementation of the platform strategy, implementation of such a strategy for some product lines may constrain future design innovations. Therefore it is imperative that the pros and cons of adopting a platform strategy be weighed prudently in the light of the company’s current product lines and future plans for expansion.

2. Product development flexibility

Because of the increase of the diversity of customers’ demands, and the rapidly changing commercial environment, the resulting uncertainty and the unpredictability present serious challenges to management of product development process [26]. To meet these challenges, flexibility in the product development and manufacturing process has become important [4] [25].

Upton [44] [45] defined flexibility as “the ability to change or react with little penalty in time, cost or performance”. Clausing’s [7] definition is “flexible technology is easily adapted into a variety of products which would result in shorter product development times, better market responsiveness and fewer consumed resources.” In a study of product development in turbulent environment, Iansiti [14] [15] proposed that flexibility hinges on a number of factors: the ability to build systems knowledge that describes the interactions between product architecture and design details, rapid decisions on critical changes and the ability to run rapid, test-driven design iterations.” Thomke [42] regards product flexibility as the incremental cost and time of modifying a design. Therefore, we define product development flexibility in this paper as: The capability of modifying the product development process with a reasonable time and cost.

There are two main benefits of product development flexibility: revising the design and the development process to meet customers’ needs quickly and efficiently, and getting a more efficient development strategy which could tolerate a higher risk of design change [42].

A platform strategy would facilitate greater flexibility by allowing for multiple platforms at the sub-systems level and then perhaps a common platform at the main system level. Thus modifications could be handled at the subsystems level by slight modifications to the platform or the sub-components.
Based on the above discussion, the following hypothesis is proposed:

\[ H1. \text{ The adaption of platform-based product development will facilitate the improvement of product development Flexibility.} \]

### 3. Product development leaness

Although the lean concept had its true origins in the Toyota production system, it became popularized when Womack et al. [48] introduced the term “lean manufacturing” in the work “The Machine that Changed the World”. Since then, “Lean manufacturing” has been used widely in the global manufacturing industry. A more academic definition of lean manufacturing is the systematic removal of waste by all members of the organization from all areas of the value stream [49]. The value stream is defined as all of the activities that contribute to the transformation of a product from raw material to finished product including design, order taking, and physical manufacture [48]. Waste is any non-necessary activity that does not add value for the customer.

Some of the typical practices of lean manufacturing include kaizen events, kanban, pull production system, quick changeovers, and value stream mapping. Table 1 shows the definition of these so-called “lean events”.

<table>
<thead>
<tr>
<th>Typical practice</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Five S events</td>
<td>Defined as the five dimensions of workplace organization. The events are designed to organize and clean. Five S events are often incorporated with Kaizen events. The Five Ss are defined as sort (identify unnecessary equipment), straighten (arrange and label the area so all tools have a specified home), shine (clean the area and maintain equipment daily), standardize (establish guidelines and standards for the area), and sustain (maintain the established standards) [48]</td>
</tr>
<tr>
<td>Kaizen events</td>
<td>Defined as continuous improvement in small steps [47], organizations typically use kaizen events to focus on improving a specific process</td>
</tr>
<tr>
<td>Kanban</td>
<td>Defined as a system that uses a card to signal a need to produce or transport a container of raw materials or partially finished products to the next stage in the manufacturing process [30]</td>
</tr>
<tr>
<td>Pull production</td>
<td>Characterized by the manufacture of a product only when a customer places an order</td>
</tr>
<tr>
<td>Quick changeovers</td>
<td>Characterized as a method for minimizing the amount of time it takes to change a machine’s setting or to prepare an area to begin processing a new product [48]</td>
</tr>
<tr>
<td>Value stream mapping</td>
<td>Defined as investigating the flow of material through the manufacturing process from the customer’s point of view. The end result highlights areas of waste [36]</td>
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</table>
According to Karlsson and Ahlstrom [18], “leaness” should not be viewed in the narrow sense of a set of tools, techniques and practices but rather as a holistic approach that transcends the boundaries of the shop-floor, thus affecting, apart from the production itself, almost all the operational aspects, like design, product development, quality, maintenance, etc. as well as the entire organization and management of the company.

Based on the above discussion, product development leaness could be defined as:

The elimination of waste due to unneeded operations, inefficient operations, or excessive buffering in operations from the product development process, in order to achieve continuous performance improvement.

The adaption of leaness in the product development process could induce the following benefits: fewer engineering hours, improved manufacturability of product, higher quality products, fewer production start-up problems and faster speed to market.

Similar to the typical techniques mentioned earlier for the lean manufacturing, there are also some typical techniques related to the product development leanness, such as supplier involvement, cross functional teams, use of concurrent engineering, integration of multi functional process, the use of a heavyweight team structure and the comprehensive management of the product development process.

A platform strategy eliminates waste by allowing for multi-purpose use of the platforms, reduction in prototype testing, and associated costs, besides the advantages mentioned elsewhere in this paper.

Based on the above discussion, the following hypothesis is proposed:

H2. The adaption of platform-based product development will facilitate the improvement of product development leaness.

As mentioned before, if a company has high product development flexibility, it could provide the capability of modifying the design and the product development methods faster with a reasonable cost, thus saving time, efforts and money when the market demands changed. Therefore, product development flexibility will foster leaness to a great extent.

Based on the above discussion, the following hypothesis is proposed:

H3. Product development flexibility has a positive relationship with product development leaness.

4. Product development performance

With the globalization and removal of the international trade barriers, there is intense competition between product manufacturers. To meet these needs and challenges, product development, recognized as a cross-functional and knowledge-intensive work [13] is becoming more and more important in the present rapid changing commercial environment. [21] states the following to be the main steps in the product development process: (1) recognizing the need and develop a product concept, (2)preparing feasibility analyses, both technical and economical, for the product and its initial marketing, (3) preparing detailed drawings, plans, specifications, and cost estimates while incorporating the results of research, (4)approving the product plans, (5) requesting bids, or negotiating with potential manufacturers, (6)awarding prime manufacturing contracts (or subcontracts, if developer managed), (7)manufacturing the product and (8) implementing quality control measures. Literature recognizes three different type of product development:
Successive: In this type, one phase begins after completion of the previous phase. This type has the longest duration of process and the slowest market reaction speed, but facilitates quality improvement, minimization of risk, and the optimization of product functions.

Parallel: In this type, the aim is to reduce the duration of product development as much as possible. This type of process has the shortest duration of product development, but creates the most pressure for the whole operation team, because there is no room for error and no chance of a second pass.

Overlap: In this type, the steps of product development overlap one another. This type of process could reduce the duration and increase the market reaction speed. But, it also will increase the complexity of management and coordination. Clearly then, product development involves so many aspects of the company operations and profound operations such as research of feasibility, product design, marketing, and manufacturing, packaging, shipping, service, disassembly, and recycling.

Thus the product development performance is critical for company success. Efficiencies in the product development performance could reduce the cost, improve the reaction speed, improve the product quality, add product value and increase the core competency of the company. Research literature defines product development performance as the extent to which product development time, design quality, and development productivity goals are achieved [24].

More product development flexibility enhances product development performance by providing reaction speed, short design cycles, relatively low cost of product development, market-oriented products and thereby product development effectiveness. Product development leanness eliminates waste and the unnecessary operations, and focuses and optimizes the efforts of the product development process. Both, product development flexibility and leanness could effectively reduce the product development time and improve the overall product quality and efficiency of the whole process, thus resulting in improved product development performance. Based on the above discussion, the following hypotheses are proposed:

**H4. Higher product development flexibility will result in the better product development performance.**

**H5. Higher product development Leanness will result in the better product development performance.**

**TABLE 2: CONSTRUCT DEFINITION**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
<th>References</th>
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<tbody>
<tr>
<td>Platform-based product development</td>
<td>The extent to which product development process adapts platform concept and the relative approaches.</td>
<td>[24]</td>
</tr>
<tr>
<td>Product development flexibility</td>
<td>The capability of modifying the product development process with a reasonable time and cost.</td>
<td>[43]</td>
</tr>
<tr>
<td>Product development leanness</td>
<td>The capability of product development process of eliminating the waste due to unneeded operations, inefficient operations, or excessive buffering in operations in order to get the continuous performance improvement.</td>
<td>[48]</td>
</tr>
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</table>
METHODOLOGY

Although this paper is presented as a conceptual paper at this stage, it is hoped that the following methodology would be used in future when data is collected to validate the stated hypotheses: development of items/constructs, structural interview, pretest of questionnaire, pilot study and large scale survey. AMOS could be used to test the validity and reliability of constructs, the model fit and hypotheses.

1. Item/construct development

It is suggested that the measures for new product development performance be adapted from Koufter, el, al [23], and those for product development flexibility from Koste,el.al. [22]. these measures have been tested in the respective research works for reliability and validity (Shown in table 3.). Additional measures would have to be developed as necessary.

TABLE 3: ADAPTED ITEM LIST

<table>
<thead>
<tr>
<th>Items</th>
<th>Description</th>
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<tbody>
<tr>
<td>Product development flexibility</td>
<td></td>
</tr>
<tr>
<td>FL1</td>
<td>Range-number</td>
</tr>
<tr>
<td>FL2</td>
<td>Range-Heterogeneity</td>
</tr>
<tr>
<td>FL3</td>
<td>Mobility</td>
</tr>
<tr>
<td>FL4</td>
<td>Uniformity</td>
</tr>
<tr>
<td>Product development performance</td>
<td></td>
</tr>
<tr>
<td>PP1</td>
<td>Time</td>
</tr>
<tr>
<td>PP2</td>
<td>Quality</td>
</tr>
<tr>
<td>PP3</td>
<td>Productivity</td>
</tr>
</tbody>
</table>

2. Structured interview

To ensure the face validity and content validity, academic experts and practitioners from industry will be invited to participate in a structured interview. They will be asked to review and examine the definition of every construct and the relationships in the structural model to ensure face validity. After this process, if they think the structure model and the constructs’ definitions are reasonable, they will be asked to
review and examine items and the questionnaire. According to the conclusion of this process, the items list and questionnaire could be revised; some items and questions could be modified, renewed or deleted.

3. **Pre-testing of questionnaire**

Pre-test the questionnaire to ensure content validity is recommended. The ambiguity, redundancy, and comprehensiveness of every item and questionnaire will be assessed.

4. **Pilot study**

It is recommended that a pilot study be conducted involving manufacturers from with the US and from outside the country. Based on the data collected, we recommend use of the confirmatory factor analysis (CFA) technique to examine the scales’ unidimensionality, construct validity, discriminant validity, convergent validity and reliability. AMOS could be used as well. The results of this pilot study could be used to refine the questionnaire and revise some items. Pilot studies also have the advantage of validating the research model before an extensive data collection on a world-wide basis is performed.

5. **Large-scale sample characteristics and methods**

Considering the possibility of low response rates, it is recommended that the questionnaire be sent to more than one thousand manufacturing companies from five industries with SIC codes 30, 34, 35, 37, 38 (Rubber and Miscellaneous plastic products, Fabricated Metal Products, Industrial Machinery and Equipment, Transportation Equipment, and Instruments and related products). The questionnaire could be sent to their CEO, CTO or product development managers to ensure the response quality. In order to improve the response rate, the telephone follow-up or e-mail follow-up could be employed as well.

To check the non-response bias, we recommend the use of both t-test and Chi-square tests to check the difference between 100 randomly picked responses from the first 300 responses and 100 randomly picked responses from the last 300 responses for each construct. It is recommended that the chi-square test to test the homogeneity (p < 0.05) be employed to rule out response bias.

To test the reliability, that is “the consistency of an experiment, test, observation, or any measuring procedure over a series of trials” [38], which represents the systemic variance of the constructs; we recommend the use of the Cronbach’s alpha coefficient [8]. The acceptable value of Cronbach’s alpha coefficient could be 0.50 [32] [40].

6. **SEM Model test**

The SEM model has two main components, the measurement model and the structural model. To test the measurement model, we recommend the use of CFA [1] index. On the other hand, to test the structural model, we recommend the examination of relationships among multiple exogenous and endogenous variables and between endogenous variables, simultaneously [23], and use of the nonnormed fit index, NNFI [3], the comparative fit index, CFI [2], standardized root mean square residual, RMSEA [5], Normal theory weighted least squares (NTWLS), and Chi-square ratio [12]. The recommended acceptable values for NNFI, CFI, RMSEA and NTWLS are _0.90, _0.90, _0.08, and the value of Chi-square divided by the degree of freedom should be no more than 3.0.
CONCLUSION AND FUTURE RESEARCH

In addition to manufacturing, platform based strategy can and will be used in the product development process as an effective method to enhance product development performance. Using platform based strategy in product development could help to promote leanness (elimination of waste) and *kaizen* (continuous improvement). All this, in turn, will help to improve the efficiency and effectiveness of the product development process.

It is suggested that future research based on this paper look at the impact of platform based strategy on product development performance in the context of various manufacturing and non-manufacturing sectors, as well as in the context of countries and cultures around the world. It is possible that while one country uses platform based strategy primarily to derive cost advantage, another will use it primarily to derive other advantages. It would also be interesting to look at the impact of platform based strategy in enhancing product development performance in the context of the literature of the influence of the leader or a heavy weight product manager on the overall product development cycle, manufacturing cost, product cost and process efficiency.
REFERENCES


