EXPLORATORY STUDY OF SUCCESS FACTORS FOR RESEARCH AND DEVELOPMENT PROJECTS RUN BY SMES IN QUEBEC LINKED TO SECONDARY AND TERTIARY ALUMINUM PRODUCTION.

1. Introduction

The Centre québécois de recherche et de développement de l’aluminium (Aluminium Research & Development Center of Quebec) was created by the Ministère de l’Économie, des Sciences et de l’Innovation du Québec (Ministry of Economic, Sciences and Innovation of Quebec) in 2001 to carry out an independent activity to achieve a specific goal. To this end, a base model was developed at the Centre quebecois de recherche et de développement de l’aluminium (Aluminium Research & Development Center of Quebec).

Despite extensive literature on the subject of success, there is no consensus. However, it is accepted that success is evaluated by certain criteria and that it is dependent on success factors. Moreover, these concepts can vary according to the type of company, project and especially the stakeholder evaluating them. Within this context, the present study will discuss these criteria and factors as applied to projects run by SMEs working in the secondary and tertiary aluminum industry. The aim of the study is to help create a generic model applicable within the specific field of R&D projects submitted to the Centre québécois de recherche et de développement de l’aluminium (Aluminium Research & Development Center of Quebec).

2. Literature review

The concept of project success has been large- sized by the Ministério de l’Économie, des Sciences et de l’Innovation du Québec (Ministry of Economic, Sciences and Innovation of Quebec). It offers financial, human and technical support to research and development projects in the aluminum sector. Its scientific committee is an advisory body to its Board of Directors and consists of 20 experts in a variety of fields. Its basic role is to evaluate projects based on relevance and quality and to recommend these projects to the Board of Directors. The challenge lies in determining a project’s chances of success based on its documentation in order to decide whether to provide funding. Since the creation of CQRDA, over 1000 projects have been submitted, of which 813 have been accepted and funded in five different areas. Evaluating a project’s chances of success is a difficult endeavor that should be optimized and given a more solid basis.

The concept of project success has been large- ly addressed in the literature. However, there is no single agreed definition or measure for this, as highlighted by Pinto and Slevin. For several years, a project was considered successful if it met the three requirements in Atkinson’s “iron triangle”: cost, time and quality. This outlook seems reduc- tive as it implies that project success depends solely on the success of its management. Moreover, the extent of a project’s success is inherently linked to the knowledge and understanding of two concepts: success factors and criteria. The problem is, given the unique nature and complexity of individual projects, it is impossible to theoretically determine all the key factors and success criteria involved. In addition, the normative aim of the theoretical processes from which they often arise makes it difficult to transfer them into practical situations, especially in certain specialized areas of activity.

Finally, the literature provides few or no answers pertaining to small and medium enterprises (SME), and these are even more scarce for those SMEs that work in the aluminum industry. Within this context, it seemed relevant to investigate the factors that lead to success for research and development projects run by SMEs working in the secondary and tertiary aluminum industry in Quebec. This research aims to identify criteria capable of predicting success for the majority of projects submitted to the Center. To this end, a base model was developed at the start of the study and was used as a guide for the resulting investigations.

2. Literature review

The design that made it possible to develop an understanding of the theoretical nature of this study is close to themes inherent in the idea of “project success” such as project management, projects, SMEs, research and development, etc. By “histori- cizing” the concept of “project success,” we discov- ered that a stream of North-American research has been studying the history of managerial thinking since the 1960s, much like the history of economic or political thought [George, 1972, Wren, 1954]. The advent of the idea can thus be traced back to this period.

Cleland and King (1983), two authors who have contributed significantly to the emergence of project management as a discipline, define a project as “a complex effort to achieve a specific goal that must follow a schedule and budget, typically goes beyond merely organizational aspects, and is unique and generally non-repetitive in its organization.” For O’Shaughnessy (2006), “a project is the implementation of specific, temporary actions with the aim of producing unique deliverable goods to achieve specific results.” Slevin and Pinto (1989) determined that a project generally consisted of four phases and used the terms “conceptualization, planning, execution and termination” to characterize these phases. The four phases are illustrated in the Figure 1.

When examining all the work linked to the subject at hand, it soon became clear that a distinction must be made between the success of a “project” and that of “its management.” As described by DeWitt (1998) and several other authors, project success is measured in relation to general project aims over a long period. According to the PML project management is defined as “The art of directing and coordinating human and material resources throughout the life of a project by using modern manage- ment techniques to achieve predetermined objectives of scope, cost, time, quality, and client and stakeholder satisfi- faction.” Project managers must steer through this con- text using knowledge they have acquired in school or on the job. In some respects, they become a pivot that links and guides all aspects of a project. They could be compa- red to octopuses, with each tentacle capable of carrying out an independent activity to achieve a specific goal.

In all studies looking at project success, the consen- sus is that this success depends on several factors and is judged using specific criteria. A distinction therefore needs to be made between these two concepts in order to demystify the language employed throughout this explor- atory study. Initially, success factors were described by Leidecker and Bruno, 1984, as “characteristics, conditions...
or variables which, when properly sustained, managed or integrated, can significantly impact the success of a firm competing in a particular industry. For Munns and BjÖrner (1996), the main success factors for a project were objective, project administration, third parties, relationship with clients, personnel, contracts, legal agreements, politics, efficiency, conflicts and finally, profits. O’Shaughnessey (2006) translated and adapted the ten key success factors of their group into project management; the need to be involved in the project; support of senior management; action/work plan; continuous communication with the client at different stages of the project; human resources; technical expertise; project management processes; methods and standards; communication with main project stakeholders; and ensuring organizational capacity for taking on the project.

3. Methodology

As part of this research, an interpretive rather than positivist approach was used for epistemological reflection. The basis of this thought implies that the majority of the available information can be found in people’s experiences. People who have accumulated decades of experience and survived several social, economic and political cycles would be able to provide an additional dimension to this research, which focuses on factors leading to success in research and development projects for SMEs in Quebec linked to the secondary and tertiary aluminum industry. The expected aims for this research are, firstly, to define criteria that would allow the COJRES to judge if a project has been successful, and secondly, to identify the internal and external variables that must be present in a project for it to end successfully. Finally, we hope to illustrate at which stage of the project these factors should be present.

Group discussions seemed to be the best way of collecting information to achieve these aims, particularly because they would allow us to explore individual reactions to existing or new information as well as to determine the extent to which opinions converged or diverged on various topics (Patton, 2002). This term relates to two types of focus groups: in the first, its members are brought together by a common experience or situation; in the second, the group is invited to “focus” its interactions on one or more predefined topics (Leclerc, Bourassa, Picard & Courcy, 2011).

This qualitative strategy made it possible to extract known variables from the literature in addition to other factors that may have been overlooked in order to build a model that could be used to evaluate the potential success of a project submitted to the Center. It also made it possible to gather a significant amount of information in a short period. Focused group discussions are not generally used to achieve consensus but rather to facilitate interactions and a process of interinfluence that results in social representations (Abric, 1994). Participants help each other to answer as adequately as possible the questions set by a facilitator. For those who can master this dynamic method using key basic principles, it can result in high-quality information. In fact, this formula lent itself perfectly to the present study and offered considerable advantages. In addition, it has the undeniable benefit of reducing the control held by the researcher by transferring some of the power to the community (Duchesne & Haegele, 2008).

The chosen strategy was divided into two main phases (Figure 2). Firstly, as shown in the literature review, stakeholder involvement is needed to identify variables and their effects. From experience, the proposed strategy made it possible to scan the information and relevant factors in order to begin the analysis.

1. Aim of the project: Clearly defined initial objectives and general instructions.
2. Support of senior management: Support of senior management in the way of providing resources and the authority/power necessary for project success.
3. Project schedule/work plan: Detailed outline of individual actions toward implementing the project.
4. Consultation with clients: Communication, consultation and active listening for all parties involved.
5. Personnel: Recruitment, selection, and training of personnel necessary for the project team.
6. Technical tasks: Availability of techniques and expertise necessary to accomplish specific technical tasks.
7. Client approval: “Selling” the final project to targeted end users.
8. Monitoring and feedback: Providing comprehensive control information at each stage of the implementation process.
9. Communication: Providing an appropriate network and necessary data to all key participants involved in implementing the project.
10. Troubleshooting: Ability to handle unexpected crises and deviations from the project plan.

TABLE 1: New product development project’s success factors
also monitor the research projects for which they are assigned. The coordinator can then demonstrate which CQRDA services can contribute to the company's activities, achievements, influence, R&D projects, and of course their needs. The support coordinator will need to study the Center's activities, achievements, influence, R&D projects, and success factors at the start of the session. As this is the key point on which the study is based, this step was essential. Once this was completed, the group discussed in general terms the criteria used by CQRDA to define a successful project. Agreement was reached for most of the ideas discussed. Some criteria were mentioned immediately, as soon as the discussion got underway. Essentially, this statement was made at the beginning of the session: “Marketing: selling many products from the project,” and in the same vein: “I have three suggestions: good, attractive and cheap.” Marketing success therefore seems to be one of the most important criteria. The idea of meeting initial targets is given similar weight. As expected from the literature review, one of the elements of the Iron Triangle (cost, time, quality) was mentioned: quality. Some linked this to respecting client needs: “That’s why you have to pay attention to quality. You can have a good quality product that doesn’t quite match client needs.” Elsewhere, marketing was also linked to client needs: “If you want it to be a commercial success, you need to meet client needs.”

Other criteria, such as creating knowledge for the industry, were hotly debated. Initially everyone seemed to agree. However, one of the coordinators remarked, “Even if the project is a total failure, at least you still learned something!” After some back and forth discussion, everyone agreed with him. This situation can only occur in focus groups.

The second part of this meeting was to classify each criterion according to its level of importance. As at the start of the meeting, the coordinators needed to be made aware of the concepts they should use to classify the criteria, since the study is based on an assessment of the Center, which is a stakeholder in every project presented to it. Initial discussions focused on the concept of marketing. Half of the participants believed that successful marketing was not a criterion for success as a project could still be technically successful. One person said: “Projects always accomplish something; there is technical success and commercial success. When it goes wrong, it’s often due to commercial failure. But it’s rare to see technical failure.” Following a lively discussion, one of the coordinators raised the point that when a project is marketed, the amount paid to the company is reimbursed and the Center becomes self-funding. Using this argument, he was able to convince other coordinators who aligned themselves with his position.

Protecting intellectual property was also the subject of some debate as some participants considered this to be an important criterion while others disagreed. The main argument that had an impact was that when a product is copied, any money invested in it could be lost. Other participants seemed to accept this point. The following table summarizes what was said during this focus group.

One of the most important criteria was without a doubt the creation of a prototype. Generally in R&D projects, manufacturing an alpha version of a product makes it possible to validate the concept. In addition, the Center requires this stage be completed before any financial support is made available.

Despite the intellectual protection and successful marketing criteria, answers obtained were unanimous and are shown in the table below.

**TABLE 3**: Summary of the first focus group

<table>
<thead>
<tr>
<th>Very Important criteria</th>
<th>Important criteria</th>
<th>Criteria of little importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client approval</td>
<td>Number of jobs created</td>
<td>Securing intellectual property protection</td>
</tr>
<tr>
<td>Improving productivity</td>
<td>Increase in turnover</td>
<td>Staying on budget</td>
</tr>
<tr>
<td>Product quality</td>
<td>Number of sales</td>
<td>Improving company competitiveness</td>
</tr>
<tr>
<td>Achieving initial goals</td>
<td>Reasonable selling price</td>
<td>Approval of the project by the project team</td>
</tr>
<tr>
<td>Working prototype</td>
<td>Manufacturing price less than or equal to expectations</td>
<td>Company investment following the project</td>
</tr>
<tr>
<td>Innovative product</td>
<td>Better product than competitor’s</td>
<td>The project ensures the continuation of the company</td>
</tr>
<tr>
<td>Overcoming expected technical issues</td>
<td>Complies with high standards</td>
<td></td>
</tr>
</tbody>
</table>

**Project managers focus group**

The second focus group with project managers provided invaluable information. As with the first group, participants were introduced to the differences between criteria and factors. Following on from this, discussions proceeded without any pauses. The first factors mentioned were leadership of team members, availability of financial resources, flexibility of participants, access to regional laboratories, predicting marketing costs at the start of the project and many other factors presented in the following table.
A comparison of factors discussed with those in the literature revealed that almost all the themes were men-
tioned, although they were sometimes expressed differ-
ently. In fact, two new concepts were discussed that had
been absent from the literature thus far. The first can be
described as flexible leadership. Naturally, promoters
mentioned that the inherent uncertainty in research and
development projects often lead to moments of dif-
ficulty. During these discouraging moments, team members infor-
mally take turns to act as motivator and leader to ensure
the project stays on track. The second newly identified
factor was that products should provide competitive cost
advantages. It was mentioned that if project delivera-
ties provide competitive cost advantages, the project has a
higher chance of being successful as it is easier to market
its market, the better its strategy will be. Factors similar to
those mentioned in the literature were noted in this stage.

The second stage of a project, planning, should be seen as
as more of a study of all the aspects that will make it possible
to complete the project. In innovative projects, it serves to
validate the technological approach as well as to monitor
prior art, plan costs and schedules, etc. We noted that the
key factors in this stage were primarily financial. Indeed,
as this stage is mostly about planning budgets, it is essen-
tial to have competent team members to create an accurate
evaluation of expenses and investments that need to be
made for this stage to be executed successfully. Moreover,
the availability of financial resources is a prerequisite for
the next stage. Once again, the results closely matched
those found in the literature.

The third stage of a project, the execution of the pro-
ject, involves implementing the strategy identified in the
first stage. It is often at these moments that the skills of all
project participants, both internal and external, are the
most called upon. Similarly, access to laboratories and ap-
propriate equipment is a bonus for innovation projects. A
comparison with the literature also revealed that following
the initial plan makes it possible to keep a project focused
on its desired targets.

Once these stages are completed, innovation projects
move on to a stage in which the functional prototype is
designed and the company initiates the marketing process.
Unfortunately, as highlighted by all our participants, com-
panies often go all out at this point, without necessarily
providing the means to follow through. For this reason, an
appropriate strategy must be defined from the beginning.

The Table 4 sets out a summary of the group discus-
sions.

Key
Factors related to competences (C)
Factors related to ways of doing (Q)
Factors that are external and cannot be controlled (E)

Factors related to monetary aspects (M)
Factors related to personal qualities (R)

The JOURNAL OF MODERN PROJECT MANAGEMENT | SEPTEMBER – DECEMBER 2016

80

Summary of the second focus group
5. Discussions, limitations and lessons learned

The main aim of this study was to identify the key factors that make it possible to assess the potential for success in innovation projects put forward to the members of the Center’s scientific committee. An analysis of the data made it possible to identify which factors the Center’s R&D team could assess. Although it is difficult to measure the perseverance of an unknown promoter, this factor could represent an asset for promoters that have already received backing and are resubmitting an application. Moreover, as the CQRDA already asks companies to present résumés for their team members and subcontractors, it can evaluate their skills and effectiveness to a certain extent. Other supporting documents such as financial packages, studies of prior art, proof of concept, market descriptions, etc. are already considered when analyzing applications for funding. The current evaluation process for projects has proved to be credible; adding a few more elements will only increase its effectiveness. These elements, which have been newly identified as critical and assessable by CQRDA, are set out in the table below:

| Identified Factors | Efficiency of the team (C) | Specialized workforce (C) | Presence of a competent university expert (C) | Competent external resources (Subcontractors) (C) | Constant technology watch (F) | Study of prior art (F) | Product in line with the company’s strategic vision (F) | Prototype for testing before manufacture (F) | Understanding of the market (F) | Understanding of the company’s limitations (F) | Product presents competitive advantages (F) | Planning for commercialization costs (M/F) | Realistic initial budget (M/F) |
|-------------------|--------------------------|--------------------------|---------------------------------------------|---------------------------------------------|-----------------------------|------------------|--------------------------|-----------------------------|-------------------|--------------------------|-------------------|---------------------------------------------|-------------------|-------------------|
| Availability of financial resources (M/F) |

Following the results obtained by this study, a strategic meeting was held for the team leading R&D projects at the Center, as this team is also responsible for preparing project documentation in partnership with companies before their presentations to the scientific committee. Subsequently, the process and project evaluation grid were subject to a strategic review with the aim of improving their content to increase efficiency. From now on, the Center will include these factors in their project analyses before awarding funding. All studies have their limitations, and these must be identified and taken into account by the researcher in their analysis and during their attempts to generalize the results. In this study, it should be highlighted that the projects studied were distributed across a wide variety of industrial sectors (transport, smelting, cycling, etc.) and were from small companies with fewer than 100 employees. This had minimal impact as most of the CQRDA’s member companies have fewer than 100 employees. Despite these specific characteristics, the research made it possible to better identify factors likely to influence the successful outcome of these R&D projects in the secondary and tertiary aluminum industry.

6. Conclusion

Completing this study made it possible to clarify some aspects of success in projects linked to the secondary and tertiary aluminum industry. Because this type of project has not yet been addressed in the literature, this study is the first step toward partly filling this void. In addition, this study revealed that SMEs do not manage their projects in the same way that large companies do. This is often because project stakeholders are usually company shareholders, and their involvement and motivation therefore have a completely different drive.

Similarly, as these are SMEs, their resources are very different from those available to large companies, and they must find the funding needed in different ways. These include using organizations such as CQRDA and many others. Completing a detailed financial package is therefore a key factor in project success. In conclusion, the knowledge gained during this study can be used and adapted by other organizations complementarily to and working in parallel with the Center. In short, this study will surely provide the Center with valuable insight, helping interested companies become aware of issues they need to take into account in R&D projects in the secondary and tertiary aluminum industry.

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