

# Do enterprises implement a Process Architecture towards Lean in Product Development? A comparative study among large and small firms

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## Abstract

The benefits of Lean Thinking have been applied and proven in manufacturing. However the potential of its application in New Product Development (NPD) has not been fully attained. Due to their iterative and evolving functions, NPD processes are generally unstructured and complex compared to other business processes. Within the scope of the LeanPPD European research project (partially funded by the European Commission-NMP-FP7-214090), which aims to propose a new model and tools to help companies implement Lean Thinking in the product development process, this research aims at understanding the opportunities in both large firms and small and medium enterprises (SMEs) to deploy a Process Architecture (PA) towards a lean new product development process. As main results, the paper will highlight relevant trends based on twenty-one face to face interviews done in eleven large firms and ten SMEs located in Switzerland, Germany and Mexico. Thus, this research provides a new body of knowledge comparing the state of art implementation of a PA within several industries.

## Key Words

Lean, new product development, process architecture, SMEs

## 1 Introduction

Research has confirmed the benefits of applying Lean Thinking not only in manufacturing, but also in many other fields of business [Baines et al., 2006]. Yet, this has proven difficult to gain a competitive advantage through its application even for those companies which have succeeded in implementing Lean in their manufacturing processes, [Womack & Jones, 1996] given the organizational-wide changes needed in all systems, practices and even culture [Baines et al., 2006]. In order to understand and continuously improve a process it must first be defined in its process architecture (PA). An established PA permits finding the state of optimal profitability of a system and enabling it to occur. Following are some definitions identified for Process Architecture (PA):

- The picture that says what process types there are in the organization and what their dynamic relationships are; a network of instances at work, all operating at the same time, some activating others and some interacting [Ould, 2005].
- A methodology for identifying and aligning an organization's key business processes against business requirements and to determine how to organize and implement formal process management. It is intended to provide clarity about what processes are critical and need to be designed and managed for sustainable performance [Performance Design

Lab, 2006].

- A schematic that shows the ways in which the business processes of an enterprise are grouped and inter-linked [Frolov et al., 2009].
- The structural design of general process systems and applied to fields such as computers (software, hardware, networks, etc.), business processes (enterprise architecture, policy and procedures, logistics, project management, etc.), and any other process system of varying degrees of complexity [Dawis et al., 2001].
- The architecture of the business processes of an enterprise is defined as the type of processes it contains and the relationships among them [Barros, 2007].

Modeling the NPD process in a traditional manner has proved difficult and resulted in many modeling techniques and frameworks proposed by the literature and industry. Different authors (Zachman [1987], Ould [2005], Rummier [2008], etc.) have proposed models consisting of multiple-phases that represent the process, resources, scope and objectives in NPD. Studies typically focus on the standard characteristics in NPD processes. Characteristics such as ambiguity, iterations and creativity have been noted, all particularly difficult to model. In order to capture these characteristics, academic research has developed modelling methods for the NPD process classified between graph-based and matrix-based techniques. Graph-based models are focused on the process' static control flow and fail to capture the dynamic characteristics of NPD in a complete manner. On the other hand, matrix-based methods despite being simple and powerful manipulations to manage the NPD process are usually only capable of showing the information flows into and out of activities and have had only limited success in facilitating process improvement. Given its importance, potential and possible areas of improvement, PA has also been studied and developed by the industry and diverse organizations. As a result, diverse frameworks or methodologies have been proposed and made available commercially, entitled PA or more commonly in a holistic approach as Enterprise Architecture (EA). Bearing in mind all the above-mentioned, one might conclude that PA's importance is widely known and applied. Nevertheless, this is not always necessarily representative of what is happening within the industry.

This paper is organized into five sections. Section 2 provides a literature review on the current practices of PA towards Lean NPD in large and SMEs. Section 3 describes the methodology and data collection strategy. The research results are provided in Section 4. Discussion, analysis and research limitations are expressed in Section 5.

## 2 A Process Architecture towards a Lean Product Development Process

NPD drives growth and the success of a company, yet at the same time often consumes a large part of its resources. On average, out of more than three thousand ideas only one ever makes it to the market. Investment in innovation has been proven to be the key to success in any industry, as long as there is a structured and reliable approach to engineering and design [UGS, 2003].

PAs and modelling techniques are enabling structures and their adoption represents a necessary, though not sufficient, condition to achieve success. Though methods and PAs alone do not assure the success in the NPD process, they are enabling factors and can support the creation of strategies, reasoning, insights and communication.

According to Dichmann [2009], a PA in NPD is a tool to effectively implement business ideas and decisions in a manner that affects the short and long term strategic outcome of a company. The types of processes it holds and the relationship among them, defines the architecture of the processes in an enterprise or company [Barros, 2007]. Developing a PA is often seen as the base in any management initiative, given that it lays the foundation of a framework for the existing processes and their relationships. Therefore, depending on their

needs, management will view different levels of detail and scope. In many cases, as companies begin to understand more and more about their operations, defining a PA becomes an iterative process. However, it is usually more convenient to develop the PA during the early stages of an organization [Frolov et al., 2009]. Nevertheless, while studies reveal that these approaches may be widely deployed in large companies, new product development in small companies is conducted in an ad hoc manner. Insufficient planning and inadequate resources, coupled with a resistance to change, are characteristic [Millward & Lewis, 2005]. The main value of defining an architecture is the possibility to establish a complete and unified blueprint of both the business and its goals. Having reached this point, the possibilities of evaluating and understanding complete, incomplete, or inconsistent intersections among the processes and activities will be of tremendous value in aligning the company to its strategy [Hendrick & Hendrick, 2010]. Table 1 displays the previously identified strengths and areas of opportunity in both large companies and SMEs.

	SMEs	Large Companies
Strengths	<ul style="list-style-type: none"> <li>• Flexibility, agility and innovation [Qian and Li 2003].</li> <li>• Strong relationships with customers, enabling rapid response to technical and market shifts. Usual good internal communications and dynamic and entrepreneurial management style [Rothwell, 1994].</li> <li>• Horizontal structures and rapid decision-making [Borja de Mozota, 2003].</li> <li>• Ability to move swiftly into a new field in order to grasp an emerging opportunity [Friedman, 2004].</li> </ul>	<ul style="list-style-type: none"> <li>• A vertically integrated supply chain, controlled environment, adjusted and optimized measurement leads to a NPD process is fairly stable and mature [Gupta et al., 2007].</li> <li>• Organic and innovative networking of new and different knowledge inside and outside the company, and the synthesizing capability to generate new knowledge [Kodama, 2005].</li> </ul>
Opportunities	<ul style="list-style-type: none"> <li>• Lack of PA to effectively manage innovation in NPD makes it difficult for such firms to identify suitable methods and adopt them [March-Chorda et al., 2002].</li> <li>• Tendency to act based solely on intuitions and routine rather than structured knowledge [Chiesa et al., 1996].</li> <li>• Avoidance of formal documented procedures, failure to undertake effective competitor analysis, not collecting adequate data for performance development, and engaging manufacturing personnel too late in the development process [Woodcock et al., 2000].</li> <li>• Lacking the budget and staff to take the risk of investing in the NPD process [Friedman, 2004]</li> </ul>	<ul style="list-style-type: none"> <li>• Simultaneous activities and shared resources through them, makes identifying key processes for improvement difficult [Gupta et al., 2007].</li> <li>• Erroneous interpretation of documents or weak collaboration among areas, emerge partially given the lack of technical competence of the developer and a poor management of the NPD process. Consequently, time constraints develop as the origin of inaccurate designs and re-work [Carbonara &amp; Scozzi, 2006].</li> </ul>

Table 1: Strengths and Challenges for SMEs and Large Companies towards a lean Product Development

Therefore, after identifying the previous challenges and opportunities, the following research questions have been proposed for this particular research: What other strengths and obstacles

that each Large and SME have to properly define a Process Architecture (PA) to facilitate Lean NPD? What can large companies and SMEs learn from each other?

### 3 Research Methodology

The LeanPPD consortium developed a questionnaire based on a review of relevant literature and collaborative work among the members of the consortium, in order to facilitate information gathering through a series of industrial interviews. As research is explanatory, a semi-structured interview approach using face-to-face discussions with key players was preferred. This methodology was chosen due to the sensitive nature of the topic for some companies and to allow the interviewee to express their own viewpoints and experience. The respondents were NPD department managers, NPD project managers and executives responsible for technology development or in the case for SMEs top management. The sample of both SMEs and large companies covered a diverse set of industry sectors: life sciences, automation, robotics, components, materials, telecommunications, energy and automotive. Most of interviews were face-to-face, carried out at the following countries: Switzerland, Germany and Mexico, yet a couple were conducted by telephone.

### 4 Results

The results were originally divided between SMEs and Large Companies. This was important given the organizational differences amongst them, which have already been stated. Furthermore, a brief comparison between the two would possibly shed some light on what these two groups may learn from each other. It is important to understand how they have defined and managed their PA, how complex and structured their NPD process is and what tools are used to support it. Within the first series of questions of the questionnaire aimed at defining PA and developing an approach for PA, some key attributes were obtained from the companies as presented in table 2.

Characteristics	SMEs	Large
Believe a Process Architecture (PA) is beneficial	70%	100%
Have a defined and implemented PA for their NPD Process	30%	100%
From those who have declared having an established PA, which have an IT System to support their defined PA	55%	80%
From those that have declared having an IT System to support their PA, which prefer an in-house developed IT system for this purpose	50%	50%
Explore parallel solutions for NPD	80%	80%

Table 2: Company's answers towards defining Process Architecture

Differences between SMEs and large companies are vast and although SMEs tend to aim at developing into a large company, as mentioned before, they hold the advantage of flexibility that may lead to greater innovation. Yet only 68% of European Union SMEs remain in the market after two years [Directorate-General for Enterprise and Industry, 2010].

When developing a new product, there standard sub-processes followed by any company in order to go from idea to market and beyond. Having determined a series of key sub-processes, companies were asked to rank them in a general relative manner according to their level of importance, cost and required time. The results shown in Figure 1, Figure 2 and Figure 3

[Cabello, 2011] were rather insightful considering not only the different approach to each by large companies and SMEs, but also comparing the different rankings of a sub-process within the same segment. This analysis for will be discussed further in the following section.

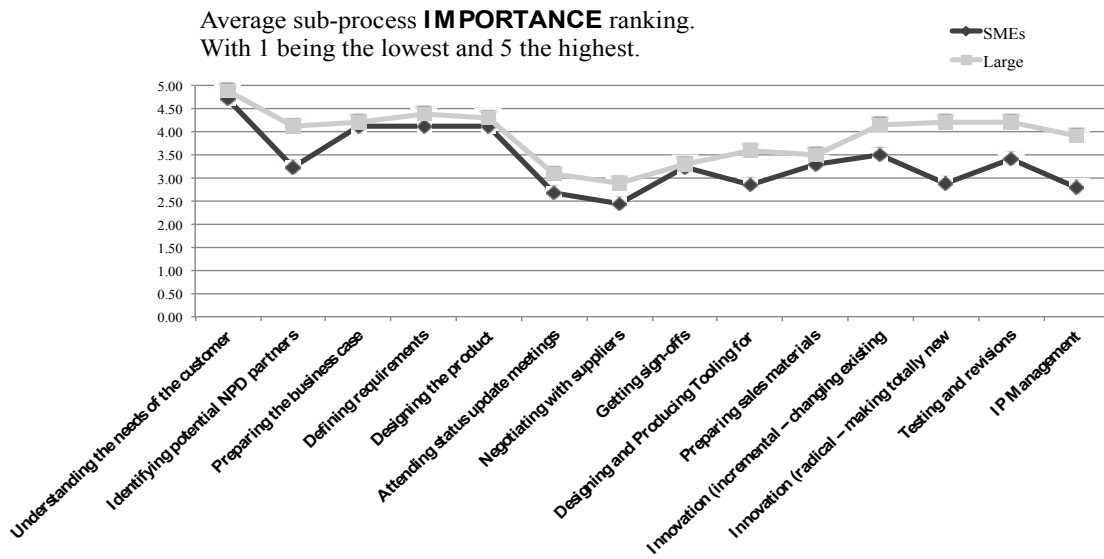


Figure 1: Key elements identified by companies in the product development process

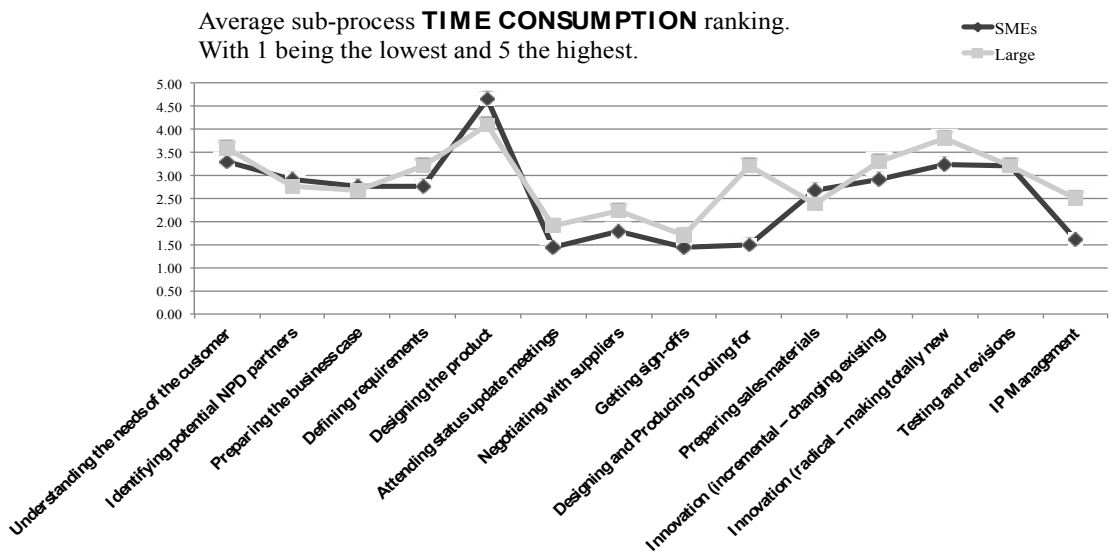


Figure 2: Most timely processes according to companies for their product development process

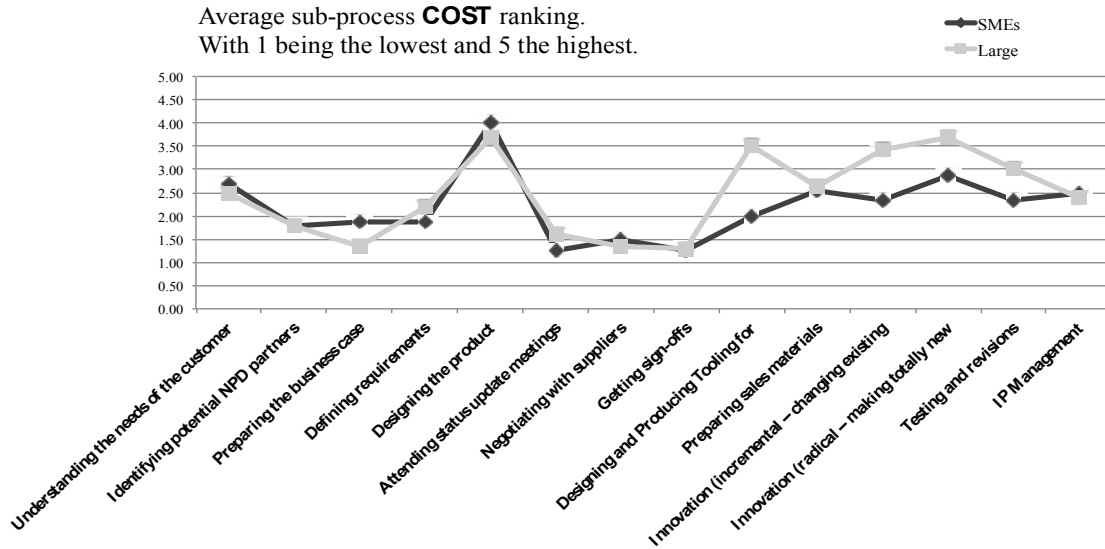


Figure 3: Relative costs incurred in the different processes required in the product development process

## 5 Discussion, Analysis & Limitations

Based upon the research performed during the course of this study, we acknowledged that there is no reference in the literature to learn the approaches of how a Process Architecture is implemented for the NPD and particularly, to compare large companies and SMEs. Given the impact of SMEs on innovation, while large companies have developed a structured and methodical approach to meet dynamic market demands, each approach is an important subject of study. Research and case studies have typically been made among enterprises of either the same industry or country. Examples of this, among others, a comparison case study between communications and pharmaceutical industries [Gupta et al., 2007], or another between Japanese and Italian manufacturers producing all sorts of industrial goods [Matsui et al., 2007]. Among others, these have provided an interesting insight into the subject and further possible areas of research.

SMEs, despite holding a promise of innovation and although the use of a PA has been proved to increase NPD performance [e.g. Matsui et al., 2007], some top managers still declared PA to be unnecessary, non-value adding or even in some cases going as far as declaring it an "overhead cost" to their process. Although more than half of the SME respondents believe implementing a PA to be beneficial for their process, only thirty percent of them have actually defined their PA. Yet in a couple of cases, upper management has successfully defined their PA and implemented an in-house tool, one manager stating on PA: "We need to understand where we are, to know where we want to go".

Large companies have been well established and continuously developing for years, in order to meet the market's constant change. Nevertheless, some processes have been carefully designed and implemented, whilst others have simply come to be and grown into the corporate culture without much understanding or analysis. As for most (if not all) large companies, managers must comply with their company's corporate strategy to define their PA. In many cases it is upper management's lack of interest for process innovation, poor implementation or failed general support that ultimately turns these tools into precisely an "overhead cost". Countless times during the course of the years have corporate misalignment and employee resistance to change been found to be the main barriers of continuous improvement.

As for IT tools for PA modeling IT, although we find several options in the market, both large companies and SMEs in half of the cases believe these tools do not add value to their process and restrict the possibilities of modeling their already defined PA.

Lean Thinking promotes the parallel development of solutions (Set-Based Concurrent Engineering) for NPD, in order to deliver better solutions. In our study, 80% of the respondents do implement set based concurrent engineering. Nevertheless, while applying the questionnaire, more than half of those respondents working with an implemented PA commented that exploring parallel solutions resulted in an even higher iterative NPD process, making the already defined PA insufficient.

Comparing the sub-processes in all categories (Importance, Time Consumption, Cost), it is interesting to find that SMEs show the greatest interest in incremental innovation, despite being thought of as being highly innovative they declare radical innovation to be amongst their lowest in level of importance. While they're large counterparts strongly push towards radical innovation ranking it amongst the highest in all categories. An implemented PA could help SMEs to grasp the benefits of incremental innovation by giving a clear view of the process of going from idea to market. Another difference is found in testing and revisions, in which large companies have a stronger focus in all categories, resources that their smaller counterparts apparently invest in the actual design of the product where a higher tendency is shown. Large companies rank identifying potential NPD partners higher in overall importance yet at the same level of time consumption and cost. During the interview, respondents referred to the uneasiness of SME managers to share or develop knowledge with other, particularly larger firms. On a related subject, a notable trend that has been observed in the interviews' results was the low significance given by SMEs to intellectual property management. Although this is a strict requirement placed by investors, the majority of SME managers described investing in intellectual property management as a waste of time and money, given the legal limitations and the perceived lack of power an SME would have against a larger or international counterpart. Could this be leading towards a new trend in IP governance?

In short, the following strengths and opportunities to deploy a PA to enable Lean in NPD for large companies and SMEs are presented in table 3 as follows:

	SMEs	Large
Strengths	Smaller structure allows easier definition and deployment of PA Easier detection of all forms of waste and value Less processes managed by less resources enable better integration	Most have experience implementing lean in manufacturing, making it a common term in corporate culture Availability of resources such as technology, external consultants, etc. Possibility of trial and error in a small unit to later expand
Opportunities	Short term vision Not a common formalization and documentation of their current processes, therefore generating difficulty to identify improvement areas towards lean Disregard to areas of business "separate" to those of the company's offering	People resilient to change, therefore, longer times to change (and improve) the NPD process towards lean Some lack of a clear strategy for continuous improvement Long bureaucratic processes

Table 3: Observed Strengths and Opportunities for SMEs and Large Companies to apply a Process Architecture in the product development process

The relatively small, yet significant sample could be stated to be among the major limitations of this research. Further research could be aimed at analyzing the role and opinions of the

actual developers behind the innovation and NPD of large companies and SMEs. In a following stage of this research a new version of the questionnaire will be elaborated according to these results, in order to develop a new framework to enable the definition and implementation of a PA in NPD that integrates lean thinking principles.

In conclusion, most of the large companies believe a PA is beneficial; on the other hand, SMEs although perceiving it as beneficial seem reluctant to make the effort to design and implement one. An architecture must not be seen as an obstacle to be creative, but a framework to enhance the possibility of encountering new solutions and areas of opportunity. Ultimately, Lean Thinking as a philosophy; represents a way of working focusing on identifying value and eliminating waste and to do so, clear processes are needed.

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