Performance limiting factors for complex projects within the Royal Canadian Air Force [1]

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Abstract

This article proposes possible solutions for the Royal Canadian Air Force (RCAF) to implement best practices, particularly in terms of the skills to be identified and developed for project managers. It has been clearly established that project performance and success are closely linked to the skills of project managers. The more skills are adapted to the characteristics and complexities of major RCAF projects, the greater the chances of success.

Key words: Complex project, performance, Royal Canadian Air Force, limiting factors, competence

Introduction

This article presents a research analysis of the factors limiting performance in the completion of complex projects within the RCAF. A literature review was carried out to determine which limiting factors affect project performance and how they can be remedied. Although several guides and tools are available within the Canadian government, the question arises as to whether these are adapted to RCAF projects based on their specific characteristics. A conceptual framework will be developed around the main limiting factor to be able to develop propositions and contributions. This will enable the RCAF to implement best practices regarding the performance of complex projects in a context of innovation. This will also include a methodical and more accurate assessment of the level and order of RCAF's projects' complexity.

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"Those who plan do better than those who do not plan, even though they rarely stick to their plan." – Winston Churchill.

***"There's a plan in everything, kid, and I love it when a plan comes together*". (Hannibal Smith, The A-Team, 1983)**

Part 1 - RCAF projects' context

1.1 Complex project – a traditional or extraordinary definition

All too often, complex projects are completed with gaps between the requirements identified in the definition and closure phases. It is, therefore, vital to identify the factors contributing to these discrepancies, from the launch of the project to its completion. Several questions are asked about the complexity of these projects, their limitations, studies, and comparisons with similar projects. The Canadian Armed Forces (CAF) have the responsibility and accountability to determine and orchestrate their various projects with a view to being operationally ready for different interventions around the world and for domestic operations in Canada. Military projects are innovative and highly complex, especially in a military-civilian model. As a result, the risks and uncertainties can be greater. "...the need to integrate multiple technologies into increasingly complex products and services, positivist and rationalist approaches to project management can lead to even more suboptimal decisions and ongoing project failures" (Brady *et al*., 2012, page 730).

Baccarini refers to dictionary definitions of what constitutes a complex project, either because of the difficulties caused by the interrelationship or interdependence of the different parts of a project. The project is then said to be difficult to supervise and complicated to manage (Baccarini, 1996). To stop at the definition of a complex project would be too simplistic in our case. The RCAF has certain specific characteristics, listed below, which mean that its major projects are not comparable in every respect with so-called traditional major projects. For example, it is assumed that the RCAF's projects are mainly out of the ordinary, i.e., extraordinary.

1.2 Complex organizational and technical features

The RCAF's organization is inherently complex due to the multitude of entities involved, both internal and external, in carrying out a major project, and which is structured in a matrix and functional manner depending on the entity. We can already see the beginnings of an area of concern generated by a temporary multi-organizational structure, which can be laborious in terms of communication and the definition of roles/responsibilities. The level of interdependence and relationships between the different organizations must also be taken into account (Baccarini, 1996).

In addition to organizational complexity, there are technologies to consider. Although the RCAF mainly uses existing technologies in its major projects, we sometimes must innovate in certain cases, considering that some technologies initially have a commercial scope that needs to be converted into a military capability. This brings added complexity to the various major projects, some of which are unique to the RCAF. For example, the CH146 Griffon helicopter is based on a Bell Helicopter platform (Bell 412), which has been militarized for various armed forces to carry out missions in hostile and combat environments. To this must be added the airworthiness standards specific to military aviation, as well as flight safety, which is of paramount importance.

Another feature of the RCAF's major projects is the acceptance of the Canadian public in the use of public funds. As a result, each project is subject to criticism from the public, which has an impact on the politics and government of the day. This is not an insignificant factor, as it means that a project may fail or even be canceled. We can compare the F35 fighter acquisition project, which has a bad reputation with the public because of its cost and low economic impact in Canada (Wilner & Wyss, 2012), with the CH146 Griffon helicopter upgrade project, which is being carried out mainly in Mirabel, Quebec and in Canada until 2028 (Thatcher, 2021) and for which there has been no bad press to date.

The final specific characteristic of a RCAF major project is the operational need. Major projects are initiated from a need or capability required for domestic or expeditionary operations. However, most operational requirements emerge at the start of a mission, mainly due to the conditions in which the aircraft will be maneuvering. These include weather conditions, protection of aircraft from hostile forces, interoperability with allied forces, ... As a result, especially when the lives of military personnel are at stake, the RCAF must carry out major

projects on a fast-track basis to meet requirements. In these specific cases, certain steps in the traditional project delivery application are deliberately omitted to speed up the project, to the detriment of the additional costs this may generate. As a result, the modern definition of a complex project with the specific characteristics of the RCAF means that projects are ultra-complex and difficult to carry out according to traditional performance criteria. This raises the question of whether performance criteria are appropriate for the success of these projects.

1.3 Limitations of models and approaches

Thus, we have determined that the main characteristics that make projects more complex within the RCAF are its organizational structure, technologies, airworthiness/flight safety standards, the appropriate use of public funds and its operational needs. It is argued that the management of complex projects within the RCAF is clearly outside the norm and requires a similarly non-traditional approach to address it. "Increased complexity in society, the economy and technology require new and adapted organization and management" (Saynisch, 2011, page 21). The traditional approach to project success is based on a triangular measure (the Project Management Institute's Golden Triangle) of performance in achieving scope, being on budget and on time. However, the ideas behind this approach are sometimes misleading, because if you try to achieve the required performance at all costs, the end product may not be operational (Orhof *et al*., 2013). Shenhar, Levy, and Dvir (1997) instead propose four dimensions of success: project effectiveness, customer satisfaction, organizational success, and future potential. (Orhof *et al*., 2013) It is then interesting to determine whether this approach, for example, is applicable to the RCAF.

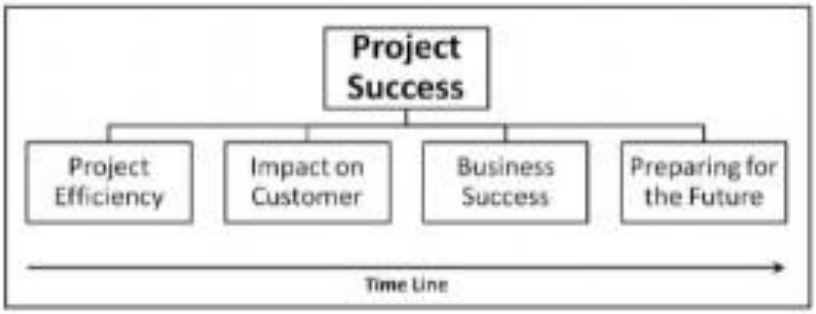

Figure 1 – Shenhar, Dvir & Levys' four dimensions for success

The RCAF's current approach is based primarily on the theories and approaches of the Project Management Institute (PMI). When we talk about a major project, which is undeniably complex

in nature within the Ministry of Defence, this implies a project cost of at least 10 million dollars, and in some cases the budget will be more than one billion dollars. In some cases, then, we are talking about a megaproject as defined by Flyvbjerg (Flyvbjerg, 2016). In fact, Flyvbjerg identified certain characteristics, typically overlooked in megaproject planning, which are mainly the risks inherent in long-term planning, leadership not supported by staff turnover, technology, and decision-making by a multitude of stakeholders (Flyvbjerg, 2016). Thus, even before a project begins, major projects are already considered to have intrinsic challenges mainly due to its size and increased complexity. It is, therefore, essential to analyze the approaches and methods used by the RCAF in carrying out its major projects and to adapt them accordingly. This is currently not the case, where the RCAF tends to use traditional methods based on general guidelines and PMI tools.

It is obvious to analyze whether the model, including the structure for managing complex projects within the RCAF, is adequate and what factors contribute to project failure. "Managers expect to be able to plan and consider all the variables of a complex project in advance, but no one is smart enough or has a crystal ball to do this" (Matta & Ashkenas, 2003, page 110). Matte & Ashkenas agree with Orhof that the risks associated with scope, budget and schedule are not adapted to the reality of a major project. Project managers inevitably neglect two other performance criteria: activities that have not been planned in advance and the integration of activities that are not interdependent (Matta & Ashkenas, 2003).

1.4 The challenges of project implementation within the RCAF

As explained above, the RCAF's major projects are atypical in terms of their complexity and characteristics. Certain characteristics specific to the RCAF mean that the use of traditional methods and approaches is not necessarily adapted to the success of projects. This can occur at several levels, including the performance of project management teams, risk management, resource allocation, political influence, and inappropriate performance measures. We can therefore analyze the main problems likely could disrupt a project. The recent scientific conversation supports these statements and proposes more pragmatic approaches to the realization of mega-projects. The main issue is whether the RCAF is using best practice to successfully complete its major projects, and what are the limiting factors that prevent it from applying them?

Part 2 - Challenges and requirements for RCAF projects

2.1 The role of technology

The main issue for major projects within the RCAF is to determine whether the best practice is being used. Before delving into this subject, it's worth looking at the impact that emerging technologies have had on project management, including practices. In fact, I believe that new technologies, especially in IT, have revolutionized the way major projects are carried out, just like the Industrial Revolution (Al *et al*., 2020). While several research studies and schools of thought have been developed to determine best practice, new technologies have rendered these practices from another world obsolete. The modern projects should be conducted by universal approaches with their critical perspectives, and by hypermodern currents of thought. (Bredillet, 2007-2008). We no longer speak of 'Major Projects,' but of 'Mega Projects', because technologies have facilitated certain areas such as administration and planning (financial and scheduling, etc.). The question to be asked at this stage is not what benefits the emergence of new technologies has brought to project management practices, but what challenges they have brought. We will, therefore, distinguish between two (2) groups of factors limiting success: those that have emerged with the new technologies and those that have always been present, independently of the technologies.

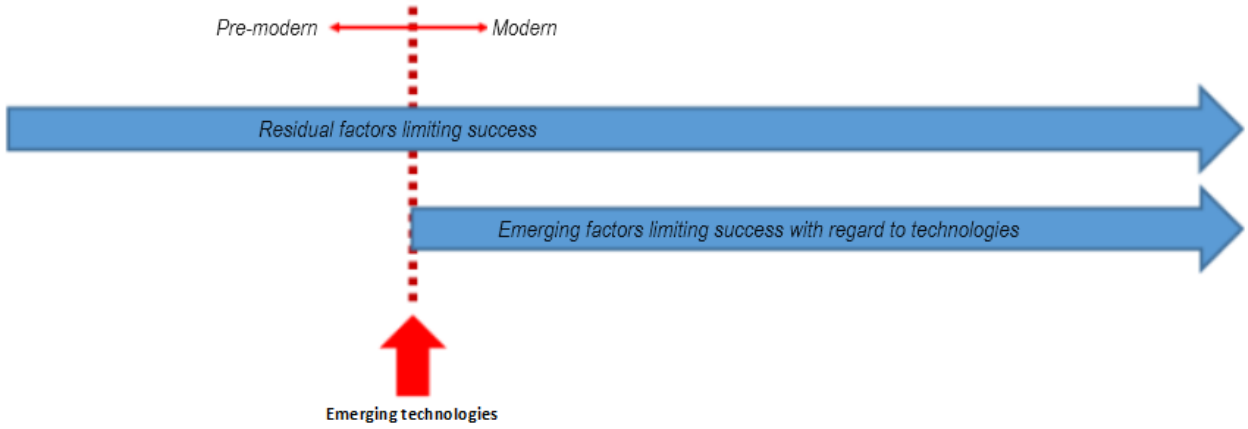

Figure 2 – Groups of restrictive factors

2.2 Residual factors limiting success

Although technologies have been able to mitigate or even resolve certain challenges, the fact remains that some of them remain a challenge in their own right notwithstanding the emergence of technologies, referred to as residual limiting factors. Major public projects are characterized by the need for them to be socially acceptable, i.e., to be of benefit to Canadians at the lowest possible cost and introduced as quickly as possible. This raises the question of whether, as a matter of practice, managers do not simply use optimistic data in their estimates, rather than using formulas such as the Project Evaluation Review Technique (PERT). In a research publication, the limiting factors identified within defense ministries in most countries were: "bureaucratic pitfalls, political interference, cost overruns and delays in completing major projects are the plight of many processes" (Auger, 2019, page i). "The management of major defense procurement projects is one of the recurring issues in Canadian defense policy. Many projects have received a bad press in recent decades because of delays, cost overruns, political interference in the process and operational problems" (Dumas, 2020, page iii). Indeed, project management within the RCAF is a unique model because it is decentralized and multi-departmental mainly for procurement and contracting with Public Services and Procurement Canada (PSPC). According to Auger (2019), there is no effective model for solving defense procurement problems in the 21st century.

Project organizations are aware that cost and/or schedule overruns are unavoidable due to an optimistic view of the situation to make projects acceptable to the public. As a result, project managers opt for easy solutions such as reducing the amount of equipment to be delivered. According to Gareth Davies, Head of NATO, "All too often, the Minister of Defense (MoD) fails to deliver major equipment contracts as planned due to a combination of supplier poor performance, a failure of the MoD and suppliers to master the technical complexity of projects, and resorting to short-term solutions to affordability problems" (News, 2021). As a result, nine (9) out of ten (10) mega-projects have cost overruns due to poor management of the risks associated with project complexity and performance management (Flyvbjerg, 2016). This raises the question of whether the RCAF is using the right calculation tools to determine costs and schedules. There are methods that can be applied and that need to be studied in greater depth, such as the analysis of delays using the snapshot method (Lorna M. Tardif, 1988). Some financial tools are innovative and adapted to complex projects, such as the Target outturn Cost

(Remington & Pollack, 2016), which are more appropriate for use by the RCAF, compared with the tools used by the Canadian government's Treasury Board.

Figure 3 – Metaphoric whole brain model
(Hertzog Du Toit,2018)

The skills required to be an effective project manager have also changed. The spectrum of skills has expanded in several areas. In contrast to Dainty's traditional competency factors and criteria (Dainty et al., 2003), we can look at Herrmann's more adapted model, which defines the required competency in terms of four (4) types of modes, including three intrinsic levels (Papineau, 2018). Thus, there are several modern models suitable for complex projects that the RCAF can draw on to adapt its competency programme, including the dimensions detailed by [Lemon] and [loop] (Medina, 2018). Currently, the government is limited to developing a generalized list of core project management competencies. In addition to these skills, managers can use individual methods to improve project performance and achieve organizational objectives. For example, certain working methods can be introduced, such as systemic observation in problem solving and change management (Morin, 2008). Here again, the RCAF, like the Government of Canada, seems to be anchored in so-called traditional methods that are outdated and unsuitable. The RCAF would do well to review its methods and become more efficient. "The worst-performing

companies devote almost 12 times more resources to projects that don't come to fruition, so it's urgent that we implement these essential changes" (Microsoft 365 Team, 2019).

When hiring project managers, the RCAF recommends engineers as the basic prerequisite for being a project manager. As a result, the RCAF does not consider an individual's people skills or know-how as the main criterion, but rather their knowledge. This has major repercussions on projects, because a project manager, although highly skilled, does not necessarily have the precise experience for highly specialized RCAF projects. For example, an electronics engineer could be responsible for a weapons project on the CF18 fighter, whereas a technologist with several years' experience on this weapon would be de facto eliminated as project manager because he is not an engineer. One of the essential skills for the success of a project is for the manager to master the techniques used by the various parties involved, so what better person than a technologist (Sébastien, 2022). However, the engineering community is more in favor of general government skills such as communication, ethics, and leadership (Government of Canada, 2022); skills that are often acquired through an engineer's training.

To cope with all the limiting factors listed above, you need to be able to clearly determine the order and level of complexity of a project. You can then assign a project manager with the skills and experience required according to the complexity of the project. To do this, you need to have a programme for assessing skills and complexity. Once again, the RCAF refers to the Government of Canada's general guides, such as the Project Complexity and Risk Assessment Guide (Government of Canada, 2015) and the Project Management Competency Development Program. It is vital to understand "that a proper diagnosis of complexity would make it possible not only to have a shared vision of the project, but also to adapt one's management style and use the right tools with the aim of fostering the success of the project" (Adam, 2002). "The growing challenges of complexitý and the threats that are accumulating on our planet urgently call for new modes of management and governance" (Genelot & Le Moigne, 2017).

2.3 Emerging factors limiting success about technologies

Technology has, unfortunately, brought with it new challenges, affecting the best practices of yesteryear. Therefore, we are going to develop some new factors limiting success in project management that are directly linked to the use of these technologies. The first of these is the interaction between the stakeholders and the members of the management team. It should be

noted that a better understanding of the stakeholders will make the performance of a project more effective (Kirsi Aaltonen, 2010). While computer technologies facilitate the exchange of information, the control of data and the ease of connecting across the world, there are some disruptive aspects to this effective communication and interaction between people. As a result, we can see that the nature of work that is shifting towards remote working from home or hybrid working is not for everyone. It also generates more individualistic work than group work in a collaborative mode.

> "Despite hopes that technology would enhance our social connectedness, more people feel lonely and disconnected, suggesting continued social challenges in a future where asocial behavior could grow in unexpected ways " (Gouvernement du Canada, 2018, page iii).

While skills had been identified as a residual limiting factor, we can say that technology has made the situation worse. Managers must not only be familiar with, but also master, new technologies if they are to remain competent in their area of expertise. We're talking here about responsibilities and roles that are additional to a traditional manager's job through agile best practices based on available technologies, establishing success factors according to modern characteristics. The manager is playing multiple roles such as social engineers, chief architect, and guardian of logic (Déry, 2020). Additional roles include information management, coordination, and modeling.

Another limiting factor is resistance to change. Traditionally, managers focused on the Golden Triangle (scope, budget, and schedule) to ensure the success of a project, but with the emergence of new technologies, other aspects need to be considered. These include the social aspect, the acceptance of the use of these technologies and their potential impact on careers (e.g., artificial intelligence), the management of higher expectations, etc. "It's not the technology that makes the difference. It's not the technology that improves organizational performance, but the way humans use it (Ho, *et al*., 1988)" (Gagnon, 2020). What's more, "some projects could be impacted by staff disappointment in proportion to the expectations created, or by change that is too radical, creating a rupture that is difficult for staff to live with" (Grenier, 1998, page 10).

According to Gagnon (2020), one response to modern management in public organizations is to "encourage the introduction of collaborative management, aimed at decompartmentalizing skills and developing collective intelligence." The author argues that the collaborative mode and

matrix structures should be favoured to achieve high-performance teams. This helps acceptance of change and improves interactions, previously listed as challenges. "To be deployed in an organization, decision-makers and operational staff must perceive the usefulness and usability of an innovative technology for improving one or more dimensions of the organization's performance" (Eric Rigaud, 2014, page 145).

2.4 Shortcomings of written documents

The scope of this study is very specific, relating to complex and major RCAF projects. We had to structure the search using various search engines (ABI, Cairn, Erudit, Scopus, Web of Science, etc.) according to the following keywords: military, aviation, Department of Defense of the Government of Canada, and major and complex projects. After the literature review, it was noted that there were some gaps in terms of relevance, with some main elements related to major and complex projects, but very few related to the military and even less to Canadian military aviation. More often, we find articles on major infrastructure projects and IT projects. Most of the articles cited are not necessarily lacking in rigour, and some are scientific and/or peer reviewed. In short, a rather generalist repertoire of articles that covers several fields but lacks depth in terms of precision in the field of military aviation in Canada.

Part 3 – Research positioning

The interest of this study is to offer something not only new, but precise for the RCAF. Canada's Department of Defense (DND) is the largest department in the country, spending over $24 billion a year. Studying best practice in project management can help the RCAF to be more efficient, and more effective, in terms of its ability to deliver a quality product at an acceptable cost and on time.

3.1 Mapping the issue's limiting factors

The graph below is a representation of the mapping of limiting factors related to the issue, in the form of two (2) dimensions, i.e., the use of best practices as a function of probability and severity. The probability indicates whether a challenge is likely to be found in part or in full within a group of projects within the RCAF, while the severity indicates the factor impacting the success of a project in sound practice management. Residual limiting factors are identified in blue, while

limiting factors related to the emergence of technologies are in red. It should be noted that only one principal author is linked to the limiting factors identified above.

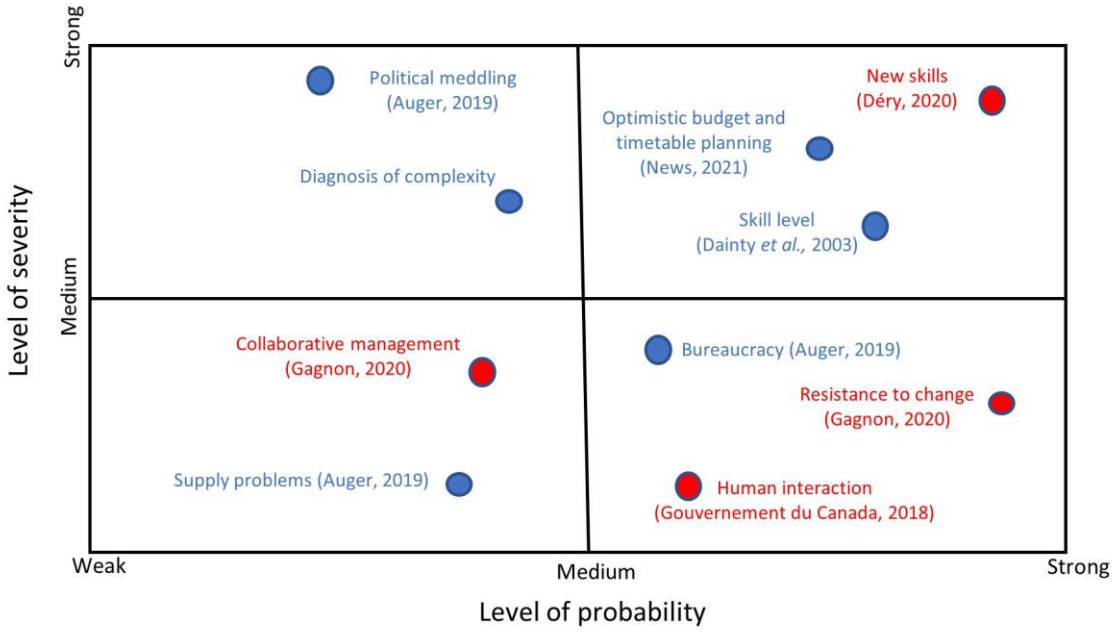

Table 1 – Mapping of literature according to two dimensions (Severity and Probability) of factors limiting success

3.2 A retrospective of the limiting factors and gaps in scientific literature

To situate the study, I am basing myself on the limiting factors and shortcomings listed in part 2. Table 1 shows that skills are a major limiting factor in terms of the probability and severity of a project's success. This limiting factor is also unique in that it was identified both before and after the emergence of technologies. It is, therefore, a limiting factor for success that has been present for some time and has certainly changed since the emergence of technology. It is interesting to learn about the impact of technology on a project manager's skills and to obtain an idea of the magnitude of this factor in relation to the limitations on the success of a major project.

Now I link the limiting factor of skills to the gaps in the scientific literature. The RCAF field requires extensive knowledge and skills not only in engineering, but also in aerospace. So, I can't afford to take skills from other fields such as construction and apply them to aerospace. As well

as specializing in aerospace engineering skills, I also must consider the military field, which is also a particularity of mine. This is a subject that will be discussed later, namely whether a project manager who has never been exposed to a military context is a limiting factor in terms of skills.

3.3 Repositioning research

Up until now we have introduced the performance limiting factors for complex projects within the RCAF as a research question. To this end, we have established a key issue, which is whether the RCAF is using best practice in its management of major projects. To begin to answer this question, we have identified and classified the factors that limit success. The competencies related to the project manager are those that have the greatest impact on the performance of a project, according to the dimensions of severity and probability. According to the gaps, although some literature has focused on skills, none of it has focused on military aviation, and even less on Canada.

So, I'm going to reposition the research towards a new problem that interests me by reformulating the issue, which by default becomes my specific objective: ***unveiling best practices for employing the most competent project managers for the performance of complex projects within the RCAF.***

Before developing propositions to address the new issue, it is essential to relate the various sub-themes to the key theme. The conceptual framework below shows three (3) secondary themes, represented in colour, as well as a pivotal theme which is "best practices". Thus, best practices must be segregated according to the three (3) sub-themes to develop propositions based on today's practices. The conceptual framework also includes definitions for a clear understanding of the different themes.

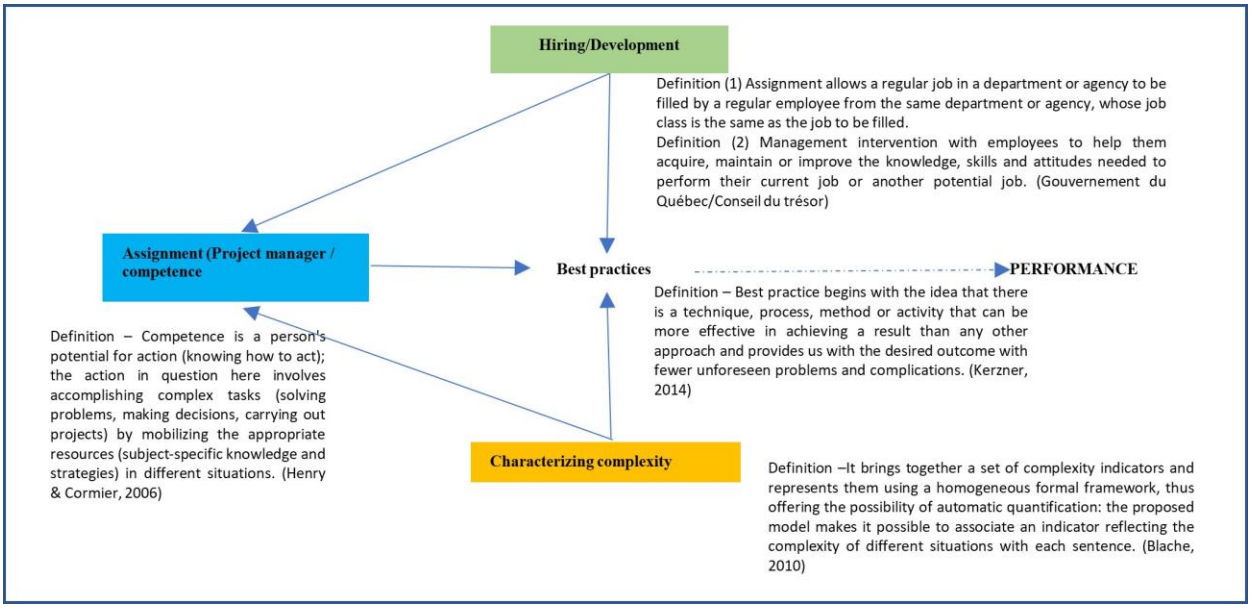

Figure 4 – Conceptual framework

Part 4 – Hypothetical responses and propositions

To develop hypothetical responses, we used the conceptual framework (Figure 4) and identified propositions between the various secondary and pivotal themes. This enabled us to develop contributions relating to the specific issue.

4.1 Assigning resources/skills.

The assignment of project managers is not really formalized within the RCAF. Due to a lack of resources, a project manager is chosen by default without much confirmation of the specific skills required and those of the manager. Within the RCAF, a project manager is a military officer or a civil service engineer. However, not all military personnel assigned as project managers have engineering training and in-depth experience. Consequently, there is already a mismatch in project manager skills. Also, a soldier will be transferred approximately every 2-3 years. Thus, with a high turnover of key personnel, there is a loss of acquired knowledge (transfer of knowledge to the project) and a negative impact on performance (Nan, 2005).

> ***Proposition 1 (P1)*** *- For complex projects with a timeline of more than 3 years, only public service employees should be considered as project managers.*

There is a relation between the experience and skills of the project manager and the success of a project. (Project Management, 2007) As mentioned above, the RCAF chooses project managers who are available to move projects forward. Some managers will delay the schedule due to a lack of experience and skills, and a high turnover in the manager's position. "70 % of projects were not delivered on time" because of the rapid turnover of managers (Picard, 2018, page 1). For example, the INGRESS (Interoperable Griffon Reconnaissance Escort Surveillance System) project on the CH146 Griffon was due to be completed in 2009 (Defense Industry Daily staff, 2008) and will, in fact, be completed in May 2023. This is mainly due to the loss of knowledge acquired during the development of the project through the high turnover of military managers and the assignment of managers without the skills required for a highly complex structural project for the use of defense weapons. Some tools for assessing skills, such as a skills matrix, in relation to the project and its complexity are not common, or even non-existent, for superiors when the time comes to assign managers to project managers when the project manager must be selected based on his or her ability to perform (Bourgault, 2015).

> ***Proposition 2 (P2)*** *- Consider a tool adapted to the RCAF to analyze a manager's skills and knowledge and assign the best manager based on the complexity and characteristics of a project.*

4.2 Hiring

All managerial positions within the RCAF under the direction of the Director General Aerospace Equipment Program Management (DGAEPM) require, as a mandatory requirement, the completion of engineering training for Public Service of Canada employees (positions ENG-04 to ENG-06) (National Defence - ADM(Mat), 2022) or be a military officer (captain or major) in the aerospace engineering trade (00185-01-G AERO) (National Defence, 2022). This is intended to ensure pay equity among project managers. We mentioned earlier that managers of major projects with more than three (3) years to run had to be from the Public Service. Now we are asking ourselves whether it is imperative that the manager be an engineer. According to the Ordre des ingénieurs du Québec (2020), project management is part of engineering practice, but it is not an activity reserved for engineers. It is, therefore, possible that aeronautical technologies

or project management specialists cannot fill these positions? For example, we have elaborated, under challenges, the fact that procurement is a major risk, so could an expert in this field (logistics) contribute more than an engineer who is not specialized in project management? If we take DND's definition of the project management function, there is no clear indication that an engineer is essential for the position of project manager:

> "The Project Management function oversees the application of sound and exemplary practices and procedures to the planning and execution of a project. This role requires a thorough knowledge of and competency in the following areas: best practices and procedures for project management, government policy on project management, project complexity and risk assessment, project approval process, expenditure authority, integrated team, and industry benefits. Strong business acumen and systems thinking. Negotiation and stakeholder management skills" (Défense nationale, 2021, page 140).
>
> *Proposition 3 (P3) - Consider hiring non-engineering technologists or specialists with specific project management skills to improve the performance of complex projects specific to the RCAF.*

4.3 Professional development

According to a survey carried out by National Defence in 2021, 12% of the engineers polled said that their development priority was related to project management. Engineers prefer to develop their skills in other areas, such as airworthiness certification or other aeronautical techniques. On the other hand, engineers recognize the importance of project management to their career path - "Respondents who worked for the Canadian Armed Forces before joining DND were more likely to say that project management was an important technical skill to improve or develop."(Défense nationale, 2021, page 22). Project managers, therefore, recognize the importance of professional development in project management and their techniques. However, according to Figure 13 of the survey (National Defence, 2021, page 41), all indications are that there is not enough training available to meet the need - "The areas with the largest gaps are: improving communication skills (48%), opportunities for innovation and creative thinking (42%), developing leadership skills (37%), developing new technical skills (35%) and improving technical skills (34%)."

> ***Proposition 4 (P4)*** *– Determining training priorities for the development of project management skills and adapting them to the needs of the RCAF's complex projects.*

The Project Management Competency Development (PMCD) certification programme has been developed by DND and can be completed at three (3) levels (Global Knowledge, 2022). This programme is based on the PMI and provides engineers with general project management skills. As mentioned earlier, engineers recognize the importance of project management skills in their career path but are more inclined to undertake technical training in the aeronautical field. Each complex project is assigned a specific PMCD level. One of the problems of this program is to have enough project managers for each level considering that this program is very demanding. For example, PMCD Level 1 requires the successful completion of eight (8) refresher courses and three (3) years of project management experience with the Assistant Deputy Minister (Materiel). Level 3 requires a minimum of eight (8) years experience. As a result, it is not uncommon to see project managers assigned to major projects without having the appropriate PMCD level. As a result, project managers do not feel obliged to take this training, as they will be assigned by default based on their experience and the lack of qualified personnel.

One hypothesis is that very few project managers sign up for this programme, as there are numerous time-consuming training courses. We might then ask why project managers don't really sign up for this programme? Indeed, there is no incentive to obtain the highest level (PMCD Level 3) except for merit points awarded for a promotion review (military only). There is also the question of whether the PMCD, which is a generalist programme, guarantees the skills required for specific RCAF projects. Indeed, the PMCD is a PMI-based programme for complex projects, but perhaps not at the level required for RCAF projects.

> ***Proposition 5 (P5)*** *– Determine whether the PMCD is a suitable programme for RCAF managers and how to encourage them to pursue project management training to develop their skills.*

4.4 Characterizing complexity

A Project Complexity and Risk Assessment (PCRA) guide (Government of Canada, 2015) and tool (Treasury Board, 2015) are available to assist in the application of the Treasury Board (TB) Policy on the Management of Projects. This tool considers certain characteristics of a project and

associated risks to determine a level of complexity. The levels range from sustained (low) to transformational (high). The guide and the tool are common to all projects and do not consider the particularities and characteristics specific to the RCAF. One of the characteristics of the RCAF are the aspects associated with navigability, which generate significant risks. Also, the tool does not consider the skills required for the manager. These are two (2) examples which suggest that the tool is not adapted to RCAF projects and that the results may be incorrect. For example, a low-risk project could be medium-risk if we consider the risks associated with the airworthiness of the aircraft and/or the human risks.

> ***Proposition 6 (P6)*** *– The PCRA should be adapted to the RCAF to include criteria such as new technologies, the level of impact on the airworthiness of aircraft, the risk of human losses, …*

4.5 Propositions and conceptual framework

The figure below shows the various propositions previously developed which are positioned in the conceptual framework developed in part 3.

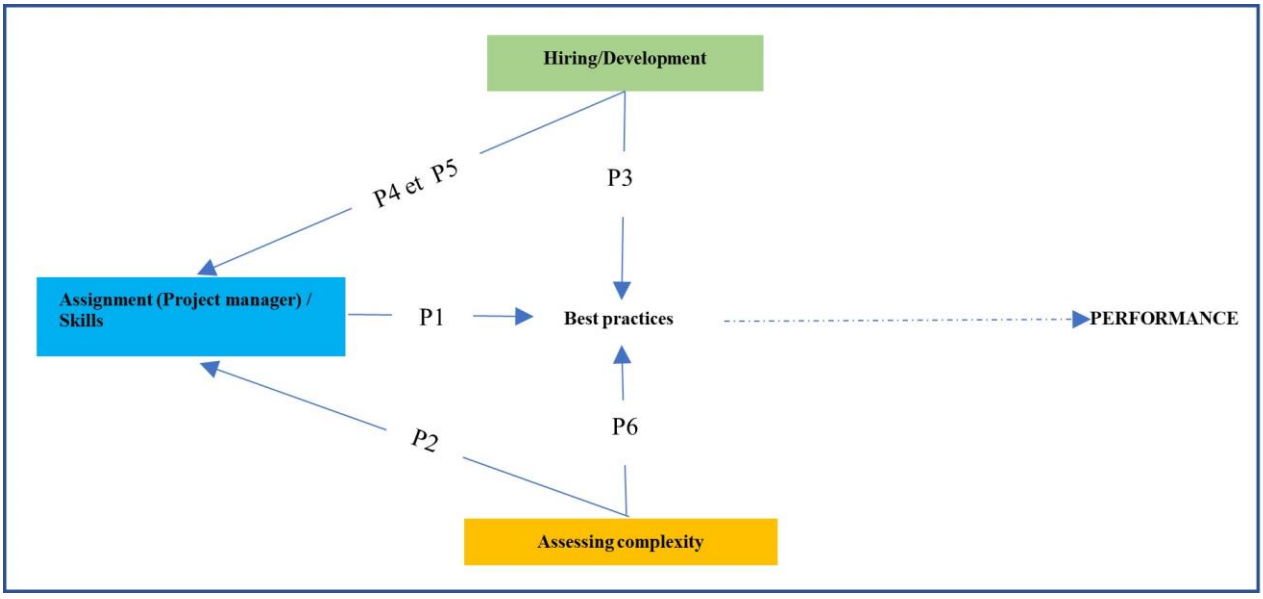

Figure 5 – Conceptual framework with propositions

Part 5 – Expected contributions

5.1 Innovation

The greatest contribution of this article is to convince the RCAF that it must adopt specific practices for its extraordinary projects. Canadian military aviation requires skills that are not necessarily required for the other branches (Army and Navy). RCAF projects require knowledge of airworthiness and flight safety. Accordingly, contributions will be drawn up based on the proportions developed above.

5.2 Assigning project managers

To guarantee the performance of a project, the stability of the team, especially for the position of manager, is a key element of success. Manager turnover leads to a loss of knowledge about the intentions behind the decisions made. This has an impact on the timetable if a new manager makes decisions contrary to those made by his predecessor without knowing the reasons for them. Team cohesion is also affected, as it takes time for the team to reach its full potential, according to Tuckman's model. A project manager who changes every two (2) months cannot contribute his full potential to the continuity of operations; he is perceived more as a hindrance by the team, which already knows that the manager is temporary. It is, therefore, to the RCAF's advantage to assign managers from the Public Service to ensure greater stability within the team and better performance at the same time. It's not a question of skills, but of solidifying the team. For example, the assignment of project managers for minor projects could be dedicated to the military, while major projects could be assigned to civil servants.

> ***Contribution #1*** *- Develop a methodology for assigning project managers between military personnel and civil servants to ensure continuity in the progress of a project and the maintenance of team cohesion to ensure optimum performance for success.*

5.3 Identifying and assigning project managers

As detailed in part 4, there is no real tool for assigning an employee to a project manager position. Assignments are usually made based on availability to ensure a balance of tasks between employees and/or the interests of the employee. For example, a drone project (open class) was

assigned to one employee because he had a personal interest in the field, whereas another employee, who had already completed a similar project, should have been given preference. In this specific case, individual needs were put first, rather than the needs of the organization through the assessment of skills and knowledge. The individual's interest in a project must be considered, as well as his or her skills and knowledge, in order to select a manager who is both motivated and competent.

> ***Contribution #2*** *- Develop a tool adapted to the RCAF's complex projects to determine and rank the most competent and motivated employees for a given project.*

5.4 Hiring policies

The classification of project managers within the DGAEPM, the organization responsible for projects within the RCAF, is exclusively in the ENG classification category, for which the prerequisite is to be an engineer. This is intended to be equitable with other DGAEPM positions, such as certification or financial management. However, it is not essential to be an engineer for project management within the DGAEPM, where certain specialists such as technologists or logisticians could be more effective for certain types of projects. It is thus important to determine which positions in the civil service can be assigned as 'non-engineers.' In practice, the essential criterion is not necessarily to be an engineer, as mentioned on job offers, but rather the skills sought.

> ***Contribution #3*** *- Redefine and improve the policy for hiring and staffing positions to give priority to the skills required to ensure project performance.*

5.5 Developing skills

There is already a skill development programme (PMCD) for project managers. However, this programme, based on the PMI, is aimed more at managers with no experience, as opposed to engineers who already have a base following their engineering training. As a result, this programme is not really suited to RCAF manager's engineers. RCAF managers prefer to undertake other types of training, such as airworthiness policies, new technologies, etc. In this sense, there is a need for an advanced programme on project management such as can be offered in universities at the master's level.

Contribution #4 *- Determine the skills required to be an excellent project manager within the RCAF and develop a development programme accordingly.*

5.6 Assessing complexity

We mentioned that project complexity and risk assessment (PCRA) within the Canadian government is global and generalized for all departments. However, the complexity of RCAF projects is characterized by extraordinary factors compared with other projects such as infrastructure projects. The risks associated with airworthiness, new technologies and flight safety increase this complexity, which is not considered in the PCRA. The skills required are also not considered in this guide and tool.

Contribution #5 *- The RCAF should develop its own guide and tool to include criteria such as new technologies, the level of impact on the airworthiness of aircraft, the risk of human losses, etc., to obtain a more realistic level of complexity for its projects.*

5.7 Contributions and conceptual framework

The figure below shows the various contributions developed previously, which are positioned in the conceptual framework developed in part 3.

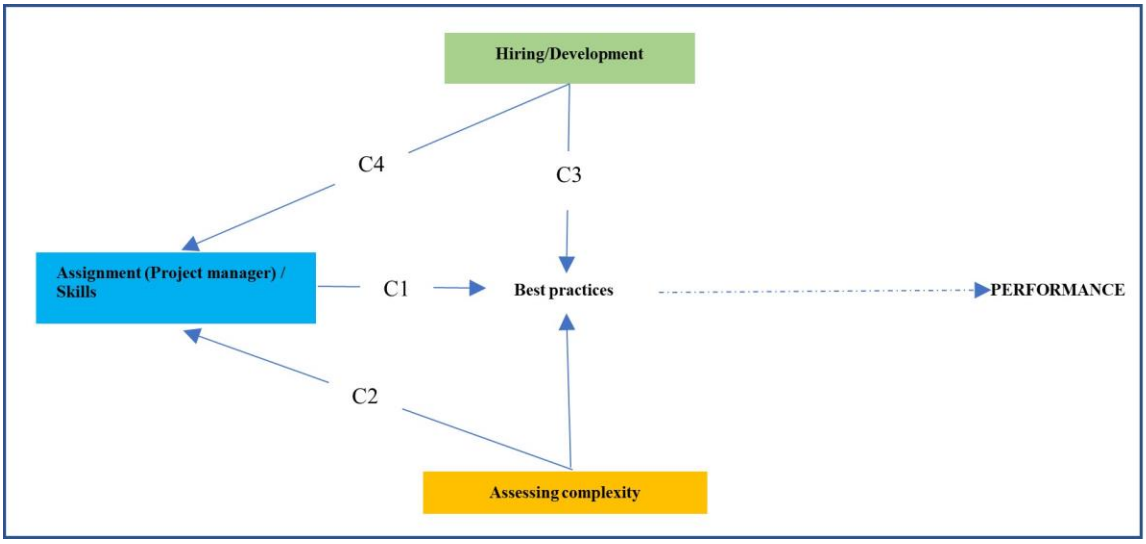

Figure 6 – Conceptual framework with contributions

5.8 Summary of propositions and contributions

The table below summarizes the various propositions and contributions developed previously regarding the concept of performance.

Themes	Concept de la performance	Proposition		Contribution	
Resource allocation	Resources must be allocated methodically	P1	*For complex projects with a timetable of more than three years, only Public Service employees should be considered as project managers*	C1	*Develop a methodology for assigning project managers between military and civil servants to ensure continuity in the progress of a project and the maintenance of team cohesion to ensure optimum performance for success*
	Performance depends on the manager's skills	P2	*Consider a tool adapted to the RCAF to analyze the skills and knowledge of a manager and assign the best manager according to the complexity and characteristics of a project*	C2	*Develop a tool adapted to the RCAF's complex projects to determine and rank the most competent and motivated employees for a given project.*
Hiring/ Development	Best practice in hiring leads to managers who perform well in their field	P3	*Consider hiring non-engineering technologists or specialists with specific project management skills to improve the performance of complex projects specific to the RCAF*	C3	*Redefining and improving the recruitment and staffing policy to give priority to the skills required to ensure project performance.*
	Acquiring new skills contributes to performance	P4	*Determining training priorities for the development of project management skills and adapting them to the needs of the RCAF's complex projects*	C4	*Identify the skills needed to be an excellent project manager within the RCAF and develop a development programme accordingly.*
		P5	*Determine whether the PMCD is a suitable programme for RCAF managers and how to encourage them to follow project management training to develop their skills*		
Assessing complexity	The assessment of complexity must be adapted to specific RCAF projects	P6	*The PCRA should be adapted to the RCAF to include criteria such as new technologies, the level of impact on the airworthiness of aircraft, the risk of loss of human life*	C5	*The RCAF should develop its own guide and tool to include criteria such as new technologies, the level of impact on the airworthiness of aircraft, the risk of loss of human life, etc., to obtain a more realistic level of complexity for its projects*

Table 2 – List of propositions and contributions

Part 6 – Conclusion

This scientific article has shown that the major RCAF projects, under the DGAEPM division, are not only complex, but extraordinarily complex in terms of their unique characteristics, mainly their airworthiness standards, the technologies used and flight safety. As a result, the various methods and guides used by the Government of Canada for all projects are not really adapted to RCAF projects. As a result, more than 70% of projects have run over budget and/or past schedule. To become a top performer, the RCAF needs to implement methods that will improve its performance and, at the same time, reduce the factors limiting success. This article focused specifically on the competencies that project managers should have and determined the best practices for achieving them, including hiring, professional development, and project complexity. Thus, five (5) contributions emerged to enable the RCAF employ best practices so that its project managers are the most competent for the performance of complex projects within the RCAF.

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