THE APPLICATION OF THE LEAN INNOVATION APROACH IN THE STAGE-GATE MODEL

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ABSTRACT

Innovation has become over the last decades an essential factor for survival of the organizations. Its scope and its its importance includes not only technological aspects but also the administrative area, with the clear objective of increasing competitiveness, thereby making the mission to innovate not only the responsibility of a single area, but the responsibility of all employees in all areas.
Accelerated competition has pushed companies to use innovation management tools in research and new product development. Although several models exist in the literature of innovation management, with regard to new product development, there is room for improvement in the management of innovation, from idea generation until product launch.
This paper seeks to identify an alternative for improving innovation management, buiding on the stage-gate model, and using the concept of lean innovation, which is a new approach toward the management of the innovation process, based on the concepts of the Toyota Production System. With the use of the lean innovation aproach during some stages of the stage-gate model, it is possible to achieve results in time and cost reduction in new product development.

INTRODUCTION

The word Innovation derives from the Latin innovatus, where "in" means movement from inside and "novus" means new, and thus, innovation is a movement to new search (Grizendi, 2011). Since the beginning of the last century, much has been discussed about innovation, its nature, characteristics, classification and sources, with the objective of understanding is role in economic development, stressing the fundamental contribution of Joseph Schumpeter (1949) that, in the first half of the century, focused on the importance of innovation in the performance of the enterprises and the economy (Marques, 2004). Several literature has supported the role of innovation for business success (Ven 1986; Betz 2003; Chen 2009), as well as pointing it as the most important factor to boost the economy (Talbot 2009), and also for implementation, institutionalization and marketing of new and creative ideas (Ven, 1986; Smeds, 1994). But in the days of globalization, price pressure and a infinity of similar product ranges has an impact on various sectors. In addition to shortening product life cycles, customers are subdivided into markets with increasing number of minor segments. Costs in research and development (R&D) have increased, and the return on investment for products decreased, even with growth in the number of products sold (Betz, 2003).
With accelerated competitiveness companies tend to utilize innovation management models, to increase the efficacy of the research and development process. Innovation management is a set of routines that describes and differentiates the answers to questions of organizations and management structure. The primary objective of innovation management is to find more solutions appropriate for the problems related to these routines as well as manage constantly this process of creative ideas, making it more suitable for the specific circumstances in which organizations are inserted. Altogether, most companies work on a portfolio of innovations, which represent developments and incremental improvements in processes and/or existing products, while others focus on more radical changes. One of the key capabilities in effective innovation management is the balancing of the composition of this portfolio, while combining it with the skills and capabilities of the company in technology and markets.
The general approach to innovation management processes can be divided into five generations described below.
The first generation, assumes that innovation is a linear process and a belief that intensive investment in scientific activity results ultimately in innovations that have considerable economic impact (Bush, 1945). This perspective is also referred to as the technology push model of innovation.
The second generation is the so-called demand pull model of linear innovation, where market demands become the main vector in relation to the direction and speed of technical change, indicating the direction in which the investment would be more appropriate, given

the technological progress (Kline and Rosenberg, 1986). This period corresponds to the 1st R&D generation, characterized by the absence of a strategy at the corporate level. The 1st R&D generation is an isolated entity, responsible for decisions on how to allocate resources for future technologies developments and the evaluation of results (Roussel at al, 1991).

The third generation, which is the model that integrates the previous two, denominated coupling model innovation, is focused on an interactive process, although the stages in the process are seen as separate. In other words, this is a sequential model, but containing feedback loops, ie combinations of pressure research and demand pull, with more balance between R&D and marketing and emphasis on integration between these areas (Rothwell,1992).

In the fourth generation, the chain-linked model or collaborative process reflects the growing understanding of the innovation process, so that this process involves more than broad-based inputs of science and the market, but includes close relationships with customers and suppliers (Graves, 1987).

The fifth generation process (Rothwell, 1994), includes a growing strategic and technological integration among different organizations. The model horizontalized the relations between different organizations that operate according to business processes.

THE STAGE GATE PRODUCT INNOVATION PROCESS

The organisational activities undertaken by the company as it embarks on the actual process of new product development have been represented by numerous different models. These have attempted to capture the key activities involved in the process, from idea to commercialisation of the product (Trott, 2008). It is possible to classify the models into seven distinct categories (Saren, 1984):

Departmental-stage models: these can be shown to be based around the linear model of innovation, where each department is responsible for certain tasks.

Activity-stage models and concurrent engineering: these are similar to departmental-stage models but because they emphasise conducted activities they provide a better representation of reality.

Cross-functional models (teams): the cross-functional teams (CFT) approach removes problems that occur within the product development process centered around communications between different departments, by having a dedicated project team representing people from a variety of functions.

Stage-gate models: or decision-stage models represent the new product development process as a series of decisions that need to be taken in order to progress the project (Cooper and Kleinschmidt,1993; Kotler, 1997).

Conversion-process models: as the name suggests, conversion-process models view new product development as numerous inputs into a 'black box' where they are converted into an output (Schon,1967).

Response models: is a behaviourist approach to analyse change. In particular, these models focus on the individual's or organisation's response to a new project proposal or new idea (Becker and Whistler, 1967).

Network Model: is the process of accumulation of knowledge from a variety of different inputs, such as marketing, R&D and manufacturing. This knowledge is built up gradually over time as the project progresses from initial idea (technical breakthrough or market opportunity) through development (Takeuchi and Nonaka, 1986; Nonaka, 1991; Hagedoorn, 1990; Trott, 1993; Nonaka and Takeuchi, 1995).

The stage-gate model has become a popular system for driving new products to market, and the benefits of using such a robust idea-to-launch system have been documented (Cooper, 2008). It is characterized by dividing the innovation process at various stages of development tasks, interspersed by moments for decision-making. It is noted to be quite useful for the definition of the process to be used for receiving, processing and developing ideas, and for the definition of the project portfolio. The stage-gate is nothing more than a structured process by means of which the project is developed. This process consists of stages separated by periods of evaluation and decision (Gates). Each stage is a set of development activities with well-defined deliverables. A model of stage-gate typically begins with simple stages with a strong character of planning, and then evolves into stages with greater commitments and with an executive character (Cooper, 1994). Although various authors have proposed different models of stage-gate, a model which is commonly used, composed of six stages and five gates, is represented in Figure 1.

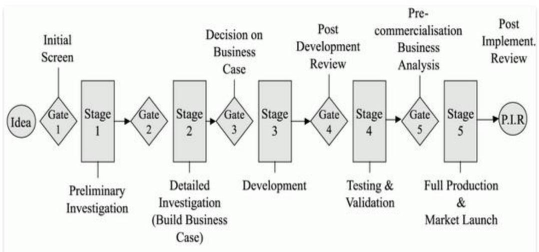

Figure 1: Stage-gate model (Cooper, 1994)

Stage Idea: pre-work designed to discover and uncover business opportunities and generate new ideas.

Stage 1**:** quick, inexpensive preliminary investigation and scoping of the project – largely desk research.

Stage 2: detailed investigation involving primary research (both market and technical) leading to a Business Case, including product and project definition, project justification, and the proposed plan for development.

Stage 3: the actual detailed design and development of the new product and the design of the operations or production process required for eventual full scale production.

Stage 4: tests or trials in the marketplace, laboratory, and plant to verify and validate the proposed new product, brand/marketing plan and production/operations.
Stage 5: launch and commercialization – beginning of full-scale operations or production, marketing, and selling.
The gates are meetings, or moments, where the design team presents the deliverables, developed over the last stage, for a commission to judge. This commission discusses, based on a set of previously defined criteria, if the project should proceed to the next stage (Cooper, 1994).
The stage-gate can present some difficulties in its application, when organizations misunderstand the concept of stage-gate and deploy it without any flexibility, as a tool to control development of projects. When this happens, the organization experiences significant harmful effects. Such negative experiences gave rise to several reviews in the literature concerning the practice of stage-gate (Connor, 1994):

- Waste of time of managers in gates that need not be carried out.
- Delays in project execution due to unnecessary activities or waiting for gates postponed due to the lack of agenda of members of the evaluation commission.
- Projects being conducted outside the system of stage-gate.
- Elimination of the innovative nature of the project portfolio of the company.
- Resistance to implementation of new development practices.

Most companies development portfolios that use stage-gate model suffer from: too many projects for the limited resources available; ineffective project prioritization; Go/Kill decisions made in the absence of solid information; and too many minor projects in the portfolio. The end result is poor performance: low-impact projects; too long to get to market; and higher-than-acceptable failure rates (Cooper et al, 2000).

THE LEAN INNOVATION APPROACH

To avoid these potential traps, and in order to achieve an innovation process with reduced resources and waste, it is suggested the use of the lean innovation approach created by (Schuh et al, 2008) that represents the systematic interpretation of the principles of lean mentality in relation to the process of product or process innovation. The lean principles initiated by Taiichi Ohno at Toyota Motor Corporation, the techniques of eliminating waste and excess from the product flows were first introduced to automotive engine manufacturing, then to the automobile assembling, and later applied to the entire Toyota supply chain (Ohno, 1988).
A central element of lean innovation is the value system, which is the basis for value stream design or value stream design innovation and development projects. The value system define structures and prioritize "values" for a specific innovation project (Schuh et al, 2008). The values are defined by all stakeholders in the process of innovation and development process, as for example, external clients and interns, taking into consideration the strategy and enterprise culture. In lean innovation there are ten principles and three specific steps (Figure 2). The first step, “structure early”, sets the innovation team, builds the hierarchy of value in the system, and defines the architecture of the product. The second step, “synchronize easily”, is where it applies the value stream mapping and capacity planning for identifying the most effective and efficient ways of innovating. The third step, “adapt securely”, sets in a permanent manner the process of continuous innovation of product design to satisfy the values and clients requirements (Schuh et al, 2008).

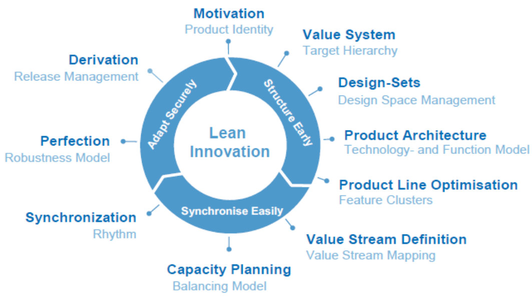

Figure 2: Lean innovation (Schuh et al, 2008)

APPLYING THE LEAN INNOVATION APPROACH IN THE STAGE-GATE MODEL

To stay competitive in R&D, you must deal with increased dynamics and complexity of products project systems. Both the effectiveness and efficiency of R&D have to be improved for complex products and design programs. The differentiation of the product has to be reached with limited resources and with economies of scale and smart set. Therefore, the intention of the lean innovation concept is the transfer of lean thinking to the management of R&D and innovation.
To illustrate the potential of the application of the lean innovation approach in the stage gate approach to innovation management, an example is provided below, concerning the idea generation phase. In the stage gate model the generation of ideas is not a stage of development in itself, but it collects ideas from multiple sources to feed the innovation process. It is considered a step with waste in the phase of product development, but after the use of the lean innovation approach it can be considered as a value-added step in terms of generating potential products. The example includes the application of the three stages of the lean innovation concept in the idea generation phase of the stage gate model.
Imagine a company that develops office chairs, and that the idea generation process is divided into 4 stages: idea generation, ideas selection, assessment and approval.
Applying the Step 1 of lean innovation – structure early: set a highly motivated team, with the requirements and a

structure of a well-defined value system adapted to meet the needs in the form of specific goals – would result in the pre-establishment of targets about what type of ideas are expected in the generation of ideas, thus avoiding ideas that are outside the main focus. For example, the following idea pre-requisites could be established: a chair for specific uses in cleanrooms; product can be introduced within one year; market potential of at least $1 million; market has a growth rate of at least 5%; product will give at least 30% return on sales; product will give at least 40% return on investment; product will achieve technical or market leadership.

Applying the Step 2 of lean innovation – synchronize easily: set the current state value stream mapping (VSM) and planning capacity for the ideas generation – would result in the definition of the sequence of activities required to produce (adding value or not) and provide a specific idea, as well as the definition of the information, materials, and work flows that accompanies it, thus define the balancing capacity at this stage (Figure 3).

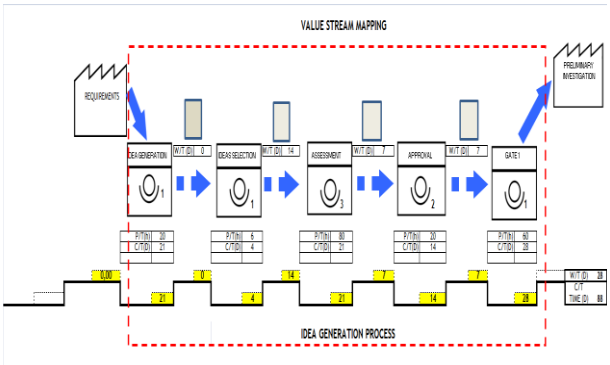

Figure 3: Generation ideas VSM

There are four standard time measures (Schipper and Swets, 2012):

Process Time (P/T): The time spent doing value-added work (headsdown time, time spent on the work on the desktop, or touch time). In this example (see Figure 3) the P/T for ideas selection is 6h, so P/T(h)= 6h.

Cycle Time through a Process (C/T): The elapsed time for a unit of work to move through a process box, including the process time. It is measured from the time the unit of work enters the process to the time it leaves the process complete, including all value-added and non-value added time. The C/T in ideas selection is 4 days, so C/T(D)=4 days.

Wait Time (W/T): The time that work sits in a queue or inbox before it enters the process. In this example, the wait time between idea generation and idea selection is zero, W/T(D)=0, because between idea generation and ideas selection there is no waiting.

Total Cycle Time: Cycle time + wait time = Total C/T. The time to complete the entire value stream, including all cycle times and wait times. In the example, Total Cycle Time equals idea generation (21) + ideas selection (4+0) + assessment (21+14) + approval (14+7) + gate 1 (28+7) = 116 days.

Applying the Step 3 of lean innovation – adapt securely: sets in a permament manner the process – would result in the definition of the sustainability of the process of generation of ideas, in order to become robust and respond swiftly to changes and market requirements. After creating a current state value stream map and identifying the supporting processes needing improvement, the value stream mapping will be ready to build the ideal future state, which can also be described as a map with the end in view for the development of the organization. The future state is just that—always in the future. The current state is just another step toward the ideal of a perfectly functioning system. To implement this strategy, the company must change its organizational thinking. Rather than just identify, eliminate waste and standardize the culture system, it now should promote the need for constant change. The new system of value can then be used to provide a more transparent overview of needs and values of all customers (internal and external).

The lean innovation approach can also be applied in other stages of the stage gate (preliminary investigation, detailed investigation, development, test&validation and launch).

CONCLUSIONS

The paper carried out for this study was based on a literature review addressing the main aspects of innovation management and we propose an articulation of the concept of lean innovation with the stage gate model of innovation management.

The lean innovation approach was applied in the idea generation phase of stage gate, where the steps "structure early", "synchronize easily" and "adapt securely", were applied with the objective of setting the values, identify opportunities for improvement through the VSM and implement these improvements. The steps of lean innovation must be made continuously in order to obtain increased perfection in the new product development process. The lean innovation approach can be applied both to large companies that have R&D, and for small businesses that do not have it, generating product differentiation with reduced resources and waste.

Most companies still do not have well established reliable and systematic processes to convert ideas into business. A well-defined management model extends the capabilities and possibilities of creation, and it can be adopted and improved, bringing favorable results and more competitive power. This approach is not well known and not yet widely used by companies, but some companies that have identified customer value in the new product development have experienced beneficial results in improving the process of innovation management in their organizations.

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