COMPARATIVE ANALYSIS OF THE MAIN GENERATIONS OF INNOVATION MODELS

Geanina Silviana BANU[1], Anca Alexandra PURCĂREA[2], Octavian ION NEGOIȚĂ [3], Olivia Doina NEGOIȚĂ[4], Mihai COROCĂESCU[5]

The innovation process represents a complex flow of activities, resources, partnerships and common objectives which require high-performance management. Present paper carries out a comparative analysis of the main generations of innovation models with the aim of identifying the attributes and limitations of the innovation process. Moreover, the aim is to establish relevant criteria for the success of innovation which can contribute to creating a basis for designing the next generation of innovation models.

Keywords: innovation process, innovation models, comparative analysis.

1. Introduction

Innovation represents "the integration of scientific, engineering and market opportunities" [1]. Science, engineering and market should be considered as the main dimensions of innovation, allowing for designing a roadmap of the innovation process. As such, a comparative analysis of the innovation models can be performed, where identifying the attributes and limitations of the innovation process is facilitated by including as many criteria as possible in defining innovation through the complex links between science, engineering and market.

When analyzing the generations of innovation models, both strengths and benefits and weaknesses and limitations should be established. Each generation constitutes a layout of the academic knowledge of a time period and a manifestation of the best practices in the field. Within this context, each innovation model elaborated overtime represents the basis on which progressively more complex and holistic models have been developed, comprising factors more and more relevant to the efficiency of the innovation process. Moreover, the design of each innovation model has generated a source of hypotheses and observations regarding the features of successful innovation and also the most complex criteria for the decision making process within innovative organizations.

[1] PhD Student, University POLITEHNICA of Bucharest, Romania,email:banugeanina@gmail.com
[2] PhD, Prof. Eng., University POLITEHNICA of Bucharest, Romania
[3] PhD, University POLITEHNICA of Bucharest, Romania
[4] PhD, Lect., University POLITEHNICA of Bucharest, Romania
[5] PhD Student, Assoc. Lect., University POLITEHNICA of Bucharest, Romania

Based in that, the main links can be established between innovation and other key processes unfolding both within the organization, e.g. management, marketing, production, and outside the organization, e.g. science & technology, government policies, universities. While having the role of providing the knowledge for understanding the innovation as a concept, the innovation models are being effectively employed by organizations, especially those in the developed economies, to design and conduct the innovation process [2].

Regardless the generation, an innovation model is designed to facilitate the market uptake of new ideas through an efficient combination of structure and flexibility, while relying on a management system able to define and supervise the unfolding of each innovation lifecycle.

Starting with Rothwell [3] and continuing with Chesbrough [4], six generations of innovation models have been defined and implemented into the innovation practice, as follows:

- The "Technology push" model
- The "Market pull" model
- The Coupling model
- The Integrated model
- The System Integration and Networking model – SIN model
- The Open Innovation model

The purpose of present paper is to analyze the above six generations of innovation models and based on the elements identified as characteristic to their related innovation process to create a set of criteria for the success of innovation, while performing a comparative analysis between the innovation models.

2. Research methodology

Based on an in-depth literature review, the authors of present paper have performed a comparative analysis of the six main generations of innovation models which have been so far conceptualized and employed in the practice of innovation. Said generations comprise of the following innovation models: the "*technology push*" model, the "*market pull*" model, the *coupling* model, the *integrated* model, the *system integration and networking* model and the *open innovation* model.

For the purpose of the comparative analysis twenty one criteria for the success of innovation have been identified, representing attributes and/or limitations of the innovation process. Said criteria have been subsequently matched with the corresponding generation of innovation model thus emphasizing the similarities and differences between them. As a result, a synthesized image of the innovation process was generated with the aim of establishing the most

complex innovation model developed so far, providing at the same time relevant knowledge for designing the next generation of innovation models.

3. Research findings

Prior to performing the comparative analysis between all six generations of innovation models, a previous/next innovation model comparison was performed. As such, a first correlation is between "technology push" and "market pull" models. When analyzing their core features, the main differences are observed. Based on the work of Gann and Dodgson [1], Herstatt and Lettl [5], Brem and Voigt [6], Lubik et al. [7] and Kotsemir and Meissner [8], Table 1 depicts the view of the authors of present paper regarding the core elements which are differentiating the "technology push" model from the "market pull" model, while highlighting both the attributes and limitations of said models. Establishing by comparison the core features of the two models is extremely important as they essentially represent the two opposite main sources of innovation in any innovation process, i.e. the Research & Development (R&D) department in the case of "technology push" model and the market/demand in the case of "market pull" model. Furthermore, when referring to the source of innovation, the features of the two models which are identified and listed in Table 1 can be employed as criteria of evaluation for the other existing or yet to be defined generations of innovation models.

Table 1

Comparative analysis between "technology push" and "market pull" models
Authors' view based on Gann and Dodgson [1], Herstatt and Lettl [5], Brem and Voigt [6], Lubik et al. [7], Kotsemir and Meissner [8]

Analysis criteria: attributes and/or limitations of the innovation process	"Technology push"	"Market pull"
Source of innovation	R&D	Market (demand)
Type of research	Basic research	Applied research
Level of technological uncertainty	Higher	Lower
R&D expenditure	Higher	Lower
Duration of R&D	Long term	Short term
Level of market uncertainty	Higher	Lower
Level of uncertainty regarding the market applicability	Higher	Lower
Time to market uptake	Uncertain/ Unknown	Certain/ Known

Integration of consumer into the R&D activity	Difficult	Easy
Market research instruments	Qualitative market research	Quantitative market research
Need for changing consumer behavior	Higher	Lower
Risk of initiating the research with a subject which can be more easily developed and evaluated	Yes	No
Risk of satisfying the needs of the atypical consumer	Yes	No
The risk of blockage in terms of one solution versus multiple solution approach	Yes	No
Risk of focusing all efforts on satisfying the more easily identifiable consumer needs with low impact	No	Yes
Orientation on the axis of change from incremental to radical	Radical Innovation	Incremental innovation
Creative/disruptive potential	Higher/Major improvements or radical changes	Lower/ Substitution of existing solutions
Level of cooperation and communication between R&D and marketing	Lower	Higher
Focus of management efforts	R&D	Marketing
Capacity of one innovation model to generate innovations which are specific to the other model	Lower	Higher
Industry transformation potential	Higher	Lower
Scientific level	Higher	Lower
Integration capacity into the existing market infrastructure	Lower	Higher
Integration capacity into the existing production infrastructure	Lower	Higher
Predisposition to imitation by others	Lower	Higher

Both “technology push” and “market pull” models have been merged into the third generation of innovation models, respectively the coupling model. The merge came as a solution to the necessity of coupling the fundamental research with the market requirements. As such, the coupling model was elaborated to be an improved innovation instrument based on its predecessors. Figure 1 depicts the coupling model by emphasizing the innovation mechanism based on the two main

sources of innovation which coordinate the innovation process, i.e. the R&D department (i.e. "technology push") and the market (i.e. "market pull").

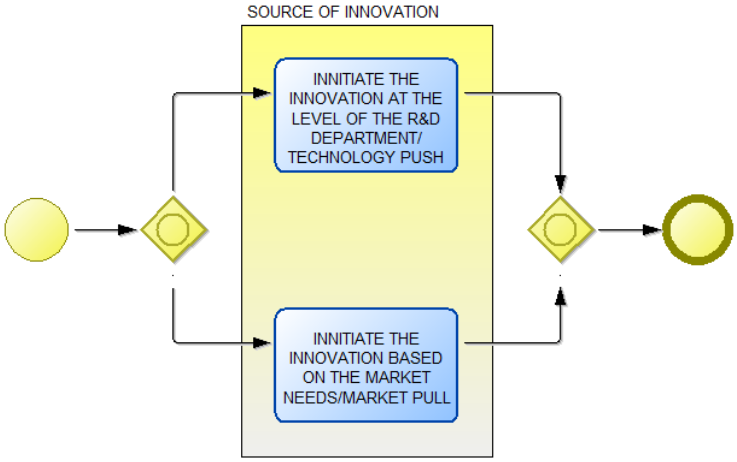

Fig. 1. The innovation mechanism of the coupling model

The same evolving mechanism is found when comparing the subsequent generations of innovation models, respectively the integrated model and SIN model. As such, the latter represents the further elaboration and "refining" of the best features of the former model. The main and most important difference between the two models is the fact that the SIN model uses information technology systems for the automation of the innovation process. Moreover, despite its name the integrated model does not essentially represent an integrated model but rather an interactive one, where the integration of the constituent activities is at an emerging phase. Table 2 presents a comparative analysis between the integrated model and the SIN model based on their main attributes and/or limitations in terms of the innovation process with the aim of emphasizing the similarities and dissimilarities between them.

Table 2

Comparative analysis between the integrated model and SIN model
Authors' view based on Gann and Dodgson [1], Hobday [2], Kotsemir and Meissner [8]

Analysis criteria: attributes and/or limitations of the innovation process	**Integrated Model**	**SIN model**
Fully integrated parallel development	No	Yes
Strategic partnerships and R&D collaboration	Yes	Yes
Automation of the innovation process by employing high-tech information technology systems	No	Yes

Focus on technological accumulation/technology strategy	Yes	Yes
Integration of departments' activities and parallel functioning instead of sequential flow of activities	Yes	Yes
Communication and intra- and inter-organizational integration, respectively between the functional departments of the organization and between the organization and the external environment	Yes	Yes
The customer – central element in elaborating all important strategies of the organization	No	Yes
Continuous guiding of the innovation process towards the external environment/Horizontal and vertical collaborations	Yes	Yes
Full network integration/System integration by creating networks of suppliers, customers, competitors, other similar organizations, universities, relevant groups and communities, etc.	No	Yes
Increase of the complexity and the strategic role of innovation management/Extending the decisional power over the external relations of the organization	Yes	Yes
Speed of innovation, cost reduction and decrease in the duration of the innovation process	Yes	Yes
Focus on organizational flexibility and rapid development	Yes	Yes

Gann and Dodgson [1] view the SIN model as a response to the increasing levels of risk and uncertainty in the innovation process. Same reasoning can be fundamentally extended to all generations of innovation models, in the sense that the related innovation models have been undergoing a continuous risk mitigation process as innovation management has been optimized. Figure 2 shows the correlation between the evolution of the decisional area of the innovation management (e.g. practices and organizational systems, technologies and capabilities, communication and external relations) and the increase of response to risk and uncertainty within the innovation process from one innovation model to the next.

The comparative analysis of the innovation models allows for identifying the main attributes of innovation based on which an organization can effectively organize the innovation process. From the first to current generation of innovation models, said attributes have been progressively defined, implemented, redefined and reutilized as the limitations of innovation were also identified and mitigated with the aim of ensuring the best practices in innovation management.

	The evolution of the decisional area of the innovation management from one innovation model to the next
I	*The R&D department is isolated from other internal departments and has no contact with the external environment of the organization.*
II	*The market needs are coordinating the R&D department through marketing.*
III	*Functional interconnectivity between the technological capabilities and market needs; interconnectivity between departments and between the organization and the external market.*
IV	*Parallel development, higher horizontal and vertical interconnectivity with suppliers, consumers and other innovation partners.*
V	*Parallel and complete integration of systems with the help of information technology/ automation of the innovation process; horizontal and vertical innovation networks.*
VI	*Exploitation of both internal and external knowledge sources; exploitation of both internal and external channels to the market uptake of the innovation; large innovation collaborations; the objectives of the innovation process are aligned with the general objectives of the management system of the organization*

Legend: I-"Technology push" model; II-„Market push" model; III-Coupling model; IV-Integrated model; V-SIN model; VI-Open innovation model.

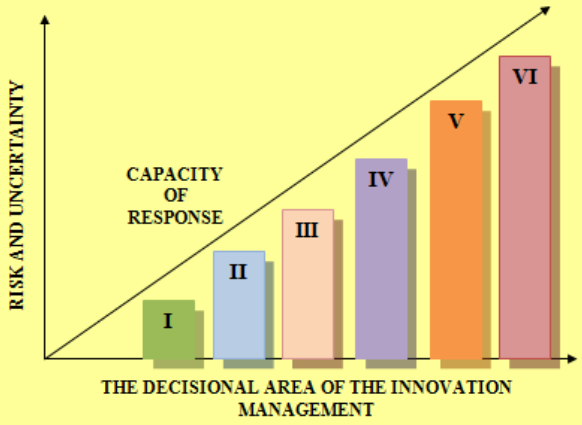

Fig. 2. Correlation between the evolution of the decisional area of the innovation management and the increase of response to risk and uncertainty within the innovation process from one innovation model to the next

Table 3 lists the features of each innovation model in terms of attributes and limitations, all being identified as twenty one main criteria for the success of innovation.

Table 3

Comparative analysis of the main generations of innovation models based on their identified main attributes and limitation (twenty one criteria for the success of innovation)

Analysis criteria: attributes and/or limitations of the innovation process	**Innovation Models**					
	Technology push	Market pull	Coupling model	Integrated model	System Integration and Networking – SIN	Open Innovation
Closed innovation system (ideas are created and developed inside the organization)	✓	✓	✓	✓	✓	
Sequential (linear) flow (phases) of the innovation process	✓	✓	✓			
Communication with the market/customers		✓	✓	✓	✓	✓
Communication with the suppliers			✓	✓	✓	✓
Feedback loops between the different phases of the process			✓	✓	✓	✓
Functional integration and parallel development of the different activities within the departments of the organization / integrated and parallel innovation process				✓	✓	✓
Vertical and horizontal integration of suppliers and customers				✓	✓	✓
Alliances and partnerships with other organizations and competitors/Vertical and horizontal collaborations				✓	✓	✓
Orientation of the innovation process towards the outside of the organization				✓	✓	✓
Flexible organizational strategies and rapid development				✓	✓	✓
Increased and sustained effort to include more stakeholders and to improve the exploitation phase of the innovation process				✓	✓	✓
Innovation networks comprising of suppliers, clients, other similar organizations, universities, communities, etc.					✓	✓
System integration and employment of concurrent engineering in product development					✓	✓

	Computerization of the innovation process/ Employment of modern information technology instruments					
					✓	✓
	Use of both internal and external knowledge sources					
						✓
	Use of both internal and external channels towards the market uptake of innovation					
						✓
	Creation, management, transfer and reuse of knowledge between innovation partners					
						✓
	Design of instruments for jointly owning and exploiting intellectual property between innovation partners					
						✓
	Integration and alignment of innovation with the objectives of the organization management					
						✓
	Creation of and integration in communities of best practice					
						✓
	Open innovation system (ideas are created and developed outside the boundaries of the organization)					
						✓

As emphasized in Table 3, the attributes of innovation which were identified by comparative analysis are not all characteristic to each generation of innovation models. On the contrary, they are elements which are partially and in various combinations comprised by the generations of innovation models, thus providing both advantages and limitations to the related innovation process. Furthermore, it can be observed that the open innovation model comprises all attributes and none of the limitations which were identified by the authors as representing essential criteria for the success of innovation.

Synthesizing the findings of the comparative analysis, it should be noted that the main criteria in the evolution of the innovation models is the process of systematically opening-up the innovation, respectively of formally exposing it to the external environment of the organization starting from the idea phase till the exploitation phase. Such exposure of innovation can be performed by including as many relevant stakeholders as possible into the innovation process.

6. Conclusions

The comparative analysis of the innovation models performed by authors in present paper allowed for drawing the following conclusion:

- The evolution of the innovation models brought continuous and substantial optimization of the innovation process;

- The development of more integrated innovation models and the design of complex innovation networks constitute an approach for extending the decisional area of the innovation management with the aim of increasing also the response to risk and uncertainty within the innovation process;
- The open innovation model stands out by comprising of all attributes of innovation which were identified during the comparative analysis; furthermore, none of the identified limitations of innovation were characteristic to the open innovation model;
- The open innovation model promotes the development of communities of best practices which can support and optimize the innovation process through the sustained collaboration of members.
- Identifying the criteria for the success of innovation provides the basic knowledge for designing new innovation models.

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R E F E R E N C E S

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