Bibliographic Review of Models of Prospecting Technology Innovation in Conditions of Uncertainty and Unpredictability: An Exploratory Study

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Abstract. This work aims to present an analysis based on literature, through a bibliographic review of the models of prospecting technology innovation in conditions of uncertainty and unpredictability. This article has as objective to analyze the main variable aspects of prospecting technology innovation. Therefore, literature of the main basis was up brought and from that, elements about the article were taken, such as authors, years of publication, as well as it was analyzed whether the articles exposed clearly the models and variables relevant to the work. At the end, the constituents of the models were presented, where the variables were identified and classified as independents, dependents and moderators. The results found were satisfactory being possible to find variables and classify them, in order to show in an objective and practical form relevant information to the prospecting technology innovation in environments of uncertainty and unpredictability.

Keywords: Technology Innovation, uncertainty, unpredictability.

1. Introduction

In current scenario, innovation is part of people’s routines [1]. It is evident that the introduction of new Technologies in innovative products being considered one of the most expressive forms of developing new functionalities and improving performance of exists products [2], [3]. Innovation is the break of previous models of knowledge and the rising of new values, for example, a novelty or renovation of a product or a process [4]. Analogously, Schumpeter treats innovation as an idea or an abstract model of something new or perfection of something existing, that materializes, economically, whenever there are commercial transactions creating richness from the previous idea or model [5]. The Manual of Oslo categorizes innovation in: Products Innovation, Processes Innovation, and Products and Processes Innovation [6].

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It is known that opportunities bring risks and uncertainties, arising from unfavourable factors to the process of prospecting Technologies, that, frequently confronted by social economical and political issues are not so easily identified ((MOHAMED, et.al., 2012; REISMAN, 2006; GLASS e SAGGI, 1998; PACK e SAGGI, 2001; MADU, 1988; MADU and JACOB, 1989; DUNNING, 1983; VERNON, 1966; STREIT, 1949 apud [7]). That way, also in environments of uncertainties and unpredictabilities, with the most diverse interferences, technological or demand uncertainties, among others, the need for innovation in products and processes is widely acknowledged [8]-[12].

The competitive advantage, bigger profits and market leadership are factors that motivate the search for innovation [10], [13]-[15]. However, it is known that the process of innovation is not easy, being the lack of available capital, the risk of failures [16], organizational issues, political and cultural issues along with the difficulty of predicting a future situation are inhibitory factors of innovation [17], [18].

The challenges of innovation are complex and diverse [7], which requires a thorough investigation (FRENZ and IETTO-GILLES, 2009 apud [19]) and a deep knowledge on the subject in question. In the case, technological innovation and with the purpose of avoiding possible dubious interpretations, since every area of knowledge applies it in their own way [20], technology can be defined as a technical knowledge that can be applied in order to involve the ability to offer products and services (BOHN, 1994, PHAAL, FARRUKH and PROBERT, 2004 and KAPLAN and TRIPSAS, 2008 apud [20]).

Technological prospection must be seen as a bibliographic way of describing future scientific and technological developments with abilities to significantly influence industry, economy or society as well as the objective to identify and answer to emergent opportunities of market and technologies [21], [22]. Technological prospection makes a collection of existing Technologies, identifies how they are inserted in society, their level of maturity, competitor Technologies, holes to be filled [23], looking forward to incorporate information to the process f technological management, in the attempt to predict possible future states of technology or conditions that affect its contribution to established goals [22], [23].

This work has the objective of gathering and analyzing the main variables of diverse models of prospecting technology innovation in conditions of uncertainty and unpredictability, from the understanding that a model aims to represent real world in a simplified form [24]. For that, a bibliographic review was used as methodology, that is some kind of secondary study with the objective of synthesizing relevant evidences about the given research theme through extensive reviews in literature [25]. Thus, the literature of the main basis was up brought, the elements about the articles were extracted, such as data about the authors, publishing date, information and gathering of models using similarity and function criteria, as well as analysing and discussing factors and variables mentioned by them.

2. Methodology

This work of bibliographic review is a adaptation the Cochrane Handbook [26], was made in six stages, as described below, all of them made in team in parallel. These stages have become necessary so that the work goals could be achieved.

Stage 1: Formulation of the Question

The bibliographic review starts with a question that shall be answered at the end of the work [27]. It is the question that shall guide the research leading the researchers about what “searching” is. All the other stages depend on the question being consistent and that it can be answered by literature. All the questions that this bibliographic review has proposed to answer were:

From the models of prospecting technology innovation in conditions of uncertainty and unpredictability presented in the current literature, which are the independent, dependent and moderating variables in these models? Is it possible to attribute some type of relative level of importance to these variables?

Stage 2: Location and Selection of Studies

In this stage researches were made in the data networks selected in order to find articles that could answer to the question made in the first stage. The following basis were chosen:

ACM Digital Library - http://portal.acm.org
For the searches in the data networks, the key words “model”, “prospecting”, “uncertainty”, “unpredictability”, “technology” e “Innovation” combined, using the logical operator “AND” and “OR”, as presented below:

Stage 3: Critical Analysis of Studies

The studies found during the search in the data networks were classified in some categories.

- Identified studies: Studies with potential to be included in the review. These ones were identified through the search in the data basis with the key words, as the combinations described in Stage 2.
- Non-selected studies: Verified studies that clearly do not meet the criteria of inclusion defined in the project of bibliographic review. Such articles were excluded after the literature in its title and/or abstract where it was ascertained that they have no relation with the proposed theme for the work.
- Selected studies: Group of studies that in a first moment fill the criteria of inclusion defined by the project of bibliographic review. These ones were selected after its title and abstract reading and the checking of the relation with the proposed theme for the work. The sum of the number of selected studies with the non-selected studies represents the number of identified studies.
- Excluded Studies: Are the selected studies that, after complete reading and due to their analysis, shows that such articles do not possess strong relation with the theme or have little technical quality;
- Included Studies: Are studies that were effectively used in the bibliographic review. These ones meet all the criteria of inclusion defined in the review, as well as were considered relevant, based of the affinity with the theme for the research, according to the defined scope in the Project of bibliographic review.

The criteria for inclusion of the article in this research were: to have relationship with the theme; publications in journals, conferences, symposia, workshops, periodicals and others; English language; articles that expose clearly the models and variables used in the work.

The criteria for exclusion of articles were: disconnected study with the proposed theme; duplicate articles, the oldest one being discarded; superficial articles that did not allow the extraction of any variables that influence the innovation process.

In this research, during the evaluation process, the included studies should meet all the inclusion criteria and none of the exclusion criteria.

Those undertaken searches, a total of 2489 articles were identified in a first search conducted in the year 2014. Then the titles and abstracts of the articles were read and they were separated from unselected and selected studies. At the end of this stage 56 selected studies and in 2433 unselected studies were totalized.

The studies selected in the second stage were read carefully checking whether there was relevant to the question asked in the first stage and so were separated and excluded studies included studies. Of these studies, 40 were excluded because they were not relevant, and 16 were included in the survey and these are the data was extracted to answer the question theme of this work. The flowchart steps can be seen in Figure 1 and Table 1 shows the amount of data bor pase studies.
Fig. 1: Steps of the bibliographic review

<table>
<thead>
<tr>
<th>Table 1: Articles by database</th>
<th>Identified studies</th>
<th>Non-selected studies</th>
<th>Selected studies</th>
<th>Excluded Studies</th>
<th>Included Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Scholar</td>
<td>150</td>
<td>138</td>
<td>12</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Microsoft Academic</td>
<td>102</td>
<td>93</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>ISI Web of Science</td>
<td>179</td>
<td>177</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Wiley InterScience</td>
<td>59</td>
<td>52</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>ACM Digital Library</td>
<td>514</td>
<td>509</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>ScienceDirect – Elsevier</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>550</td>
<td>538</td>
<td>12</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Emerald</td>
<td>935</td>
<td>926</td>
<td>9</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>2489</td>
<td>2433</td>
<td>56</td>
<td>40</td>
<td>16</td>
</tr>
</tbody>
</table>

Step 4: Data Collection

The data collection was made in a parallel way to the third stage. To verify that a particular study met the inclusion requirements, relevant information was already taken from it and they were tabulated and then analyzed and validated by the group members. The types of tabulated data in this study can be seen in Table 2.

<table>
<thead>
<tr>
<th>Table 2: Data extraction about review studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Extraction</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Identifier</td>
</tr>
<tr>
<td>Title</td>
</tr>
<tr>
<td>Author</td>
</tr>
<tr>
<td>Country</td>
</tr>
<tr>
<td>Year</td>
</tr>
</tbody>
</table>
Stage 5: Data analysis and presentation

The extraction process aims to ascertain, comprehend and relate relevant information in order to achieve the results described in the goal of the bibliographic review project. In this stage organizing data was necessary to facilitate their interpretation. The collected and tabulated data were reorganized in groups in a new chart. Then a relation was made among the articles, so that from dependent variables, it was sought to relate data with independent and moderating variables. The data were qualitatively and quantitatively analyzed, with the purpose of answering in a satisfactory way to the research’s issue proposed by this systematic review.

Stage 6: Interpretation of Results

The group organization and data presentation raised by the stages previous to this review were essential to establish the results. The effort in determining important information to the analyzed studies regarding its relevance in prospecting technology innovation in environments of uncertainty and unpredictability.

In a first moment, there was a classification of the models, and then, they were gathered in a way the made possible to extract the variables the composed each one of the prospecting models presented and how they would relate. Thus, it was possible to obtain information in common with these models and the forms they correlate, then, being able to find similar points to find a structure of a prospecting technology innovation model in environments of uncertainty and unpredictability.

3. Results

A lot of information was raised from the included articles in this bibliographic review in the attempt to ascertain their importance. Table 3 shows the relation of periodicals where they were found in the articles, as well as the quantity of articles present in each one, besides information regarding to data bases where the articles were located and indexed.

<table>
<thead>
<tr>
<th>Name of Periodical</th>
<th>All Article</th>
<th>Reviewed by Citations</th>
<th>Data Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal of Business &amp; Industrial Marketing</td>
<td>3</td>
<td>81</td>
<td>Emerald/Google Scholar</td>
</tr>
<tr>
<td>Journal of Product Innovation Management</td>
<td>3</td>
<td>52</td>
<td>Emerald/Wiley InterScience/Google Scholar</td>
</tr>
<tr>
<td>R&amp;D Management</td>
<td>2</td>
<td>38</td>
<td>Wiley InterScience/Google Scholar</td>
</tr>
<tr>
<td>Journal of Engineering and Technology Management</td>
<td>2</td>
<td>320</td>
<td>ACM/Google Scholar/Science Direct</td>
</tr>
</tbody>
</table>
Table 4 shows the grouping of several working areas of the authors of those studies included in this study.

**Table 4: Area of the authors with their occurrences in their respective studies**

<table>
<thead>
<tr>
<th>Area of training of authors of such studies</th>
<th>Occurrence</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing, management and business</td>
<td>12</td>
<td>[S1], [S2], [S3], [S4], [S5], [S6], [S7], [S8], [S9], [S10], [S11], [S12]</td>
</tr>
<tr>
<td>Engineering</td>
<td>3</td>
<td>[S1],[S5], [S13]</td>
</tr>
<tr>
<td>Art</td>
<td>2</td>
<td>[S13]</td>
</tr>
<tr>
<td>Economy</td>
<td>2</td>
<td>[S7], [S14]</td>
</tr>
<tr>
<td>Commerce</td>
<td>1</td>
<td>[S2]</td>
</tr>
<tr>
<td>Political Science</td>
<td>1</td>
<td>[S15]</td>
</tr>
<tr>
<td>Chemical</td>
<td>1</td>
<td>[S16]</td>
</tr>
</tbody>
</table>

Table 5 shows the departments and institutions / universities which the authors of the articles act. Similarly Figure 2 makes a relation between the included articles and the performance of departments of the authors of those studies.

**Table 5: Departments, Institutions of researchers.**

D1 - Department of Management, Politics, and Philosophy, Copenhagen Business School, Frederiksberg, Denmark  
D2 - Swarthmore College, People's Light and Theatre, Swarthmore, Pennsylvania, USA  
D3 - Department of Global Health and Social Medicine, Harvard Medical School, Boston, Massachusetts, USA  
D4 - Department of Management and Technology, Ecole des sciences de la gestion, Universite du Quebec a Montreal, Canada  
D5 - Department of Mathematics and Industrial Engineering, Ecole Polytechnique, Montreal, Canada  
D6 - Department of Management, Virginia Polytechnic Institute and State University, USA  
D7 - Lappeenranta University of Technology, School of Business, Lappeenranta, Finland  
D8 - University of Oulu, Faculty of Economics and Business Administration, Oulu, Finland  
D9 - Department of Business Management; Fashion, Marketing & Retailing, The University of Sheffield, Sheffield, UK  
D10 - Department of Marketing, University of New Hampshire, Durham, New Hampshire, USA  
D11 - Lally School of Management and Technology, Rensselaer Polytechnic Institute, New York, USA  
D12 - Science & Technology Studies, Gebze Institute of Technology, Turkey  
D13 - Lubin School of Business, Pace University, USA  
D14 - Wesley J. Howe School of Technology Management, Stevens Institute of Technology, USA  
D15 - School of Administrative Studies, Faculty of Liberal Arts and Professional Studies, York University, Toronto, Canada
Among the items included in the survey, it was noted that the United States contributes with most part of the research, totaling 62.5% of the studies. Other countries that have contributed less relevantly were Canada, Denmark, Taiwan, Finland and the UK, as shown in Figure 3. In relation to the publication period it was noted that researches in the focus area of this article have been growing in recent years, as it can be seen in Figure 4. Regarding the research method we observe in Figure 5 that the “survey” is the most common way, being present in 75% of the articles, other methodologies less used were case study, literature and documentary research, once the concepts of each of these methods are shown in Table 6.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case study</td>
<td>Adequate study to answer to questions as “how” and “why” which there is not wide control of the events [28];</td>
</tr>
<tr>
<td>Documentary/</td>
<td>Documentary research is based on material that did not suffer analytic treatment, that is, a compilation of information that was dispersed ensuring a new value to</td>
</tr>
</tbody>
</table>

Table 6: Concepts of Used Research Methods
4. Structural Analysis of a Model

The results presented here were extracted from included studies. For each model, evidences that influence the innovation process were extracted. From these models were extracted the main variables that composed them. These variables were tabulated, and then, gathered by similarity, in a way to synthesize information and correlate common aspects to the models. The variables were classified in three macro groups: variables, independent, dependent and moderators [29], [30], according to the conceptual models proposed by the above-mentioned study. Figure 6 shows the drawing of the adopted model in this review in order to analyze primary studies.

4.1. Moderating Variables

In the present study, moderating variables represent the environment that the innovation process is inserted, featuring conditions that make it unstable and that might affect the innovation positively or negatively [31]. Moderating factors were listed at the primary studies, in many cases, one factor shows up in different studies with different terms, but synonyms. That was the first step to gather them with single variables.

- Environmental Uncertainties

Environmental uncertainty is about situations that interfere in the innovation patterns and innovation speed, considering external resources, possible environmental turbulences, and even political interferences [2, 5, 10]. Studies and the current organizational research has aimed to examine organizations under points of view that involve their interaction with wider environmental context. Each organization has an environment that is real, measurable and external to this very type of uncertainty that becomes noticeable at the moment that managers face such interferences. This reality might impose certain limitations to the way each enterprise operates [1, 3, 6, 10, 11, 12, 13, 15, 16].

- Technological Uncertainties

Technological uncertainties are about the scenario of technological changes in general, mainly when they happen in an accelerated way [3, 9]. In these cases, measuring these changes represents a tough process, considering not being possible to predict tendencies and their impacts on the products, services, and even in commercial systems. Still, technological notelties are also considered technological uncertainties, that might be product of radical innovation as well as the turbulence they can cause [2, 4, 6, 7, 9].

- Market Uncertainty

The market uncertainty is related to product acceptance factors and / or services by consumers and evaluated issues such as design and quality [4, 12]. Similarly, market uncertainty considers the confidence of consumers in companies, based on their size and market time, which usually changes its
confidence level [S6]. Finally, political and cultural issues in countries where certain product or service will be offered, influence and interfere in the market [S4], [S6], [S8], [S9], [S14].

- Changes in Team

Another important factor is the departure of team members, considering the influences of external and internal environment of the company (such as better working proposals, major changes in private life, or even disagreement with the decisions taken for the team). Sometimes the entrance of a member which could be of great importance within the team becomes impossible due to external or internal environment of the company. [S5].

4.2. Independent Variables

The independent variables are the factors that are manipulated to cause late effects, which will be measured in the dependent variables [29]. Just as the moderating variables, the factors that define the independent and dependent variables were analyzed in order to be grouped by similarity in single variables.

- Creation Abilities

The ability to create variable relates to skills and good practices implemented by teams in order to add value to a product or process [S1], [S5]. Such creation abilities of the team usually impact the time efficiency and innovation standards [S4], [S5], [S9]. Organizations use new knowledge to develop products and features to create new markets or replace existing products [S4], [S5]. Learning, dedication and multidisciplinary are issues related to the organizational aspect that will reflect on the skills of the teams involved, as well as a entrepreneurial guidance. [S1], [S4], [S5], [S9], [S16].

- Market Proficiency

The market proficiency deals with the skills, ability and applied technical knowledge about a particular market in which the organization operates, and the integration of the organization with customers [S3], [S8], [S14]. The market mastered proficiency is one of the main factors to control the market uncertainty, which is considered one of the variables that define the conditions of uncertainty and unpredictability [S14], [S8] [S9]. Still, knowledge and marketing investment are cited as facilitators associated with market knowledge to overcome the uncertainty [S3], [S8], [S9], [S12], [S14], [S16].

- Technical proficiency

Technical proficiency is defined as the deep technical knowledge regarding the area of innovation which proposes a new product or service [S9]. The technical proficiency goes beyond the technological orientation involved, but also relates to the level of flexibility of the team involved to propose new solutions, for example, in [S3] shortage of particular resource, [S6]. Technical proficiency is enrolled as a resource to bring the organization's security, especially with regard to technological uncertainty, which is considered one of the variables that define the conditions of uncertainty and unpredictability [S3], [S6], [S8], [S9], [S14], [S16].

- Project Optimization

The project optimization relates to process improvements that make up the project as a whole, aiming to improve time efficiency [S4], [S9]. These improvements internally organize the processes seeking to decrease them. In some situations, it may even eliminate processes, like replicated processes [S4], [S9]. The time efficiency to innovation is considered as one of the most important success measurers, then the optimization of the project proposes an analysis that will improve the project so that it is possible to reduce the time for innovation within the organization [S4], [S9].

- Strategies for innovation

Strategies and practices for innovation are defined by the structure, posture and actions to be adopted by the organization in search for innovation [S1], [S3], [S11]. This variable verifies the influence of innovation strategies and structure and how it interferes on the patterns of innovation [S1], [S11]. The strategic orientations must be evaluated mainly in the prospecting Technologies, as well as in the perception of vulnerability, since they define the positioning of the enterprise in relation to external tendencies and effects, verifying technical and architectures to be used, patterns of interface, alliances with other organizations [S2], [S11], [S12]. Likewise, the environment’s structure may be evaluated, as the market, concurrents, business models, once a turbulent environment might cause technological discontinuity and restructuring of the needs.
[S4]. Abilities, practices and rewards based on speed must be included as innovation strategy [S1], [S2], [S3], [S4], [S7], [S11], [S12], [S13].

- Cooperation Network

In sociology, the concept of networking is based on membership, complementarity, sharing, exchange, and mutual aid [32]. An enterprise searches a network of cooperation with other organizations to acquire expertise, access to specific resources, and critical knowledge [S1], [S16]. It is currently observed in the environment of organizations, a need for companies to act jointly [S8]. The sources of knowledge that are outside the company are of great importance, so that cooperation agreements between private companies, public institutions, universities, are examples of cooperation [S1], [S8], [S10], [S15], [S16].

4.3. Dependent Variables

- Innovation

Innovation is the ability of a company to introduce new products and processes in order to ensure better market opportunities [23]. It is possible to measure the level of innovation by the average number of patents that the company has, since patents are directly related to the invention [S10] [S15]. However, a large number of patents does not necessarily imply financial performance. The financial performance for this study, in the sense that innovation will occur in a timely manner. Attitudes such as aggressiveness, competitiveness and risk facing, influence companies to become proactive, differentiating themselves from their competitors by improving their products and production methods [S1], [S2], [S3] [S4], [S5], [S6], [S7], [S8], [S9], [S10], [S11], [S12], [S13], [S14], [S15], [S16].

5. Discussions

This study presents several factors that can affect positively or negatively the prospecting process of technological innovation in different areas. This study also has listed and analyzed the many prospecting technology innovation under uncertainty and unpredictability in the literature, analyzing and gathering the variables found in the primary studies included in the research.

It was observed that the research field related to prospecting technology innovation has been growing in recent years, especially in the US. The researchers of this topic act mainly in Marketing, Business and Management, the areas of Engineering and Economy also present themselves in a shy way, as collaborators of this research area. It is noticed that the search field is at an early stage, the research groups go through a training process, the trend is that the number of studies in this area have a gradual growth, and can have a global reach.

In the search for the structure of a model that represents the various scenarios for prospecting technology innovation in conditions of uncertainty and unpredictability, similarities were found in the dependent and moderating variables. For the definition of scenario, namely uncertainty and unpredictability, defined the moderating variables: environmental uncertainty, technological uncertainty, market uncertainty and changes in staff. Regarding to the performance measurements presented by the studied models, the innovation is shown as dependent variable. The factors listed as a possible means to pursue the exploration of technological innovation and impacting a greater or lesser degree the search for innovation are presented as independent variables. The three groups of variables, as they have been grouped, are presented in Appendix B.
Fig. 7: Frequency of variables, level of influence and betweenness centrality
Fig. 8: Network of relationships of variables.

The frequency with which the variables appear in the selected studies, a summation of the number of citations of selected studies that bring the same variable, and the betweenness value of each variable is shown in Figure 7. The betweenness is calculated by determining how many times a node (in our study, a variable) is used as part of the possible paths between the other two nodes. The idea is that the more a node intermediates, the shorter the path connecting two nodes, the greater its importance within the network, and the greater its betweenness degree, which indicates a more central node [33]. In our study we connect the nodes (variables) based on their appearances together in the text of each primary study, forming a network (check figure 8). Because of this, even if a variable appears within the primary studies, in these studies it is adjacent to a large number of other variables, the variable A will have a smaller value for its frequency of appearance in the studies, however it will have a high value of betweenness. In this case, the number of times that a variable acts as a "bridge" over the shortest path between two other variables, was quantified. The idea...
is that the more a variable intermediates the path that connects the other two variables, the greater is its importance within the network.

As it can be seen in Figure 7, the independent variables creation skills, market expertise, technical proficiency, and strategies and innovative practices have higher values of betweenness, which presents strong evidence that these variables have a high level of importance in the innovation process. Independent Variables design optimization and cooperation network have betweennes values close to zero, indicating little relevance to the innovation process. The variable restraining market uncertainties, on the other hand, has a higher value of betweenness, which may indicate a greater importance thereof to the innovation process. The variables moderating changes in staff, environmental uncertainties, and technological uncertainties present very low betweenness, indicating the possibility that these variables exert little influence in the innovation process, even considering that the last two have a high frequency value or number of citations within the primary studies.

Figure 8 shows the relation of the set of variables appearing through a network built from a symmetric matrix representing the connection between the variables. The network connections were obtained from the joint appearances of the variables within a primary study, and the weights assigned to the connections between variables were obtained from the sum of the time that these variables appear together, for primary study. Figure 9 presents a model based on the survey made by this review and the variables found.

6. Conclusion

6.1. Implications for the theory and practice

This research was presented in an objective and practical way to search, through the bibliographic review, which are the variables and the level of importance of these models to prospect information technology in environments of uncertainty and unpredictability.

The models presented in the literature were synthesized and its parts were identified in three categories, independent, dependent and moderating variables. This allowed a broader view of models and the possibility of combining these variables in order to find common aspects and group them by similarity, making possible the reduction of their number and the attempt to regroup them in a new model. Thus, we sought to find results that could add value to the management of organizations in regarding prospecting information technology, in particular in a scenario of uncertainty and unpredictability.

In this sense, there was a facility to find out the variables that verify performance-dependent variables-moderating variables. Thus, it was not the same with the independent variables, where, even synthesizing and grouping similar factors, it is still possible to find many variables that are not necessarily connected to one another.
As many times values of betweenness disagree with the values of frequency and the sum of citation numbers, when it is about attributing importance to a variable, it more difficult to draw solid conclusions in this sense of our analysis. For a more complex ascertainment, seeking a practical validation, it is suggested that a survey is made with area experts. In order to find this result, we can avail ourselves on a judgement matrix to be presented to area experts where they could attribute weights to each one of these variables, as they cause bigger or smaller effect on the prospecting technology innovation. With that, it would be possible to have an upgrading in the model that would ascertain the results of these variables about the performance and innovation of organization in a scenario of uncertainty and unpredictability.

6.2. Limitations and Recommendations

It is important to highlight that other variables may emerge over time, as new studies can be carried out and find new factors that can influence the search for innovation.

So for future works, there is the indication of a survey research with experts with technical and scientific knowledge of the area where it is intended apply a model in order to validate the factors obtained in the literature. Thus, it is yearned for more-specific contribution to certain context and area as well as the possibility of future discussions related to the proposed theme.

7. References


8. Appendix A. Included in Review Studies


9. Appendix B. Table Variables and Quotes

Table showing the list of variables defined in this study and the original variables presented in the studies included in this review.

<table>
<thead>
<tr>
<th>Variável</th>
<th>Citação</th>
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<tbody>
<tr>
<td>Creation Abilities</td>
<td>Value creation [S1]; Project team characteristics[S4]; Presence of new business creation skills on team [S5]; Entrepreneurial orientation [S16]; Project Team [S9]: &quot;</td>
</tr>
<tr>
<td>Market Proficiency</td>
<td>Customer relationship orientation [29]; Customer orientation [S3], [S8]; Market orientation [S16]; Marketing Proficiency[S9]; Marketing's technical knowledge [S12]&quot;</td>
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<tr>
<td>Technical Proficiency</td>
<td>Technology orientation [S14]; Cross-functional teamwork and interdepartmental connection [S3]; Team improvisation and unlearning in a NPD (new product development) team [S6]; Technology orientation [S16]; Internal integration [S8]; Technical Proficiency [S9];</td>
</tr>
<tr>
<td>Project Optimization</td>
<td>Process Compression [S4] [S9];</td>
</tr>
<tr>
<td>Strategies and Practices for Innovation</td>
<td>Digital systems to support innovation processes [S13]; Innovation strategy and structure [S1]; Prospecting Strategy [S2]; Strategic orientation [S3]; Predevelopment activities [S4]; Top Management Support, Clarify of Goals, Speed-based Rewards [S7]; Strategic posture, Organization structure [S11]; Innovation posture [S12]; Innovation practices [S1], [S3];</td>
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<td>---------------------------------------------------------------</td>
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<tr>
<td>Cooperation Network</td>
<td>Network orientation [S1], [S16]; Stability and magnitude of federal R&amp;D expenditures [S15]; Supplier integration [S8]; Network centrality [S10];</td>
</tr>
<tr>
<td>Environmental Uncertainties</td>
<td>Valuable unpredictability [S13]; Velocity, Institutionalization, Challenge, Uncertainty [S1]; Uncertainty and hostility in their environment. [S3]; Environmental turbulence [S6]; Environmental dynamism (industry; firmsize; firmage; R&amp;D input) [S16]; Policy Volatility [S15]; Environmental uncertainty [S10], [S11], [S12]; Environmental hostility [S11];</td>
</tr>
<tr>
<td>Technological Uncertainties</td>
<td>Technological Capability; Resource Complementarity; Resource Similarity [S2]; Technological environment [S4]; Environmental turbulence - technology [S6]; Technology novelty, Technological turbulence [S7]; Technological Uncertainty [S9];</td>
</tr>
<tr>
<td>Market Uncertainty</td>
<td>Market uncertainty [S14], [S9]; Market environment [S4]; Environmental turbulence - market [S6]; Demand uncertainty [S8];</td>
</tr>
<tr>
<td>Changes in Team</td>
<td>Behaviors, Attitude [S5]; existence of a continous project team[S4];</td>
</tr>
<tr>
<td>Innovation</td>
<td>Accidental innovation [S13]; Patterns of innovation - emphasis on transforming knowledge into products [S1]; Economies of Scale; Reduction of Uncertainty &amp; Risk; Speed in Product Development [S2]; Innovative performance - radicalness of the firm’s innovation output [S14]; Performance of process innovation [S3]; Time Efficiency, Profitability [S4]; Successful new market creation for BI projects (New applications emerge) [S5]; Successful new market creation for BI projects (Value chain agents engaged; BI project financial success) [S5]; New product success [S6]; Innovation Speed [S7]; New product commercialization performance [S16]; The number of total patent applications [S15]; Green product innovation; Green process innovation [S8]; Time Efficiency [S9]; Innovative performance [S10]; Organization innovativeness [S11]; Firm performance [S12];</td>
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