Towards an agile innovation capability maturity framework to enhance investments on ICT organizations

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Abstract. Innovation is a complex process that has been studied from different perspectives. There are numerous studies, standards and reference models in the literature about it. Just a few works have been focused on covering a significant problem: innovation limits caused by public or private funding because of the restrictions imposed on the project in terms of scope and time. These restrictions are usually caused by the lack of trust and understanding of the innovation process by investors. In this Ph.D., the aim is to propose a framework that measures innovation maturity and capacity from ICT organizations. The initial hypothesis is that this Framework will allow improving investment since investor's risk will decrease and the trust will be increased, both, based on the maturity of the companies. The increasing of trust will eliminate the restrictions caused by financing, making it more adapted to the needs of innovation. Besides, organizations will have a framework that will allow them to compare their innovation maturity. As regards the research strategy is concerned, this Ph.D. will follow the Design Science methodology. A framework will be designed, developed and validated in a real use case in an ICT company. The framework is intended to assist public and private investors in the financing of ICT organizations.

Keywords: Innovation · Capability Maturity Framework · Agile · Public Funding · Business Angel

1 Introduction

Innovation is a very unusual business process, since creativity, which needs freedom, plays a decisive role [14, 11]. Moreover, for a project to be innovative, it must be executed as soon as possible while maintaining its initial scope. Scope, time and cost are important. The cost is obtained from external sources, which stress time and scope, causing projects to lose their innovative character.

As innovation is implemented through projects, it is subject to the Triple constraint or Project Management Triangle [2]: scope-time-cost, which is particularly crucial since:

- **Scope** is the root idea, which arises from the discovery process. It is a novelty and has a significant associated risk.
- **Time** determines whether an idea becomes an innovation. If it is not executed in time, another idea comes forward.
- **Cost** is the fuel of the project. The funding comes to alleviate its lack, but the other two restrictions are affected.

Innovation is a dual process [8] that needs systematisation and creativity, both, internal aspects of organisations. Despite the existence of numerous models that have tried to explain the foundations of the innovation process, most of them are unable to capture all the complexity that they try to describe [3]. Some studies have noticed that standardizing the innovation process results in higher process control, which may disrupt the level of freedom necessary for creativity and R&D processes [14, 11].

In this Ph.D., taking as reference the Frascati and Oslo manuals [21, 22], innovation will be considered as a business process that involves different stakeholders within its value chain. In both cases, innovation is considered to be a process carried out through projects. Innovation is a very unusual business process, since creativity, which needs freedom, plays a decisive role.

In this work, "agile" means to be able to move quickly and easily the private and public organizations' investments towards ICT organizations to enable their research, development, and innovation. Then, to evaluate innovation capacity processes and maturity levels on ICT organizations, an iterative and increment life cycle process will be defined following the Deming Cycle phases (plan, do, check, act). These phases will include the division of tasks into short phases of work and frequent reassessment and adaptation of innovation evaluation plans. In these lines, a set of principles will guide the methods, techniques and/or practices included in each phase. These principles will be focused on build trust, less funding risk, fewer project restrictions, and R&D agile in time and scope.

This paper presents a Ph.D. project in the context of business innovation. It contests if the current standards and models contribute to the proper development of innovation because they do not consider such a relevant factor as funding restrictions.

The rest of the paper is organized as follows: Section 2 states the problem that aims to be solved in this research work. Section 3 illustrates the methodology that guides the development of this thesis. Section 4 enumerates all the artefacts that will be generated to response the objectives stated in section 2. Section 5 describes the closest research in relation to the topic treated in this research. Finally, section 6 summarizes the conclusions and states a set of future work.

2 Research Objectives

2.1 Problem Statement

To carry out innovation, resources (mainly money), are needed. They constitute the third element (in addition to systematization and creativity), and it

is external to the organisation. Funding, according to the EU Green Paper on Innovation [7], is the obstacle to innovation that companies cite most, regardless of their size, in all European Union countries and practically all sectors. Moreover, they state that coping with or even shortening the time taken considering the applications for government aid is particularly important in connection with innovative projects.

Fig. 1, represents the problem statement and the Ph.D. focus. The cost is provided by investors, who due to their lack of trust, impose a series of restrictions on project time and scope. The outcome is distorted and usually remains outside the market, no longer being an innovation.

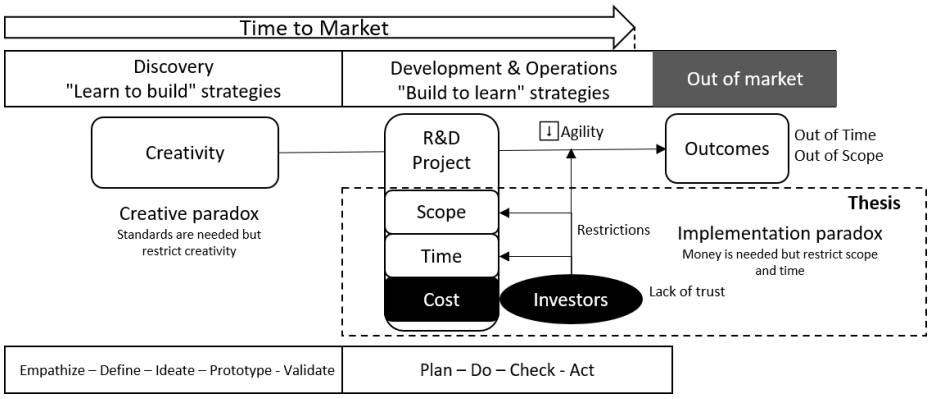

Fig. 1. Problem statement

From an idea generation perspective, innovation, as a business process, must be systematised, but it is inherently a creative process that needs agility and freedom. This fact is considered as the *Creative paradox* in this Ph.D., which has been extensively studied in numerous studies [27].

From an ideas execution perspective, innovation needs speed. Once an idea is created, it needs to be executed through a project as soon as possible. The maximum resources have to be provided to be executed explosively. Otherwise, its *momentum* will be lost. However, public aid and private investment are slow, restricted and bureaucratic processes. This fact is considered as the *Implementation paradox* in this thesis.

Discovery strategy is tightened by frameworks, models or standards while *Development & Operations strategy* is tightened by Funding (See Fig. 1).

Most studies focus on the first part of the problem (Creative Paradox), defining reference models, standards or capacity assessment systems. They share a common objective: to systematically and efficiently manage company innovation processes to improve innovative capability and business performance[18]. However, the problem caused by the need for funding, which once achieved limits innovative Development & Operations strategies by imposing severe restrictions

on Scope and Time, has not been considered by these reference models. This often interrupts or distorts the innovative process, leaving discovery results unexecuted or the results outside their "Time to Market". Discovery results without execution within a Development & Operations strategy is useless. Furthermore, it is counterproductive since frustration is generated in the teams. Innovation depends on *standards and reference models that measure maturity in innovation*, *resources (funding)* and *creativity*, which is tightened by the first two elements. Most studies focus on the relationship between frameworks and creativity, ignoring the *relationship between resources and discovery execution (projects*), cf. Fig. 1).

Obstacles and restrictions are imposed by public administration and private investors when they provide resources for innovation because they lack the necessary confidence. Investors don't have an instrument to assess the *maturity* and *trust* of innovative organisations.

- The purpose of the ISO/UNE R&D standards is not to provide trust to investors.
- There are no standard definitions, concepts and practices that measure maturity in innovation.
- Restrictions on funding have not been analysed.
- Investors operate on intuition rather than analysis.
- There is no agility in funding. Innovation needs speed. Innovating using financing is slow.

2.2 Aim and objective

This Ph.D. seeks to answer the second part of the problem described above by tackling the *Implementation Paradox*.

The aim is to design a *framework* that facilitates investment, by *reducing risk* and *increasing trust* based on the *maturity* of ICT companies (Fig. 2). This will make the funding's models more agile and adapted to the needs of innovation. ICT companies are chosen because, overall, they have more developed innovation processes, and it seems easier to implement a first iteration of the proposed framework. Subsequently, the framework can be scaled to any organization.

The organization's innovation maturity needs to be understood to *build trust* for public and private investors. By doing so, public and private investment processes will be optimized.

Innovation needs to generate ideas, and then implement them in the shortest possible time through projects. The first phase involves *creativity*, the second *resources*. Resources come from investors, which impose a series of restrictions on the project triangle, that depend on the degree of trust with the organization. If trust is increased, the restrictions would decrease and R&D capabilities too.

Trust depends on the investor's knowledge of organizations [6]. Understanding their maturity and capacity to execute R&D is a means of building trust. For this purpose, a distinction is made between *three types of investments*:

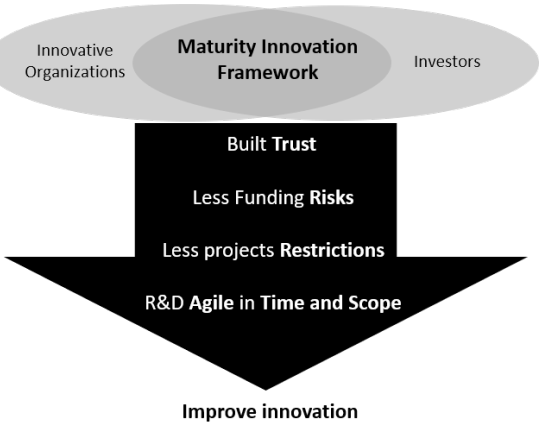

Fig. 2. Benefits of innovation Maturity Framework

- Public aid: Aid from public bodies is slow, and its structure and bureaucracy are contrary to the principles of innovation. A model that measures the organizations' maturity is necessary to ensure that the public administration is becoming more agile. This framework will simplify the administrative procedures and their requirements, helping through maturity levels to increase trust.
- External private aid: Venture capital in Europe is clearly lower than in other regions such as the US. Less risky investments prevail as well. Large commercial banks are reluctant to get involved in financing innovation. Their ability to appreciate the technological risk of innovation and their relations with innovation organizations are generally weak. Tools that facilitate their development are necessary, turning risk into the trust.
- Internal private: Companies are very little prone to risk. Investments with own capital are very limited, although they are the most appropriate way of promoting innovation projects since they involve very few restrictions.

Table 1 describes these three types of investment, classified into: agility, investor confidence and availability. It shows that for organizations, public funds are the most available, but they are yet the least aligned with innovation, as they generate the most constraints. If trust is increased, bureaucracy will be less and agility will increase, so the most available funding will also become the most suitable for innovation.

Therefore, this Ph.D. aims to *create a framework (integrated set of good practices) to assess the R&D maturity and capacity of ICT organizations*, which will be used as a methodological scale of investor trust to agility the funding process. In addition, the framework will help organizations to develop strategic, agile and comparable R&D.

Table 1. Innovation Investment classification

Investments	Less Bureaucracy	Need for Trust	Agility	Funding availability	Total
Public external	1	1	1	3	6
Private External	2	2	1	2	7
Private Internal	3	3	3	1	10

2.3 Research questions

The primary research objective of this Ph.D. is to investigate how innovation can be enhanced building investor's trust, through the assessing R&D maturity and capabilities in the organizations. For this purpose, a maturity innovation framework will be developed to reduce the gap between financing models and the requirements of the innovation process. To this end, the following research questions (RQ) guide the research:

- RQ1. How much important is to measure the innovation capability maturity level of an organisation?
- RQ2. What is the state-of-the-art in measuring the capability maturity in terms of innovation of an organization?
  - RQ2.1. What methods, techniques or tools have been investigated for developing R&D in ICT organizations?
  - RQ2.2. Which have been used for developing R&D in ICT organizations?
  - RQ2.3. What is the nature of found results to help ICT organizations develop R&D?
  - RQ2.4. What are the objectives pursued in research to help ICT organizations develop R&D?
- RQ3. What key performance indicators should be considered to measure the innovation maturity level of an organization?
- RQ4. How should a capability maturity framework be to enhance investment on ICT organizations?
- RQ5. How can the capability maturity framework be evaluated?

3 Research Approach

In the literature, there are many publications on research methodologies for both natural and social sciences. In this Ph.D., the Design Science research methodology will be followed. This research methodology was provided by Johannesson and Perjons [12] in combination with the guidelines by Wieringa [26] and Peffers et al. [23]. Design Science introduces a method framework for design science research that can be used by any design science project. The framework consists of four components:

- A number of logically related activities, with well-defined input and output.
- Guidelines for:
  - Executing the activities.

- Selecting research strategies and methods to be used in the activities.
- Relating the research to an existing knowledge base.

The method framework includes five main activities that range from problem investigation and requirements definition, through artefact design and development, and finally, to demonstration and evaluation. In addition, this PhD thesis won't undertake all of the five activities of the method framework in depth. Instead, this PhD thesis will focus on one or two of the activities, while the others are treated more lightly. Then, this PhD thesis will follow a Problem-Focused Design Science Research combined by a Requirements- and Development-Focused Design Science Research. The rest of the activities will undertake lightly. Figure 3 shows the main activities and artefacts that will be obtained in each activity.

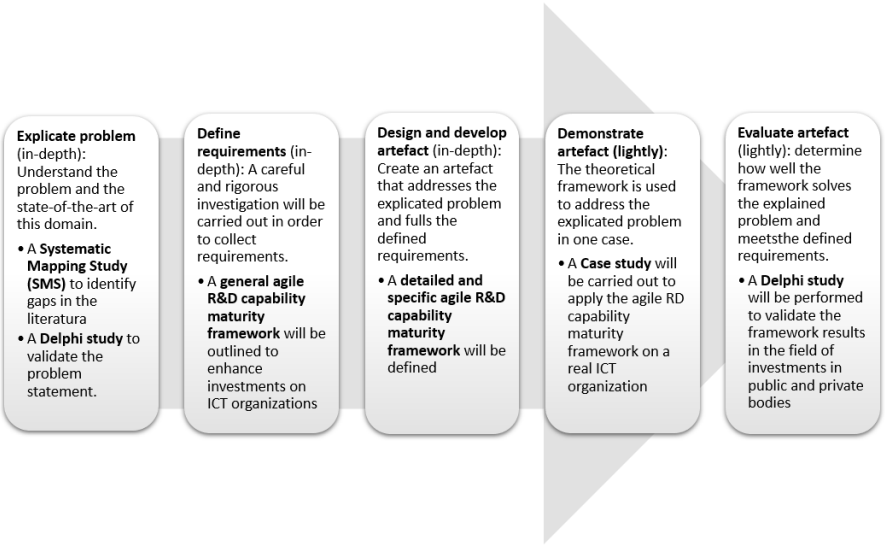

Fig. 3. Research approach and main activities

4 Research Contributions

Based on the identified problem that there are no approaches to increase investor confidence in R&D and that current investment conditions distort results, a wide variety of Design Science activities and contributions have already been identified, which are summarized below:

– A Delphi study [16] to validate the baseline problem.
– A Systematic Mapping Study (SMS) [24] to solve the problem described before, first trying to understand the state-of-the-art, and then identifying any gaps in current research.

- An agile R&D capability maturity Framework to serve as a reference for the public administration, decreasing bureaucracy and restrictions and leaving more freedom to companies funding. Likewise, private investors will have a methodological reference to base their trust when investing in R&D. Private investment could increase, and public investment conditions could be improved.
- A Case Study for a real ICT organization to validate the framework applicability and its benefits.

5 Related Work

Concerning the proposal presented in this work, to evaluate the capacity and maturity of ICT organizations in the context of R&D, some related works are described below.

Berg [4] proposes a method for assessing the quality and maturity of R&D in companies examining six viewpoints: R&D as part of business strategy and product and technology strategy, strategic implementation, outputs, implementation of projects and R&D as a business section.

Several proposals study how to evaluate the innovation capacity in projects or companies [1, 10, 5, 9, 28]. Bouwer [5] proposes a framework based on ten innovation management capabilities with strong interdependencies and critical relationships to support successful innovation within enterprises. However, they have not presented a real-context validation. Knoke [13] presents a framework result of the BIVEE research project, where the concept of the collaborative innovation capability maturity model (CICMM) is described.

On the other hand, Raghuvanshi et al. [25] carry out a state-of-the-art study on innovation capability frameworks. Their classification framework analyse different variables that enhance the innovation capacity of any organisation. The closest proposals to the topic of this Ph.D. are those related to the evaluation of the maturity and capacity of companies [20, 17, 19, 15].

Finally, standards that references to maturity and/or capability assessment related to this topic of this Ph.D. are described in Table 2. All of them, present a superficial description, and the need to measure maturity is not developed, nor does it offer frameworks for this purpose.

The biggest difference of this proposal, with respect to the related work described above lies in that they do not enough consider the critical factor that investors have in innovation processes. R&D maturity models proposed ignore the gap produced by the barriers that investors cause due to their lack of confidence. Therefore, a framework that helps to increase investor confidence is necessary to decrease the restrictions applied to projects when they are financed.

6 Conclusion and Future Work

This paper presents a Ph.D. approach to enhance the innovation process in ICT organizations. It focuses on the gap that public or private funding leads

Table 2. Standardized Innovation Management Systems by region. Update of [18]

Family Code	Family Name	Region
ISO 56000	Innovation management	International
CEN/TS 16555-1:2013 EX	Innovation management	European
CWA 15899:2008	Standardization innovation capability SMEs	Europe
CWA 14924	Guide good practice knowledge management	Europe
UNE 166000:2006	Innovation management	Spain
BS 7000-1:2008	Design management systems	UK
FD X50-271:2013	Innovation management	France
DS-hæfte 36:2010	User oriented innovation management	Denmark
NWA 1:2009	Guide good practice innovation	Ireland
NP4457:2007	R&D&I Management	Portugal
GOST R 54147:2010	Strategic and innovation management	Russia
PAS 1073: 2008	Assessing innovation capability manufacturing companies	German
ABNT NBR 16501:2011	Guidance for R&D&I Management	Brazil
NTC 5801:2008	R&D&I Management	Colombia
NMX-GT-003-IMNC-2008	Technology management system. Requirements	Mexico

to distortions in the execution of innovation projects. For this purpose, Design Science [12, 26, 23] methodology has been selected to guide the research and five research questions have been proposed.

To validate the problem statement asked in RQ1, a Delphi study [16] will be performed. The response of RQ2 will be the results of the execution of an SMS [24]. On this basis, the performance indicators should be further refined and validated giving response to RQ3. RQ4 will be answered by developing the capability maturity framework under consideration of the KPIs defined in RQ3. Finally, the capability maturity framework will be evaluated in a real-world industrial context to offer a response to RQ5. Although this work is in an early stage of its development, the SMS and Delphi study artefacts have been already started obtaining promising results.

To sum up, this Ph.D. contributes to the knowledge base of software development by providing a capability maturity framework that offers an organisation the possibility to know its maturity level and compare it with other organisations.

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