A Framework for Positioning and Assessing Innovation Capability from an Organizational Perspective

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Abstract

The evolution of a new information society and new technologies has led to the involvement of organizations in a highly competitive business market where innovation plays a key role. Improving the understanding of the innovation process will help organizations bring more competitive solutions to society more promptly. Currently, there are still too few mechanisms that help organizations to model innovation knowledge and measure their innovation capability. To deal with this gap, this paper presents the Innovation Capability Framework that models innovation knowledge and assesses the innovation capability of organizations for guiding future innovation processes. This framework comprises a conceptual model, a graphical modeling language, and an Innovation Positioning System (IPS), which are supported by an Inno Modeling Tool (InnoTool). Modeling capabilities and the IPS mechanism have been empirically validated through various case studies. In this paper, we present the InnoTool *analysis of an exemplar innovative product such as Skype.*

1. Introduction

The development of a new information society and new technologies has led organizations to be involved in a highly competitive business market. In such a business situation, innovation is a potential driver for organizations to achieve competitiveness, quality, and time-to-market [1][12]. Innovation is a multi-stage process whereby organizations transform ideas into the production of new or significantly improved products (goods or services), processes, or business models to advance, compete, and differentiate themselves successfully in their marketplace [2]. Improving the understanding of this multi-stage process—*innovation process*—will help organizations to quickly incorporate innovation to offer solutions that are more competitive and useful for society. This is particularly important for software organizations or ICT organizations in general, given the current fast-paced technological advancement.

However, there are a few mechanisms that help organizations to model organizational factors that are relevant to innovation and to measure, qualitatively or quantitatively, the innovation capability of an organization with regard to one or more products, processes, or business models under analysis. In this regard, it would be desirable to have mechanisms for (i) characterizing innovation through different dimensions; (ii) identifying organizational determinants—strategic, tactical, or operational—that have a relationship with innovation, that could provide organizations with innovation, or that somehow impact it; (iii) quantitatively and/or qualitatively assessing the innovation capability of organizations based on a set of organizational determinants. This information may assist and guide organizations to be able to understand the innovation process; the effects of organizational determinants (and how much they impact) on product, process, or business innovation; and how much more an organization needs in the future to support its innovation strategy.

This paper presents a modeling framework to capture innovation knowledge and assess the innovation capability of an organization with regard to an innovative product, process, or business model. This *Innovation Capability Framework* comprises (i) a conceptual model of the characteristics and determinants of the innovation process based on the literature review conducted by Crossan & Apaydin [4], (ii) its corresponding graphical language to facilitate model usage, and (iii) a system for positioning and assessing the innovation capability of an organization based on a (sub)set of determinants of organizational innovation, which we term the *Innovation Positioning System (IPS)*. This framework is supported by a tool called the *Inno Modeling Tool* (InnoTool) that models innovation knowledge and measures the innovation capability of organizations. This allows a retrospective evaluation and may result in implication and recommendations for managers to guiding future innovation processes. The modeling capabilities and the IPS mechanism of the framework have been empirically validated through various case studies. One

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of them was about Skype as an exemplar of a business organization that adopts innovation on a continuous basis[1]. In this study, we use the InnoTool to assess the innovation process of Skype. This assessment was performed on the basis of the knowledge of a (sub)set of organizational determinants that impacted the innovation outcome of Skype. The information for the Skype case study was collected through a systematic literature review [14], while ATLAS.ti[2] was used for managing documents obtained from the literature review and for analyzing the qualitative data from the documents.

The structure of the paper is as follows: Section 2 describes the background. Section 3 presents the Innovation Capability Framework. Section 4 describes the Skype case study and the results of the IPS. Section 5 discusses related work. Finally, conclusions and further work are presented in Section 6.

2. Background

Innovation is defined in terms of its *dimensions* and *determinants* [4]. The characterization and definition of these dimensions and determinants have been recurring issues in the past [2][4][5][11][19][20]. Specifically, this section presents an overview of a set of widely used dimensions and determinants based on the literature review conducted by Crossan & Apaydin [4].

The dimensions of innovation are usually classified from two viewpoints: the process and the outcome (see Figure 1). The first one characterizes innovation as a process, while the second one characterizes innovation as an outcome.

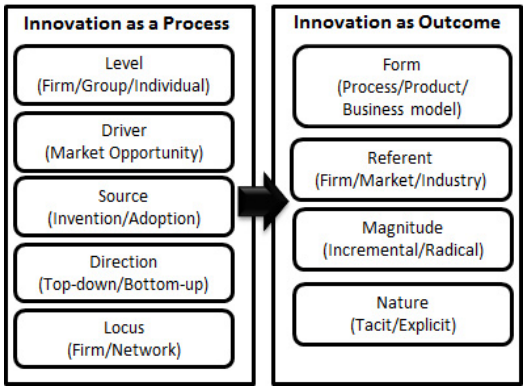

Figure 1. Dimensions of innovation, based on [4]

Innovation as a process has the following dimensions [4]: The *level* dimension delineates the difference among individual, group, and firm levels of the innovation process. The *driver* and the *source* dimensions define the aspects that make innovation possible or that permit the initiation of an innovation process. The *direction* or *view* dimension defines how the innovation process begins and develops: top-down or bottom-up. Finally, the *locus* dimension defines the extent of an innovation process: firm-only (closed process) or network (open process).

Innovation as an outcome has the following dimensions [4]: *form, referent*, *magnitude*, and *nature.* The form of innovation can be any one of the following forms: *process innovation* that focuses on changing how something is done, that is, "the introduction of new production methods, new management approaches, and new technology that can be used to improve production and management processes" [23]; *product innovation* that focuses on what is done, that is, "the novelty and meaningfulness of new products introduced to the market in a timely fashion" [23]; and finally *business model innovation* that focuses on "how a company creates, sells, and delivers value to its customers" [5]. In this regard, it is important not to confuse process as a form of innovation outcome with innovation viewed as a process. The referent is the subject for whom innovation is new: the *company* [5], the *market* [15], or even the *industry*. Depending on the referent, the novelty of an innovation outcome can vary. Finally, the magnitude is the degree of novelty of an innovation outcome with respect to a referent: *incremental* and *radical* or *disruptive* [13].

In addition to dimensions, there are three determinants of innovation: Leadership, Managerial Levers, and Business Process (see Figure 2).

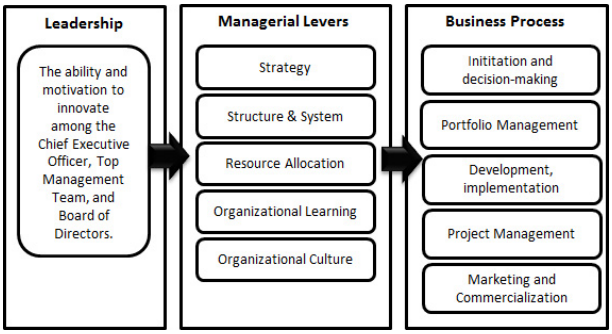

Figure 2. Determinants of innovation, based on [4]

The *Leadership* determinant indicates the importance of leadership in the innovation process, as leaders promote innovative efforts at the initial creative stage, facilitate effective interactions among groups [24], and create conditions for implementing innovation [16]. This determinant is a combination of the ability and motivation to innovate among the *Chief Executive Officer* (CEO), the *Top Management Team* (TMT), and *Board of Directors* (see Figure 2). All of them possess associated factors that could influence the innovation process (see Table 1).

The *Managerial Levers* determinant establishes the following five managerial levers that enable

[1] Through the different firms that have purchased Skype
[2] http://www.atlasti.com/index.html

innovation: S*trategy* establishes the direction that an organization must follow. *Structures and systems* and *resource allocation* support innovation practices. *Organizational learning* as well as *organizational culture* help to maintain innovation processes. There are numerous factors associated with each of these levers that could influence the innovation process in an organization (see Table 2).

Table 1. Leadership—Factors[3]

CEO	TMT	Board of Directors
Tolerance to change	High educational level	Institutional shareholding
Self-confidence	Age heterogeneity	Executive stock options
Openness to new experiences	Top executive extra-industry ties	Board diversity - occupational background
Unconventionality	Diversity of background	
Originality	Diversity of experience	
Proactivity	Less tenure executives	

Table 2. Managerial Levers—Factors[4]

Structure and System	Resource Allocation	Organizational Learning	Culture
Flexibility	Slack resources	Tolerance of failed ideas	Autonomy
Administrative intensity	Annual turnover of resources	Adopting risk-taking norms	Climate attractiveness
Decentralization	R&D Intensity	Learning & development of employees	Extrinsic motivation
Stratification	Differentiated funding	Acceptance of diversity within the group	Shared vision
Specialization		Experimentation support	

Finally, the *Business Process* determinant of innovation comprises five phases [4]: *Initiation*, that is, innovation through the generation of new ideas or their adoption. *Portfolio management*, that is, making strategic, technological, and resource choices that govern selection over a set of innovation projects [3]. *Development and implementation*, that is, prototypes and production. *Project management*, that is, processes that turn inputs into a marketable innovation. *Marketing and Commercialization*, i.e., administrative and management issues of organizations [22].

It is necessary to emphasize that all determinants and factors described here are initially relevant for innovation as described in the literature [4]. What this paper presents is a framework that allow managers to analyze how significant these factors are to determine the innovation capability of an organization.

3. Innovation Capability Framework

Since the characterization and definition of innovation dimensions and determinants in the literature [2][4][5][11][19][20] is not automated or systematized, it is rather difficult to exploit, reuse, or even reason from previous experiences on innovation. In this study, we have taken a step forward to facilitate the characterization of innovation in a systematic and automated manner. Models support the formal specification of systems and their exploitation and automation through software tools [17]. Formally capturing innovation supports the storing and mining of related information and then reasoning over the space of innovation knowledge. This is why the Innovation Capability Framework we present in this work is based on a conceptual model.

In this section, we describe the Innovation Capability Framework to capture innovation knowledge and reason with it, as well as assess the innovation capability of an organization based on the dimensions and determinants of innovation (see Section 2). This framework comprises (i) a conceptual model—termed the *Innovation Capability Model* or *ICM*—to characterize dimensions and determinants of innovation, which is described through the specification of a metamodel; (ii) a graphical language to facilitate innovation characterization; and (iii) the *Innovation Positioning System* (IPS) for positioning and assessing the innovation capability of an organization. The framework and its mechanisms are supported by the *Inno Modeling Tool* (InnoTool), which is also presented in this section.

3.1 Metamodel Definition

The ICM metamodel (see Figure 3–Figure 8) comprises a set of inter-related metaclasses. These metaclasses define a set of properties and services for each concept, dimension, or determinant considered in the ICM. On the one hand, metaclasses, their properties, and their relationships describe the structure and provide the information that is necessary to capture the dimensions and determinants of organizational innovation. On the other hand, the services of metaclasses support the management of models by creating, destroying, adding, or eliminating elements that are compliant with the constructors of the metamodel[5].

Figure 3 depicts the package structure of the ICM. There are two main packages: *Determinants* and *Dimensions*. In turn, the package *Determinants* contains the packages *leadership*, *managerialLevers* and *bussinesProcess*.

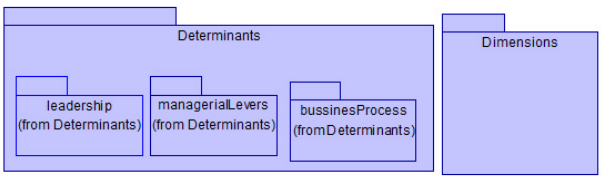

Figure 3. Package structure of the ICM

[3] Due to space constraints, not all the factors are enumerated. There is a total of 14 CEO, 7 TMT, and 4 Directors' factors.

[4] Due to space constraints, not all the factors are enumerated. There is a total of 9 structure, 4 resource, 5 knowledge, and 7 culture factors.

[5] Services are not described due to readability reasons.

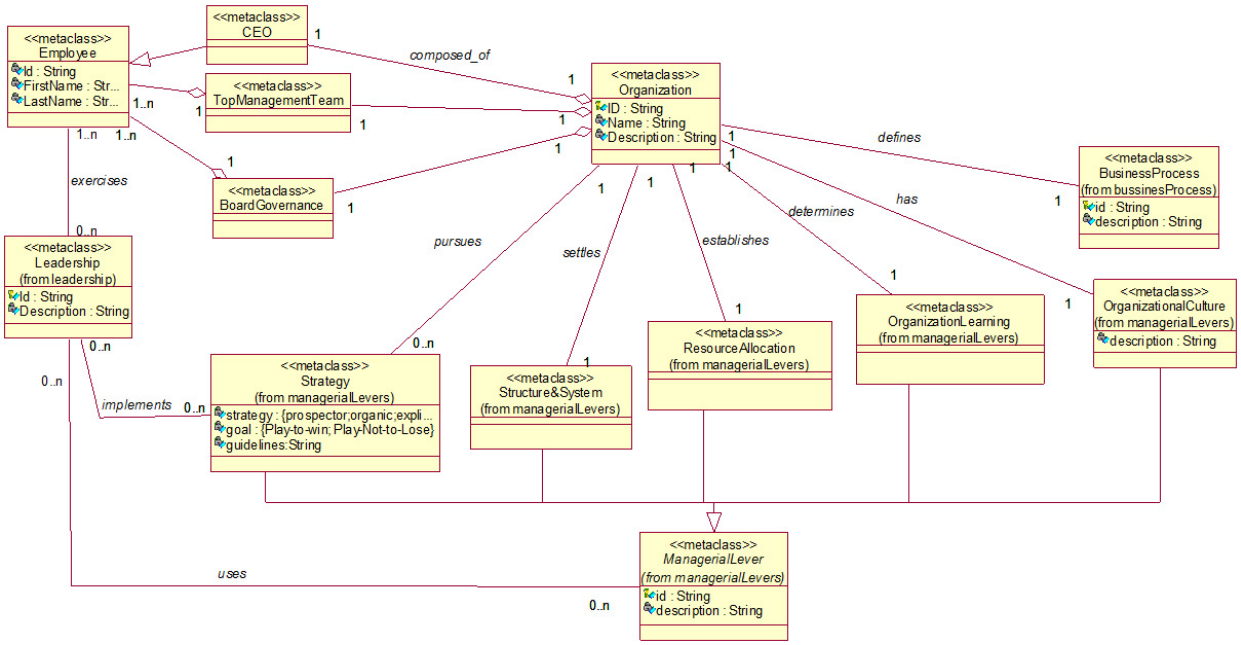

Figure 4. ICM – Determinants package

The package *Determinants* (see Figure 4) comprises the metaclass *Organization* that is composed of a CEO, a top management team, and a board of directors (see aggregation relationships from metaclass *Organization* to *CEO*, *TopManagmentTeam*, and *BoardGovernance*). In turn, the metaclasses *TopManagmentTeam* and *BoardGovernance* have a composition relationship with the metaclass *Employee*, while the metaclass CEO inherits from *Employee*. Employees exercise their leadership by using managerial levers (see the association relationship *exercises* between the metaclasses *Employee* and *Leadership* and the association *uses* between the metaclasses *Leadership* and *ManagerialLever*). Leadership usually results in innovation strategies (see association *implements* between the metaclasses *Leadership* and *Strategy* in Figure 4), such as actions and decisions taken by leaders to deliver innovation. Organizations pursue strategies to innovate, e.g. "play-to-win" or "play-not-to-lose" (see association *pursues* between the metaclasses *Organization* and *Strategy*). Finally, organizations settle, establish, determine, possess, and define their structure, resource allocation, organization learning, organizational culture, and business processes, respectively (see Figure 4).

The package *leadership* (see Figure 5) comprises the metaclasses *CEOFactor*, *TMTFactor*, and *DirectorFactor* that are inherited from the metaclass *LeadershipFactor*, i.e., the innovation factors (abilities) associated with CEOs, top management teams, and boards of directors. This implies that employees—a CEO, managers, or directors—exercise leadership to innovate through these factors (see the association class named *ExecutionLeadership* and the aggregation between this and *LeadershipFactor*). Each factor is described by one of the possible values of its corresponding data type—*CEOEnum*, *TMTEnum*, and *BoardEnum* (see Figure 5 and Table 1).

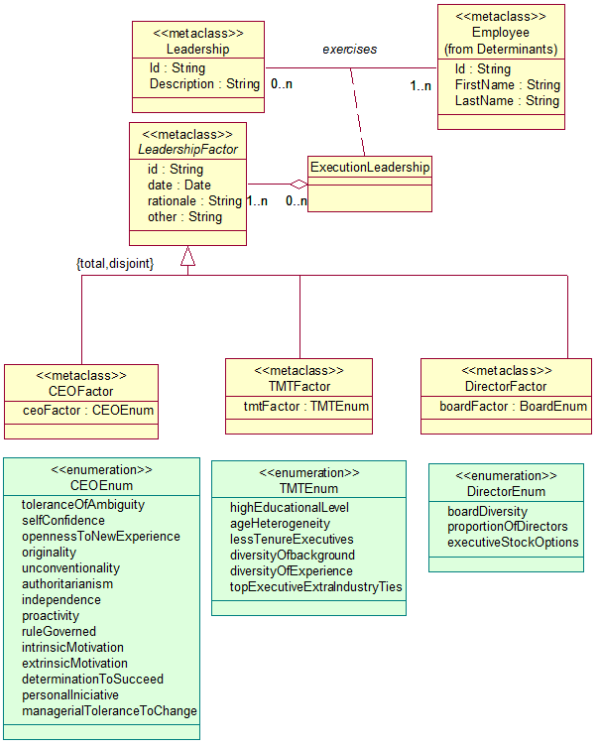

Figure 5. ICM - Leadership package

Further, the package *managerialLevers* (see Figure 6) comprises the five metaclasses that provide the primitives for modeling the five levers described in Section 2 (for example, see the metaclasses *Strategy Structure&System* and *ResourceAllocation* in Figure 6). These levers are usually composed of a set of factors. For example, the structure and system lever contains a set of factors specified by the metaclass *StructureFactor* and the enumeration *StructureSystemEnum* (see Figure 6 and Table 2).

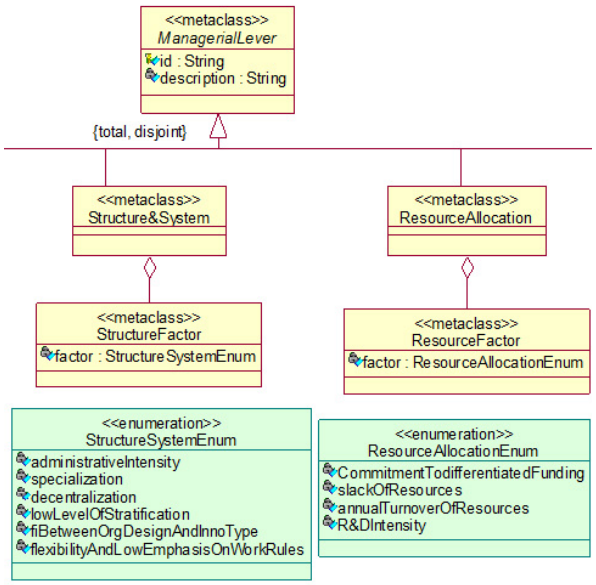

Figure 6. ICM- Managerial levers package

The package *business process* (see Figure 7) comprises five metaclasses that provide the primitives for modeling the five phases described in Section 2 (for example, see the metaclasses D*evelop and Implementation*, or the *Portfolio Management* in Figure 7). Several of these phases comprise a set of factors. For example, *Portfolio Management* is composed of a set of factors specified by the metaclass *PortfolioFactor* and the enumeration *PortfolioManagementEnum* (see Figure 7).

Finally, the package *Dimensions* (see Figure 8) comprises the metaclasses *InnovationProcess* and *Outcome*. The first one defines a set of attributes that characterize the innovation process: *id*, *level*, *direction*, *locus*, and *source*. This metaclass is composed of external and internal drivers (see the metaclasses *ExternalDriverFactor* and *InternalDriverFactor*). The second one defines a set of attributes that characterize the outcome: id, name, description, *form* (product, process, or business model), *referent*, *magnitude*, and *nature*. The metaclasses *InnovationProcess* and *Outcome* are related through the association relationship termed *results_in*.

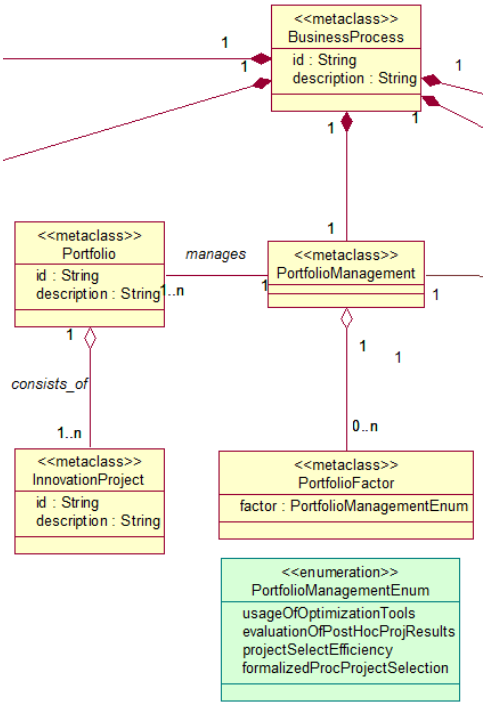

Figure 7. ICM – Business process package

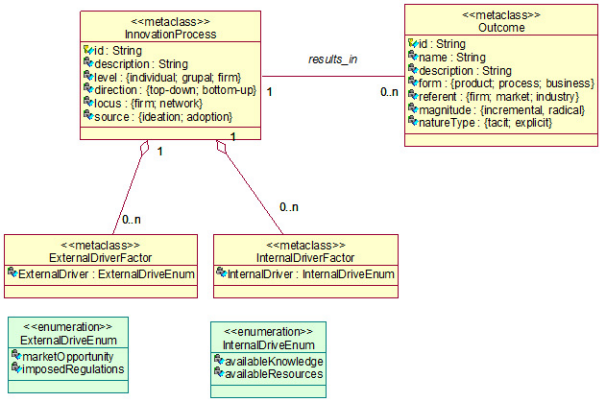

Figure 8. ICM . Dimension package

3.2 InnoTool: Graphical Language support

To make the use of the ICM feasible and friendly, we defined a graphical modeling language for describing ICM models that conforms to the ICM metamodel (see section 3.1). The definition of the language involves defining a set of modeling primitives and associating them to elements of the metamodel. This graphical language definition and mapping have been performed by using the Eclipse Modeling Framework (EMF) [6] from the Epsilon Generative Modeling Technologies (GMT) research project [8]. As a result, we developed the InnoTool for the community as an Eclipse plugin[6].

[6] https://syst.eui.upm.es/INNO/home

InnoTool provides a set of modeling facilities (see Figure 9) that comprise (i) a palette that provides a set of icons to model the determinants and dimensions of innovation specified by the ICM metamodel (see Section 3.1), (ii) a canvas where the ICM models can be drawn by drag and drop of the palette's icons, and (iii) a view of the properties where it is possible to specify the value of the attributes of determinants and dimensions.

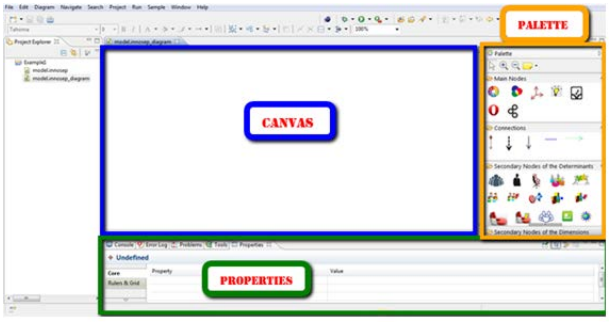

Figure 9. InnoTool Eclipse plugin

Figure 10 and Figure 11 depict several examples of determinants and dimensions modeled through InnoTool, respectively. Figure 10 shows the representation of the Leadership determinant denoted by an arrow where someone leads the efforts to the same direction. The CEO, TMT, and Board of Directors only can be dropped onto the canvas within the Leadership modeling element to denote that Leadership is exercised by a CEO, TMT, or a Board of Directors. The graphical representation of CEO is an individual, whereas TMT and Board are represented by teams to illustrate the number of people. In addition, each corresponding type of innovation factor can only be dropped within its corresponding leadership canvas, that is, CEO, TMT, and Board (see Enumerations in Figure 5). For example, the TMT's leadership includes the diversity factor. Figure 11 illustrates the representation of the dimension views Innovation Process and Innovation Outcome, with their properties and relationships. The innovation process is represented by a set of working gears, while the outcome is represented by a capital letter "O," thereby depicting their meaning. On the other hand, the drivers on the Innovation Process are represented by a signal that illustrates the different paths that can be followed. Finally, it is important to mention that all three—process, drivers, and outcome—only support the dropping of the modeling primitives that characterize them onto the canvas. For example, the external and internal drivers only can be dropped on the driver modeling element.

Figure 10 InnoTool—Modeling leadership

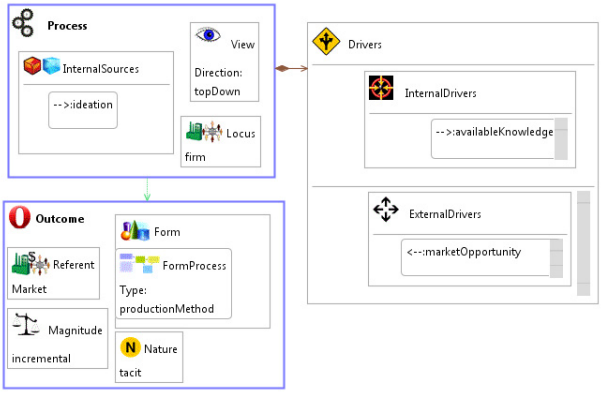

Figure 11. InnoTool—Modeling process and outcome

3.3 Innovation Positioning System (IPS)

In addition to modeling primitives for capturing and describing the dimensions and determinants of innovation, InnoTool provides the IPS: a system for positioning a company based on a (sub)set of determinants of organizational innovation. The IPS has been implemented by using the Epsilon Generation Language (EGL) from the Epsilon Generative Modeling Technologies (GMT) research project [8].

When an organization has to use the IPS to assess its innovation capability, it must adhere to the following three steps:

1. Modeling the ICM using InnoTool from the innovation knowledge of the organization regarding an innovative product, process, or business model under analysis.
2. Configuring the determinants to be assessed by IPS by using the settings menu of InnoTool. This

means that the organization managers can select the determinants to be analyzed.

3. Executing the automatic generation of the IPS.

These steps can be repeated to analyze more than one product, process, or business model, thereby obtaining a more complete vision of the organization.

Figure 12 presents an example of the IPS. The IPS comprises a spider chart whose axes represent a (sub)set of organizational determinants and their factors. These determinants and factors are (i) Leadership determinant—specifically CEO, TMT, and Director 's factors (see Table 1); (ii) Managerial Levers determinant, specifically those factors related to each one of the five levers—that is, Strategy, Structure and System, Resource Allocation, Organizational Learning and Organizational Culture (see Table 2); and (iii) Business Process determinant, specifically those factors related to Product Management, Portfolio Management, Risk Return, as well as Marketing and Commercialization factors.

Figure 12. An example of IPS

The IPS shows two data series (see Figure 12) that represent (i) the percentage of factors that have been acquired, promoted, or implemented by the organization under assessment (and there is evidence for it) (see solid line in Figure 12); and (ii) the sum of the first percentage and the percentage of those factors for which there is no evidence—that is, the users/evaluators have no information regarding whether these factors have been implemented or acquired by the organization (see dashed line in Figure 12). These last "unknown" factors create a certain level of uncertainty regarding the innovation capability of organizations. We considered that the representation of these last factors is important as it provides the maximum value of innovation capability that could be achieved by the organization if these factors were known or there was evidence of their implementation or acquisition.

Each IPS axis indicates how innovation capability is positioned based on the factors of the (sub)set of determinants under analysis. For example, Figure 12 shows that the CEO's leadership is supported by a large number of factors (approximately 70%), which could contribute to increase the innovation capability of the organization. Additionally, no evidence exists for approximately 10% of the CEO's factors (note that the CEO factors implemented by the organization and the factors without evidence of application add up to 80%). With regard to Portfolio Management, it is only supported by the 30% of the factors that could impact innovation capability, while there is another 30% of factors for which there is no evidence.

4. Putting the Innovation Capability Framework into Practice

The case study presented here is a technique for detailed exploratory investigations for understanding and explaining phenomena or testing theories using primarily qualitative analysis [18]. Therefore, to validate the Innovation Capability Framework, we used the case study technique. Specifically, this section presents the empirical validation of the framework through a case study that assesses the innovation process of Skype. This validation comprises the generation of its IPS after modeling those dimensions and determinants that characterize Skype's innovation process from the organizational perspective.

4.1 Product under Assessment

Skype was created in 2003 by two entrepreneurs from Sweden and Denmark: Niklas Zennström and Janus Friis. Skype is a software product that supports several types of communications over IP (VoIP), such as text communications, voice and video.

When it first came into the market, Skype was entirely based on a peer-to-peer architecture. Apart from the servers used to download the software and authenticate users, the application ran entirely on users' computers. As a result of this structure, adding a new user cost Skype one-tenth of a cent, as reported in *Fortune* in 2004. However, Skype was not the first Internet-telephony application; it was not even the first one based on a peer-to-peer architecture [21]. However, the experience that the Skype team had gained developing KaZaA and a clear focus on voice quality and ease of use resulted in an application that surpassed the quality of existing Internet-telephony applications and was offered for free. Thus, one of its main strengths is voice communication that is free of cost between Skype users anywhere in the world. It

also supports special calls, at a very low cost, between a computer and landline or mobile. In less than two years after its launch, the Skype peer-to-peer solution for VoIP attained leadership in the global market in VoIP.

Therefore, Skype is an exemplar of business organization that adopts innovation on a continuous basis. This is why it is interesting to analyze the organizational implications associates with the innovation of Skype.

4.2 Research Method

We conducted a systematic literature review (SLR) to collect all available information regarding the organizational innovation that could have impacted the success of Skype. Following the guidelines put forward by Kitchenham [14], the SLR comprised three main phases: *planning* the review, which aims to develop a review protocol; *conducting* the review, which executes the planned protocol in the previous phase; and *reporting* the review, which involves relating the review steps to the community. The review protocol mainly involves defining the objective, the formal search strategy to identify the entire population of material to be considered, and the data extraction and synthesis strategies.

For the SLR of Skype, the review objective was to identify those dimensions that characterize the innovation process of Skype and those organizational determinants that probably affected or impacted it. To that end, we conducted a search in the set of electronic databases and consultants shown in Table 3 and defined the inclusion criteria (IC) and exclusion criteria (EC) to determine whether every potential material should be considered for the SLR. Finally, the extraction process involved identifying the date required to fulfill the review objective. Toward this end, we used a tool called Atlas.ti[7] that facilitates the collection of studies to be reviewed, as well as the qualitative data analysis of these studies by providing capabilities for storing and categorizing key concepts (see Figure 13). The synthesis process involved organizing and structuring the key concepts for modeling the innovation knowledge of Skype from the organizational perspective.

As Table 3 shows, in the search for material on Skype, we retrieved over 316 results, from which we selected 13 studies relevant to the review objective according to the inclusion and exclusion criteria.

Table 3. Data sources—SLR

Data source	Retrieved	Excluded	Included
Electronic Databases			
ACM Digital library	74	74	0
IEEE Xplore	5	3	2
Springer Link	27	26	1
ScienceDirect	11	8	3
White papers	20	20	0
Consultants			
Tech Republic	74	73	1
Gartner	1	1	0
Digital Library Tech	9	9	0
Mckinsey Quarterly	17	17	0
The Register	1	1	0
Safari Books ProQuest	72	71	1
Hand searches	5	0	5
Total	316	303	**13**

After analyzing and processing these studies, we obtained a set of networks of concepts using Atlas.ti (e.g., see Figure 13) to identify the organizational dimensions and determinants of Skype. First, this facility enabled us to visualize the organizational factors identified and described in the selected material and studies, the relationships among these factors, as well as the number of apparitions within all the studies that we selected (see the numbers in parentheses in Figure 13). Second, we categorized these factors according to determinants. For example, Figure 13 depicts the family "CEO Factors of Leadership" that comprises 11 different factors that were identified from across the selected studies. Figure 13 also shows the evidence and the source for the factor *extrinsic motivation*.

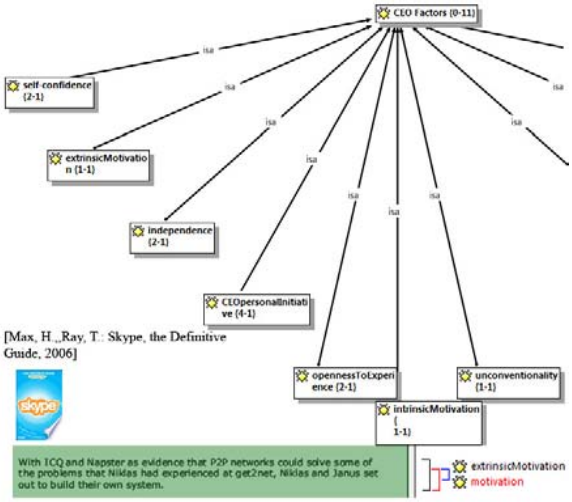

Figure 13. Network of concepts (Atlas.ti)

4.3 Positioning Innovation: The Skype Case

We modeled the Skype ICM from the information that was retrieved in the SLR, that is, we modeled the dimensions and determinants of the innovation process of Skype (specifically from 2003 to 2011, before it was acquired by Microsoft). The resulting IPS of Skype is depicted in Figure 14. The IPS graphically presents those organizational factors that Skype Inc. had acquired, promoted, or implemented,

[7] http://www.atlasti.com/index.html

which have been verified from the SLR (see the solid line of implemented factors in Figure 14). Hence, the CEO axis shows that 70% of the factors were implemented by Skype Inc. (see symbol √ in Table 4). Additionally, the IPS shows those organizational factors for which there was no evidence in the SLR that they were implemented by Skype Inc. (see the dashed line of the sum of implemented factors and factors without evidence in Figure 14). Hence, the CEO axis shows that there was no evidence for approximately 20% of the factors (see the dashes in Table 4).

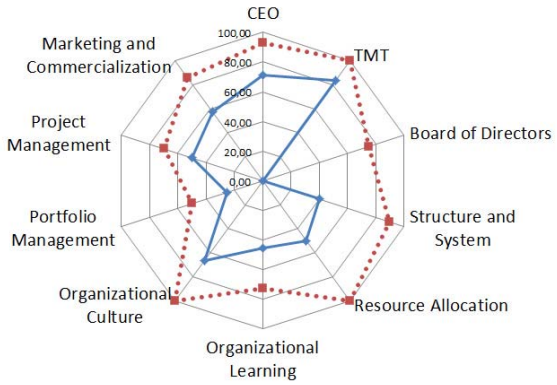

Figure 14. IPS of the Skype stydy case

Therefore, Figure 14 provides a global view of those organizational determinants that could have influenced the innovation that led to the development of Skype and the extent to which Skype Inc. has promoted, acquired, or implemented the factors of each determinant. Comparing a wide set of successful and innovative products could reveal those organizational factors that are key to lead to innovation (for an organization, industry, etc.).

Table 4. Breakdown of the CEO axis

CEO Factors	
Proactivity	√
Self-confidence	√
Openness to experience	√
Unconventionality	√
Originality	√
Adherence to rules	--
Authoritarianism	X
Independence	√
Tolerance of ambiguity	--
Intrinsic motivation	√
Extrinsic motivation	√
Determination to succeed	√
Personal initiative	√
Managerial tolerance to change	--

4.4 Limitations

The main limitation of this study is related to the collection of information for assessing the innovation process of an organization, such as in the case of Skype Inc. As innovation knowledge on a particular organization could be very sensitive information, we had problems at the time of collecting information regarding all the Skype factors. This is a limitation of the case study in terms of the accuracy of data. However, this is not a limitation for the Innovation Capability Framework, as this framework has been devised for the internal appraisal and assessment of the innovation capability of organizations themselves.

5. Related Work

Much of what is written about innovation focuses on frameworks for designing, planning, and managing the innovation process (e.g., [5], [19], the W-Model [10]), including the selection of the innovation strategy, generation and management of ideas and knowledge [22][23], their communication, or the decision-making process. However, it must be recognized that often a breakthrough or significant product innovation cannot succeed without the support of a set of organizational determinants that have a relationship with innovation or that could somehow impact innovation. These organizational determinants correspond to a *top management vision*, from either the strategic, tactical, or operational viewpoints. In this regard, Crossan & Apaydin [4] provided a conceptual framework of dimensions and organizational determinants of innovation from a systematic literature review conducted by them. However, they do not provide organizations with support for capturing and modeling these dimensions and the determinants of innovation or for ascertaining the positioning of an organization regarding an innovative product, process, or business model, and a (sub)set of these determinants of innovation. This study addresses these gaps based on the conceptual framework defined by Crossan & Apaydin [4], which has been widely used and cited although it is relatively recent. Finally, the Innovation Capability Maturity Model (ICMM) [9] is a promising approach that defines five maturity levels. Although we do not provide these pre-defined levels of maturity, we complement ICCM with support and automation for storing innovation knowledge and generating the IPS.

6. Conclusion and Further work

The complex and multifaceted phenomenon of innovation is a current critical issue in organizations due to the fierce competition in the market. The characterization of its dimensions and determinants from an organizational perspective could help organizations to reason about the innovation process and could guide future innovation processes. Toward this end, we presented an Innovation Capability Framework that enables organizations to store and analyze the innovation knowledge related to their

products, processes, or business models, as well as to assess their innovation capabilities. This framework is based on a set of organizational determinants that could influence the innovation process and comprises the ICM, its graphical language, and the IPS, which are supported by an Eclipse plugin called InnoTool.

The Innovation Capability Framework is not specific for software organizations. In fact, the starting study of this framework (i.e. the SLR by Crossan & Apaydin [4]) surveys a great number of studies from diverse areas, such as communications and drug industries; small and large firms; and technological and social points of view. However our research is focused on software organizations and that is why our case study is Skype.

The ICM modeling capabilities and the IPS were validated through the study of the innovation process of Skype. The analysis of a great set of innovative products can help identify those key organizational determinants to lead innovation. This allows a retrospective evaluation and may result in implications and recommendations for managers in terms of organizational determinants to be reinforced, improved, or changed. From the Skype analysis the importance of the CEO, TMT and organizational culture is highlighted, but also it is possible to see that weaknesses regarding the board of directors or the portfolio management did not prevent Skype to become successful.

Currently, we are applying the Innovation Capability Framework to survey a set of diverse products in the software industry. The goal is to obtain a panoramic perspective of the determinants that have been significant in the innovation process of successful products. The significance of the determinants could depend on the kind of product or industry, or even the current business situation, among others. This is an issue to be analyzed. Finally, it would be desirable to extend the list of determinants, as well as their factors, to obtain a more precise IPS.

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