

# NEW PRODUCT DEVELOPMENT (NPD) PROJECT PORTFOLIO MANAGEMENT: WHAT IS THE ROLE OF LEARNING?

Mariastella Messina \*

\* Department of Economics, University of Messina, Messina, Italy  
Contact details: Department of Economics, University of Messina, 75 Verdi's Street, 98122 Messina, Italy



## Abstract

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Project portfolio management is a strategic weapon. Despite, the abundant amount of literature on research and development (R&D) project evaluation and selection, earlier research does not exploit the potential of learning even if it may generate significant opportunities. The aim of this paper is to deepen the knowledge on how a learning process could favor the selection and management of projects to include in the portfolio, considering the relevance of strategic orientation. Grounded on learning the concept of pragmatic constructivism (PC), this paper presents a qualitative and interpretative approach conducted in a single case study. The selected company is a multinational, operating in the semiconductor industry. Data were collected by combining different sources such as semi-structured interviews, direct observation, meeting participation and use of archival sources. The results show that the role played by previous learning can provide very useful information for division managers in the company to pick up the best project to include in the portfolio, which meet business strategic priorities. The results provide some practical implications in supporting the decision-making process of division managers on how to choose the best project portfolio, meaning to pick up the right projects to increase the performance of the project portfolio as well as company performance.

**Keywords:** Innovation, Portfolio Management, Learning, Pragmatic Constructivism

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## 1. INTRODUCTION

Today's business environment is complex, requiring faster decisions as well as better allocation of scarce resources. To complement this fact, the project portfolio management introduces doing the right projects, creating a link between projects and

the organization's strategy, and adopting a long-term perspective. Portfolio management has earlier been studied extensively in the new product development (NPD) context (Cooper et al., 1998; Koskinen et al., 2020) and recognized as a key competence for obtaining and maintaining a competitive advantage, especially in technology-intensive firms with

substantial research and development (R&D) investment (Gupta et al., 2022).

As a result, the choice of which potential NPD projects to include in the portfolio is a major concern for enterprises (Teller et al., 2014).

The current literature highlights the importance of project portfolio management in evaluating, prioritizing and selecting projects in line with the business strategy (Meskendahl, 2010).

Contributions in this stream do not help to better understand the role of learning from previous projects in selecting appropriate projects and managing ongoing projects (Eken et al., 2017). Earlier research also indicates that positive uncertainties such as synergies and learning are not always exploited in project portfolios even if they may generate significant opportunities (Martinsuo et al., 2014, p.735).

All these points relate to whether and how a learning process could favour the selection and the prioritization of projects to be included in the portfolio considering different business strategies which is the research question we want to address.

The work is based on the theoretical framework of pragmatic constructivism (PC), which is a useful guide to applying a learning method for analyzing the effect of change in selecting and prioritizing projects in a portfolio context. This study presents the findings of an interpretative case study conducted in a company, here referred to as Semicom.

The contribution of the work is twofold. First, this study contributes to the project portfolio management literature. We respond to the call for more detailed examinations of the learning influence on the project portfolio (Martinsuo et al., 2014). Especially, the findings identify the link between strategy and portfolio selection (Cooper et al., 2001) confirming that the different strategic orientation of a business influences the relationship between project portfolio structuring and its success (Meskendahl, 2010). The findings reveal that the business strategy assigns a different value to the learning acquired from previous projects. Second, we contribute to the PC literature by showing qualitative evidence of the different ways in which the project portfolio is managed considering the different business strategies. The approach chosen provides a better understanding of project portfolio management in practice (Nørreklit, 2017).

The paper is structured as follows. The presentation of this article starts with a review of the relevant literature on project portfolio management in Section 2. Section 3 describes the theoretical framework identified. Section 4 describes the methodology chosen and the analysis of the multiple data sources. The findings and discussions of theoretical and managerial implications are presented in Section 5. Finally, conclusions and limitations are reported in Section 6.

## 2. LITERATURE REVIEW

### 2.1. Portfolio management

Portfolio management has earlier been studied extensively in the NPD context (Cooper et al., 1998; Koskinen et al., 2020) and recognized as a key

competence for obtaining and maintaining a competitive advantage, especially in technology-intensive firms with substantial R&D investment (Gupta et al., 2022).

As a result, the choice of potential NPD projects to be included in the portfolio is a major concern for enterprises (Teller et al., 2014). Indeed, NPD project selection is considered a dynamic, strategic and crucial decision due to several selection criteria and factors related to dynamic customer demands, multiple and often contradictory objectives, resource allocation, project interactions, various risks, market share and other factors (Abbasi et al., 2020; Cooper et al., 2001). The selection process is aimed at maximizing the value of the portfolio, balancing risk and keeping with the company's strategic objectives (Abbasi et al., 2020; Cooper et al., 2001; Elonen & Artto, 2003; Ghassemi & Amalnick, 2018). Deficiencies in selecting criteria could prevent the implementation of portfolios to achieve their strategies (Bai et al., 2022). During the selection process, several problems can occur<sup>1</sup>. For instance, Cooper et al. (2001) identify the missing link between strategy and portfolio selection as one of the major problems in portfolio management. Nevertheless, several studies point out the relevance of strategic orientation to influence portfolio decisions and, therefore, the structure of the portfolio (Morgan & Strong, 2003; Talke, 2007). Meskendahl (2010) affirms that the different dimensions of strategic orientation of a firm support in a positive way the relationship between project portfolio structuring and project portfolio success. Moreover, Bai et al.'s (2022) findings showed a method which could help managers in the selection of an optimal project portfolio considering strategic criteria. In fact, selection ensures the alignment of the selected project portfolio with the company's strategy. For this reason, there is the need to set the goals of a portfolio before the selection of the projects to meet the firm's overall objectives. The current literature highlights the importance of project portfolio management in evaluating, prioritizing and selecting projects in line with strategy (Meskendahl, 2010). However, the relationship between strategy, project portfolio management and business success has been explored by few studies (Cooper et al., 1998; Elonen & Artto, 2003), even if project portfolios are an important part of the strategic management enabling a successful strategy implementation.

There is an abundance of literature on the evaluation and selection of R&D projects, indicating hundreds of models using various mathematical-based approaches (Chu et al., 1996; Ghassemi & Amalnick, 2018). In many cases, managers try to mitigate uncertainty in the NPD portfolio by building a project portfolio with a heavy weight on projects aimed at a familiar market and using familiar technology<sup>2</sup>. Sommer et al. (2009) suggest the use of trial-and-error learning when

<sup>1</sup> Research has identified six problems in project selection and portfolio management, namely: no link between strategy and project selection; poor quality portfolios; reluctance to kill projects; scares resources (a lack of focus), selecting short terms and easy projects; information overflow and lacking quality of information, decision making basing on power (Cooper et al., 2001; Elonen & Artto, 2003).

<sup>2</sup> Focusing on the familiar will not only reduce uncertainty but also result in more successful projects, two dimensions of uncertainty: technical uncertainty and market uncertainty (McDonough & Spital, 2003).

uncertainty is not predictable and project complexity is high. High uncertainty makes it difficult to learn from the past (Teller et al., 2014), but knowledge transfer and learning between projects are repeatedly encouraged in project portfolios (Martinsuo & Lehtonen, 2007). Capturing and sharing lessons learned in previous projects is considered an appropriate practice for the continuous development of organizational capabilities and improving overall project performance in the future (Kock & Gemünden, 2019), given the strategic perspective assigned to learning and knowledge development in a project portfolio context (Martinsuo & Killen, 2014).

Contributions in this stream do not help to better understand the role of learning from previous projects in selecting appropriate projects and managing ongoing projects (Eken et al., 2017), even if it can create significant opportunities (Martinsuo et al., 2014).

Due to the complexity of managing the project portfolio, in recent years, companies have increasingly supported the project portfolio management processes using specific software. As evidenced by Meyer's (2019) results, the organizations surveyed have special software for project portfolio management. This means that a special information system can support the learning tasks of the portfolio by providing a database that can document, share, and search for the knowledge shared in other project developments. In fact, Kock et al. (2020) investigated 181 project portfolio samples and found that digital tools are positively related to the quality of portfolio management processes and the success of project portfolios. Digitalization can, therefore, support knowledge transfer if the company culture promotes learning, even from mistakes (Kock et al., 2020).

However, previous studies have shown that learning in the project portfolio is not always exploited (Martinsuo et al., 2014). The project management literature on the selection process of new projects to be included in the portfolio needs to be strengthened and the role of lessons learned from previous projects in the portfolio selection process to be studied.

For example, the decision-making process of managers selecting projects may be very strongly influenced by joint learning (Laine et al., 2016).

All these points relate to whether and how a learning process could favour the selection and the prioritization of projects to include in the portfolio considering different business strategies which is the research question we want to address.

Project portfolio management is a multi-faceted process that overlaps with the whole functional organization of R&D, marketing, and production. Therefore, the portfolio structure process is usually a committee process where the most affected functions are involved in portfolio decision-making. Given the different views of the actors involved in managing the project portfolio, the study draws on the PC approach. The proposed approach is considered a useful guide in explaining how to use a learning method to analyze changes in the selection, priority setting, and management of project portfolios related to different strategic

contexts. The chosen approach does not entail the use of a specific set of tools in the portfolio selection process but involves a reflective and interactive approach to the selection process.

## 2.2. Lesson learned process

The PC approach enables the exploration of new possibilities and the invention of new ideas in a dynamic and high-innovation environment, such as NPD. The chosen approach rejects the general mechanical model of portfolio management and rejects the view that managers are passive adapters. PC assumes that in the NPD process, learning supports managers to solve the problem and promotes the selection of projects to include in the portfolio (Seal & Mattimoe, 2016). However, learning may play a different role related to both the specific business and the actors involved (Seal & Mattimoe, 2016). Given the multidimensionality of the analyzed process, PC argues that successful project portfolio management must be business-specific and co-authored with the contribution of both internal and external participants, because of the participation of both internal functions and external stakeholders (such as customers or suppliers) in the selection process, depending on the business strategy. When customers are involved in portfolio decisions, they can play an important role in idea generation and project execution (Meskendahl, 2010).

To continually improve the portfolio selection process, learning processes should be developed. In previous research, it has been found that the emphasis on learning aspects was essential in implementing the R&D and competitive advantages of the company (Aaltola, 2018; Chiesa et al., 2009). Learning and knowledge development are considered strategic dimensions in project portfolios (Martinsuo & Killen, 2014). Even if you can take the lessons you have learned, it can be difficult. New learnings have changed the way companies solve problems and helped avoid repeating previous mistakes, supporting the development teams to improve the performance of future projects (Hansen & Svejvig, 2022; Kleinsmann & Valkenburg, 2005). The literature highlights that past experience affects how learning processes are carried out (Giannetti et al., 2021). Some authors (Nonaka & Takeuchi, 1995; Boisot, 1998; Baumard, 1999) have suggested that organizational learning dynamics can be portrayed as cyclical patterns. This means continuous learning and improvement (Nørreklit et al., 2016), which may lead to the gradual accumulation over time of new knowledge that can contribute to the management of portfolios. In the NPD context, learning can help improve the performance of NPD through better knowledge (Mitchell et al., 2021).

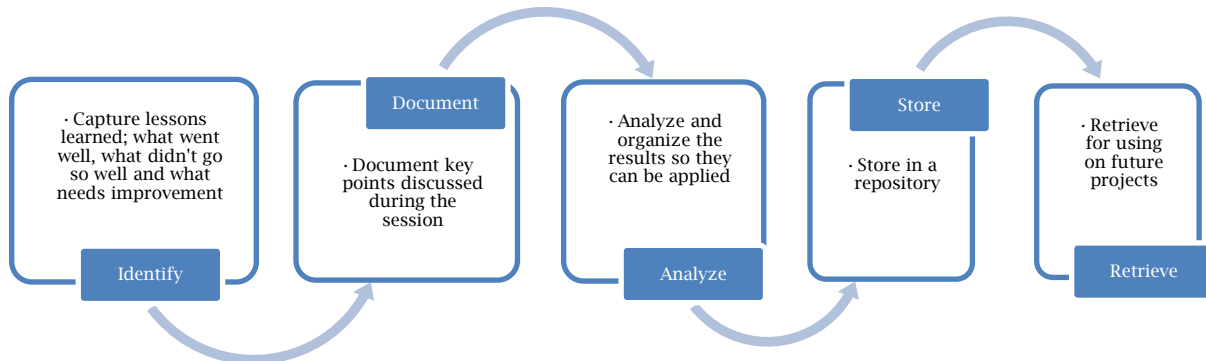
In the learning context, training or small-talk-people help to exchange and acquire a lot of situational information that may function as background situational knowledge (Nørreklit, 2020).

The aim of the learning process is to define the activities needed to capture and apply the learning successfully. The lesson learned process is shown in Figure 1 (based on Rowe, 2008). It is a comprehensive approach to ensure the application

of lessons and includes five activities: identification, documentation, analysis, storage and retrieval. This process can be summarized into two main parts: capturing and applying lessons learned. Capturing

lessons learned includes the first two activities: identify and document, while applying lessons learned includes the last three activities: analyze, store, and retrieve.

**Figure 1.** Lesson learned process



Source: Rowe (2008).

It is important to include both successful and failed projects. Once the organization has identified the projects on which it carried out the lesson learned, then a root cause analysis will be conducted for each project and the main points will be documented. The aim is to identify the root causes and come up with a solution to eliminate them. In this analysis, the team can also identify the best practices and incorporate them into existing methods, procedures, and processes.

Then the lessons learned are stored in a repository. However, to obtain data on these lessons easily, information must be stored in a simple retrievable manner. The lessons learned template should include previously agreed fields such as category, lesson learned, action taken, how did you arrive at the action taken, root cause and keywords (Pritchard, 1997). The last but certainly not least activity is to retrieve lessons learned. By having a lesson learned repository, the NPD team or division manager can retrieve lessons learned and review them prior to starting a new project (Rowe, 2008).

### 3. RESEARCH METHODOLOGY

An exploratory qualitative case study was conducted in a multinational company operating in the semiconductor industry. A case study design was chosen to enable an in-depth analysis of a relevant and not well-known phenomenon

(Yin, 2009). The qualitative and interpretative approach employed in this study is useful for answering the research question related to how a learning process could favour the selection and the prioritization of projects to be included in the portfolio considering different business models (Yin, 2009; Silverman & Marvasti, 2008)<sup>3</sup>. The case is unique in terms of in-depth and longitudinal access of the researchers to the research site.

The case company in our study here is referred to as Semicom<sup>4</sup>. The company was chosen primarily on the basis that it has multi-project R&D activities. The company had a long experience working in such settings and the NPD projects are well-formalized through rich documentation related to the different aspects of the NPD project portfolio, which are well-described and stored in the different digital tools related to the project development process. To further increase our sensitivity to the finer points of NPD project portfolio management, we monitored two divisions, here referred to as Alpha and Beta<sup>5</sup>. Both divisions are part of the same group, but they address different end markets and have different business models. The first division addresses all four end markets (automotive, industrial, personal electronics and communications equipment, computers & peripherals) while the second one addresses personal electronics only. Table 1 below shows the main differences between the two divisions analyzed.

<sup>3</sup> The aim is to develop gradually an understanding related to the phenomena investigated (Alvesson & Skoldberg, 2009).

<sup>4</sup> An invented name was used to respect the privacy of the company.

<sup>5</sup> Invented names were used to respect the privacy of the two divisions.

**Table 1.** Comparison between the two divisions

<i>Features of the two divisions</i>	<i>Alpha division</i>	<i>Beta division</i>
Strategy	Mass market business model: best compromise between cost and customer value	Customized business model: customer focusing strategy
	Profit oriented	Customer oriented
	All four end-markets served by Semicom	Personal electronics and communication
Scope	Execution of complex/easy contracts for several customers	Execution of complex contracts basis for one strategic customer
Size (in terms of customers)	Customers > 10.000	Customer = 1
Project management structure	Matrix structure: all projects cross-functionality coordinated by project managers	Matrix structure: all projects cross-functionality coordinated by project managers
Project portfolio	1 project for more customers	1 project for 1 customer
Number of projects	Projects in portfolio: 50	Projects in portfolio: 20
Size	Time to market: 3/5 years	Time to market: 1,5/2 years
	Average life of the product: 10 years and more	Average life of the product: 2 years
Technical complexity	Risk blending	High risk/high opportunity
Uncertainty in the projects	Primarily market uncertainties	Primarily technical
Prime emphasis	Product performance, effectiveness and creativity	Time and customer request
Learning process	Application driven lesson learnt	Customer driven lesson learnt
Risk	Risk related to cost structure	Risk related to market of customer
	Usually no exclusivity of the project	Exclusivity of the project
Communication	Marketing synthesis of many communications with the customers	Frequent communication driven by the customer
	Management accounting information focused on project profit	Management accounting information focused on customer satisfaction
	Quartely Meeting, report and software	Weekly meeting, report and software

The data collection takes the form of a multi-method qualitative study including the use of semi-structured interviews, direct observation, participation in meetings and the use of archival sources as displayed in Table 2. Data collected from multiple sources of evidence aims at data triangulation, which has been applied in this study (Modell, 2005, 2009; Yin, 2009) to solve potential

reliability concerns dealing with individual interviewees' bias and researchers' analyses of them. To mitigate this concern, the findings were discussed many times with the company representatives and the data were jointly and individually analyzed by the researcher to avoid misunderstandings.

**Table 2.** Data collection

<i>Data source</i>	<i>Semicom</i>	
	<i>Alpha division</i>	<i>Beta division</i>
Where?	Alpha division	Beta division
Focus?	Focus on project portfolio management	Focus on project portfolio management
How?	Interpretative case study	Interpretative case study
(a) Interviews	10 semi structured interviews, on average two hours per interview	3 semistructured interviews, on average two hours per interview
(b) Observation	Two days per week for eight months	Two days per week for eight months
(c) Meetings	Approx. 3 meetings and 1 concluding workshops/seminars	Approx. 3 meetings and 1 concluding workshops/seminars
(d) Documentation	Project related documentation such as strategic plans, budgets, NPD stage-gate models, NPD profitability models, NPD project report, project portfolio management, document describing the technology, products and company history, projects reports	Project related documentation such as strategic plans, budgets, NPD stage-gate models, NPD profitability models, NPD project report, project portfolio management
(e) Other	Informal meetings, launches, coffee breaks, etc.	Informal meetings, launches, coffee breaks, etc.

The study started with a documentary analysis of each division to get a "first understanding" of the context, strategy, and overall organizational structure. After that, all 13 semi-structured deep interviews were performed and transcribed<sup>6</sup>, to get a better understanding of the various portfolio management in each division. We interviewed managers in the positions of group's financial controller, division manager, application manager, design manager, marketing manager, product engineer, program manager, business unit manager, business unit financial controller and design program manager. On average, they lasted two

hours. From these interviews, we sent a preliminary case report with background information and a series of selected quotes to some interviewees to validate the data. Then, the informal discussion took place outside the interview sessions. This means that during the data collection, the same problem or fact was addressed by more than a single source of evidence. This study was followed by a seminar with approximately 13 participants during which the findings were presented, discussed, and validated. All the documents analyzed were in English while the interviews were in Italian.

The analysis followed a grounded theory-based approach on PC, and a central activity was to generate a description that captured vital aspects of the phenomenon under study.

<sup>6</sup> Semi-structured interviews were chosen to be utilised in this study as a set of specific topics can be addressed with this interview type while still having an adequate level of freedom in research (Bell et al., 2022).

In the next section, the empirical organizational setting will be described in brief. This contextual information is important to frame the managerial actions for managing the project portfolio.

#### 4. COMPANY OVERVIEW

Semicom has a matrix organizational design and a global workforce of about 48,000. Semicom had a turnover of \$12.8 billion in 2021.

Innovation has always been at the heart of Semicom's strategy, based on the introduction of new products and new technologies. The company serves more than 200,000 customers, which are located mainly in the Asia Pacific (68%), then Europe, the Middle East and Africa (EMEA) (20%) and Americas (12%). 45% of the revenues come from the top 10 customers (original equipment manufacturers (OEMs)), which include Apple, Bosch, Continental, Delta, HP, Huawei, Intel-Mobile, Samsung, Seagate and Tesla.

Semicom products are used in various applications. This allows Semicom to choose a broad strategy covering four end markets: automotive, industrial, personal electronics and communication, equipment, computers and peripherals. However, companies follow different strategies in the various end markets, depending on their business strategies.

Semicom is facing a dynamic and volatile market. So, choosing a balanced portfolio of R&D requires significant effort and analysis (Gemici-Ozkan et al., 2010). Semicom believes that partnerships with customers and industrial partners are essential to success. In fact, customer alliances provide them with a valuable system, application knowledge and access to the markets of key products. Alliances with customers and industry partners are critical for succeeding in the semiconductor industry. As Semicom has become more competitive and reduced market time, it has integrated customers as innovators in the NPD process and developed a joint development strategy in one of its businesses to gain a competitive advantage and reduce development costs. Many Semicom chips are custom designed to handle special functions of electronic devices. This means that customers and Semicom are generally responsible for developing new products. This means that the customer must be part of the development process. This is consistent with the trends in the semiconductor business over the past few years.

##### 4.1. Alpha division

The Alpha division is an excellent example of an industrial product development portfolio. It has a wide portfolio of projects that covers all four end markets. For the automotive and industrial markets, it addresses a wide customer base, particularly in industrial, with a broad and deep product portfolio. While in personal electronics and communications equipment, computers, and peripherals, it has a selective approach both in terms of the customers it serves and in the technologies and products it offers. The division manager stated: *"Let me give an example. When I received a request to develop a smartwatch, I rejected it four times, as happened*

*several times"*. Therefore, it is not only necessary to determine the appropriate returns of investments, but also to determine whether new projects are consistent with the company's strategy. Therefore, the divisional manager rejected the new proposal because it was an opportunistic project that was not in line with Alpha's strategy (Meskendahl, 2010).

In this division, the project portfolio management involves three types of projects: "completed projects", where the lessons learned can be retrieved, "ongoing projects" as the projects being executed and "potential projects" that the division is considering bid/undertaking. Many products have a lifetime on average of 10 years, with a product development process length of between 3 and 5 years.

There is no "one best way" on how to perform the project portfolio management, but it needs to be a combination of improvisational and planned actions. The goal of the division is to select NPD projects to be in line with the division's strategy. However, the main issue is: how to select a set of projects in line with strategic and financial considerations? The financial controller stated: *"When you work in an organization with many projects, it is very hard to determine how many projects you can carry out at the same time. Because the projects differ in terms of size, time and number of people employed"*.

Alpha's division decided to employ a scoring model, establishing clear criteria for making go/kill decisions and prioritizing projects (Teller et al., 2012). The selection and progress of the projects are monitored according to the 7-indicators rating matrix. This way of proceeding considers simultaneously quantitative indicators (i.e., net present value (NPV), internal rate of return (IRR), payback period) as well as the qualitative ones (strategic fit) related to the project (Christiansen & Varnes, 2008; Cooper et al., 2001; Cooper et al., 1998). The new project must satisfy the criteria expressed by the 7-indicator rating matrix:

1. Manufacturing constraints.
2. Design.
3. Manufacturing margin.
4. Timing.
5. Strategy roadmap.
6. Entry barriers.
7. Revenues.

For each indicator a score from 1 to 5 is assigned. The spreadsheet elaborated a table with the score assigned for each project, then Alpha's division manager prepares a forecast about the priority list of the new projects. The projects were selected from the highest to the lowest score until the budget available for the period was spent. The goal is also to achieve a desired balance of projects in terms of several parameters, for example, long-term projects versus short ones; high-risk versus lower-risk projects; across various markets, technologies, product categories and product types (Teller et al., 2012). *Vis-à-vis* communication is crucial because sometimes it happens that a project that is located at the bottom of the list could be re-evaluated and get to the top of the list. Profitability is always a major factor in the discussion when it comes to establishing priorities among projects. This means that the profit

is a necessary but not a sufficient condition. By focusing only on the financial value of the project portfolio, the division may not be allocating and developing its resources with a long-term vision and may be missing strategic opportunities. Hence, for project prioritization, additional parameters are considered, such as the project closer to completion, commitment severity and customer's weight, the strategic importance of the business and confidence in staying inside the opportunity window. The division manager is responsible for defining the requirements for new projects to meet the needs of technology and the market. The division manager is responsible for defining the products and the requirements of the new projects so that they meet the market needs. The division manager stated: "*The critical issue is to understand the dependency that exists between the different projects. We have 50 ongoing projects on average, when one project is delayed our planning change*". Dependencies between projects within a portfolio need to be taken into consideration since they may significantly affect the portfolio success. Various types of dependencies can be present between projects, such as resource, market/interest dependency, product dependency, financial dependency as well learning dependency (Bilgin et al., 2017)<sup>7</sup>. Alpha's projects concern both the area of low/high technical uncertainty and the area of low/high market uncertainty (McDonough & Spital, 2003). This means a well-balanced portfolio according to risk, innovativeness and long- and short-term opportunities (Teller et al., 2012).

Roadmaps<sup>8</sup> are not decision-making tools, but they are used for charting the planning of future technology and products with the integration of business and technology strategy (Killen & Hunt, 2013).

In the Alpha division, many projects are carried out at the same time, and everybody works on a lot of projects. This enables the division to share the expertise of a single individual on more than one project (McDonough & Spital, 2003). The project teams vary between 10 and 20 people involved.

The portfolio is reviewed on a quarterly basis to analyze if the projects are in line with expectations as well as to solve dependencies, detect coordination and check errors in the project

portfolio. The review process allows the team to share learning, identify problems and change direction if necessary (McDonough & Spital, 2003). The division manager added: "*The division's profitability should reach at least 15% of the revenues. If the results do not meet expectations and the deviation is so high, we will conduct a mid-term review called the major deviation review (MDR)*". The division manager stated that: "*If the expected time or cost of the project differs by 30-40 percent, it is necessary to reorganize the priority list established at the beginning*".

For ongoing evaluation, each product's profit and loss (P&L) is calculated. This is important because it helps to understand whether the project's P&L is at least consistent with the division's average P&L and division strategy. By ignoring the relevance of the project to the long-term strategic objectives, projects that are suitable for the division may be rejected in the short term (Eken et al., 2017).

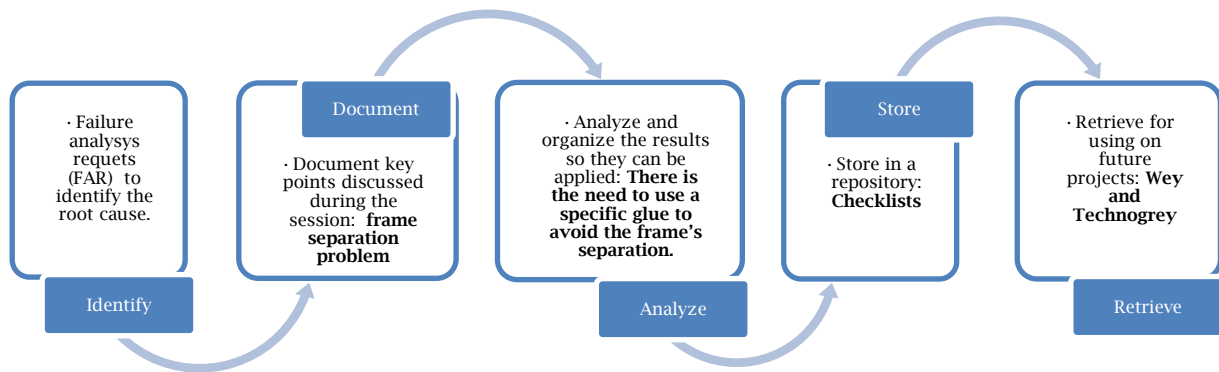
The division manager stated: "*Today, the division's margin is 42% on average, so if there is a project that has margin of 38%, the project will have a negative impact on the division margin and should be eliminated*". The decision to terminate or withdraw projects from portfolios is difficult and often overlooked (McDonough & Spital, 2003).

In fact, one way to mitigate risk is to learn lessons from previous projects. In this division, a post-mortem analysis is carried out on the most important projects and failed projects at the end of the project by a meeting. Post-project evaluation research is an effective and widely adapted way of recording lessons learned. However, the actors can employ plenty of knowledge that presupposes previous learning in the selection of the new projects. An example of a learning opportunity of the Alpha division was the project Tegase (see Figure 2). The development process of the latter did not succeed, but it allowed the division to acquire new learning from failure (Martinsuo et al., 2014). Indeed, the lesson learned acquired from the two past projects, Tegase and Wey, enabled the division to acquire a lot of information and knowledge (Nørreklit, 2020) for the development of the Technogrey project (will be mentioned below). The previous failures allowed the division to explore how the learning experience affected the project portfolio management (Hansen & Svejvig, 2022).

<sup>7</sup> The learning dependency refers to the obtained knowledge in one project that could be employed in another project. For instance, problem that affects the knowledge gained during execution of a new process in one project may affect the other project that the same new process is being used (Bilgin et al., 2017).

<sup>8</sup> Miller and O'Leary (2007), for instance, found that the industry-wide technology roadmap shaped the development of the semiconductor industry. The roadmap was, in part, an instantiation of the predictions set out in Moore's Law: it envisioned a common technological and economic future for the actors in the semiconductor industry. By way of representing a possible common future, the roadmap became a central instrument through which the various strategies and investment programs of individual companies were mediated.

Figure 2. Lesson learned process: Tegase project



The Tegase project was the first project of the ElecF product family, which was introduced in Alpha's portfolio in 2012 to satisfy a specific request coming from a strategic customer. The project was ambitious. Unfortunately, during the development process, some technical problems arose, and the customer decided not to buy the product. The marketing manager stated: *"Unfortunately, something was wrong with Tegase project, and the customer decided to take away our shares. Therefore, we had expected to sell high volumes, and instead sold zero"*. The application manager said: *"We were facing problems at the end of the project when we were reaching the field test"*. In order to understand what had really happened, the post-project review was carried out by a formal meeting of the project team to discuss what can be learnt for the future projects. In fact, failure analysis requests (FAR) have been performed to identify problems, and the analysis highlighted technical problems related to the glue used. The application manager said: *"This type of product requires a specific glue to prevent the separation of the frame. Once the problem has been identified, it should be stored in the checklist. This will prevent this problem from happening"*. The example highlighted the importance of capturing and sharing lessons learned as an appropriate practice to increase the performance of the future projects (Kock & Gemünden, 2019). The marketing manager added: *"The lesson learned was useful to better understand the root cause in order to share the new knowledge across the division to prevent the repetition of the same mistakes in the future products"*. After the documentation and the analysis phases, the lesson learned was stored in a repository, called a checklist. The checklist supports portfolio learning for documenting, sharing, and finding knowledge and by making competencies transparent to other projects. Indeed, the lesson learned retrieved was employed for the development of two future projects, namely Wey and Technogrey. This way helps to avoid the repetition of previous mistakes (Goffin & Koners, 2011). In this project, the importance of project-to-project learning has been recognized and encouraged in Alpha's project portfolios (Martinsuo et al., 2014) to be applied to future projects (Goffin & Koners, 2011). Indeed, new learning and acquired knowledge are considered pivotal in the decision-making project portfolio to

favor the development of a new product for another strategic customer, developing Wey's project (Martinsuo & Killen, 2014). However, due to the geopolitical restrictions, the second development project (Wey) represented another failure. From these two failures, the division has a favorable learning opportunity (Gutjahr, 2015). Technogrey was the next customer who recognized the potential advantages of the new product and decided to assign to the division the development of the new project. At the moment of the research, the Technogrey project overcame the agreement stage, and the other phases will be carried out in the next three years.

In particular, the Tegase project example highlighted the importance of relevant lessons learned from previous projects. With the inclusion of a learning circle, the department was able to understand what worked and what did not work in the development process (Mitchell et al., 2013). New knowledge was disseminated throughout the division and was useful in avoiding repeating the same mistake in the next project, Wey and Technogrey. Both projects were strategically important, as they were in line with the business strategy.

#### 4.2. Beta division

Beta division is an excellent example of customized products and follows a co-development development strategy<sup>9</sup>. The division is responsible for the development of products in the field of personal electronics. For this end-markets the division has a selective approach both in terms of the customers it serves as well as in the technologies and products it offers. Furthermore, the roadmap is used to chart technologies. This means that Beta's division must adapt its NPD business strategy in accordance with its customer strategy. Indeed, the customer plays a crucial role in managing the project portfolio. The financial controller stated: *"The division doesn't choose the projects to develop, but the customer leads the business"*. This means that the new project proposal comes directly from the customer and the division participates with other suppliers to win the award of the project. The financial controller

<sup>9</sup> This means that one of the major customers is involved in the development process since the early stage of the process.



added: *“In this business, our project is a small part of the final one”*.

In this division, the project portfolio management involves two types of projects: “completed projects” and “ongoing projects”. The project is highly innovative and difficult to manage, and each project requires from 50 to 100 people to work on it. Everybody works full time on one project. However, the customer knows exactly what he wants, so he provides the Beta division with detailed product documentation about the design of the new. In the Beta division, a few projects are developed at the same time (4 is the exact number) and each project lasts for approximately two years. The product engineer stated: *“The challenge for these products are time and performance”*. These projects have a high degree of uncertainty, which requires the employment of more learning in order to diminish it (McDonough & Spital, 2003). To keep the lessons learned, the division had project-learning meetings with inter-project teams and the results are stored in a spreadsheet called a matrix. The financial controller stated: *“We’re working on a database in which failures and learning lessons can be stored. In this way, we can look back to understand what we have learned and what we should improve the next time”*.

The customer, participating in the entire evolution of the project, requires a lot of detailed information by comparison with other divisions. The customer’s and the division’s team meet at least once a week to review the project portfolio and the performance of the ongoing projects. These meetings are also a valuable and useful way of exchanging ideas, know-how, experience and transferring knowledge. There are various kinds of information to be exchanged (e.g., technical, commercial, and planning information) and “rapid” communication is needed. To do this, for example, development engineers from both sides can communicate directly with each other, in this way, communication lines will be short (Wynstra & Ten Pierick, 2000). During this meeting, the customer’s “mirror development team” confirms if Beta is on the right track. A regular update is one of the best ways to improve the NPD process, until the lessons learned databases will be introduced. The customer’s team followed up by contacting the Beta’s team development or the single functional manager to understand the reasons for the deviations from the initial specifications (learning). When problems are identified, the customer’s project team facilitated a learning process through dialogical and reflective interaction. In this way, the Beta’s team increased their skills and understanding (Liboriusen et al., 2021).

The product engineer stated: *“What happens during NPD is a continuous improvement and learning, which is much stronger than in other businesses”*. The financial controller added: *“The customer values our ability to learn from mistakes. This also considers into the overall evaluation that the customer gives to the division”*. For this reason, the division is trying to implement

a database to facilitate the re-use of the knowledge developed in previous projects. The goal is to codify and store knowledge developed during the execution of a project and document it so that it becomes more easily accessible and exploitable for the rest of the organization’s members.

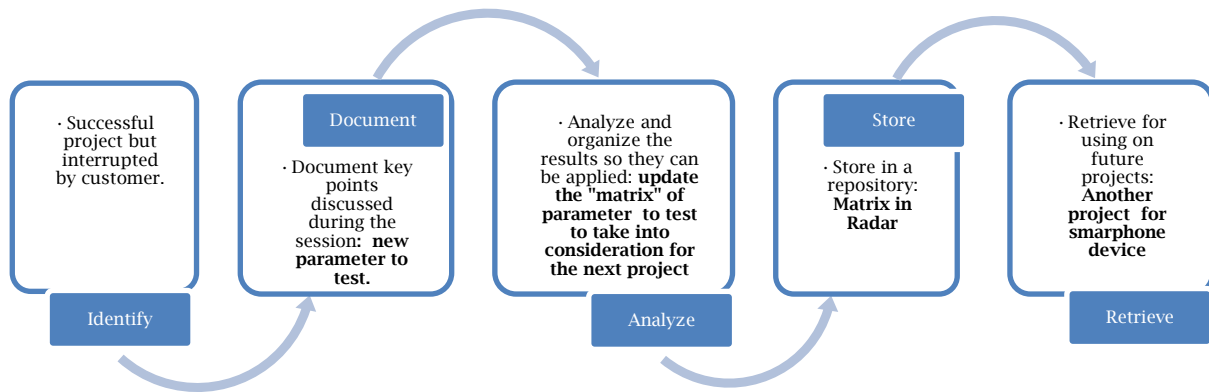
The database is also important because the customer at the beginning of each project asks to fill out a checklist, because the lesson learned from other projects may affect the development process of the new ones.

However, the problem is that much of information cannot be stored in the database because of the sensitive and classified nature of information. At this moment, the transfer of project knowledge occurs through people-to-people communication.

The financial controller stated: *“In fact, we have begun to set up specific procedures necessary to respond to customer requests. If a customer asks how we deal with a specific problem and what criteria are used to determine whether something is good or not, we are in great difficulty because we usually solve this kind of problem in an unstructured manner. For example, when choosing between two technical results, the technician considers his own experience and knowledge. However, the customer wants to know the rule applied by the technician. As a result, all technicians with the same problem can establish rules that can be applied”*. In order to meet the needs of the customer, the division has begun to define rules that can be applied to answer in an objective manner. The financial controller added: *“We must explain to our customer which criteria and rules we follow in selecting the development path rather than another one. We usually translate the way of reasoning into numbers because it is easier to communicate. However, explaining the process of achieving this conclusion is crucial, so that learning becomes a shared mechanism by transforming one’s intuition into knowledge available to all. We know that this process does not apply to other divisions, but we must comply with the requests from our customers, who are too demanding”*. There is a need to structure and formalize creativity and numbers so that it becomes a universal heritage of all people who need it, not only for those who have gained experience.

An example of a learning opportunity was the “B” project, which represented a successful development process that was interrupted by the customer. The project “B” referred to the development of a device for the smartphone. The project had already been at the trial phase. The prototype delivered to the customer was well-working, so the product was ready to be put into production. Despite the positive results, the customer decided to interrupt the process. However, the division decided to carry out the lesson learned process to improve the knowledge about this type of device. To this end, the learning process, as shown in Figure 3, is being conducted to find a new parameter to test in the next development project in order to reduce the risk of failure.

Figure 3. Lesson learned process: "B" project.



First, when the customer decides to interrupt the process, the identification phase began. Unfortunately, the Beta division did not know exactly the reasons for this decision. Motivation may be linked to two reasons. One reason is that other suppliers are unable to supply any devices, so it makes no sense for customers to continue the development process with Semicom suppliers because the final product cannot be implemented. Secondly, customer management decided to change the strategy, so the product under development did not align with the new strategic direction. The financial manager stated: *"In this business, our project is a small part of a larger project"*. When the project is interrupted, the division cannot develop the device for other customers, because of a specific agreement with the customer. Moreover, because the product is so specific, it is very hard to find another customer with the same need. The product engineer stated: *"Usually, when the customer interrupts suddenly the development process, then it will ask us to develop a new project larger than the interrupted project in order to cover the costs incurred"*.

Secondly, in the document phase, the new parameter to test are identified. The analysis results allow uploading the matrix list, which will be stored in a repository. By having a lesson learned repository with keyword search capability, the project manager or division manager can retrieve lessons learned and review them when the customer sends a new development request.

The matrix list was alive, constantly evolving and incorporating new learning. The example of the "B" project highlights the crucial role of learning for the Beta division. In order to improve its knowledge, the division is able to learn not only from failure but also from success processes. This means learning from every and each project developed.

The division cooperates with a highly demanding customer, and it is expected that the Beta division would offer fertile ground for identifying mistakes to avoid their repetition in the future.

This means continuous learning and improvement (Nørreklit et al., 2016), which may lead to the gradual accumulation over time of new knowledge that can positively contribute to the Beta portfolio management in terms of increasing the number of projects assigned by the customer. Given the increase in learning the customer could decide to assign more projects to the division.

Furthermore, learning can help to improve the performance of NPD through better knowledge (Mitchell et al., 2021).

## 5. FINDINGS AND DISCUSSION

To begin with, the scope of the projects was different in the two contexts analyzed. The Alpha division serves the mass market, addressing the four end markets; while the Beta division develops only new products in the personal electronics and communications equipment end market. Thus, the rationality of the Alpha division is to include as little technical innovation as possible in the projects in order to be cost-efficient. Indeed, the division has a well-balanced portfolio, including projects located in the low and high technical uncertainty and low and high market uncertainty area (McDonough & Spital, 2003). Instead, the rationality of the Beta division is to be as innovative as possible to maintain the strategic relationship with the customer. To this end, the division projects are in a high position related to technical and market uncertainty. The Alpha division is approximately larger than the Beta division in terms of product portfolio size.

Second, the complexity of the projects differs. Alpha division runs many large projects with long duration comprising many different technical sub-systems and components, and with a strong emphasis on performance and technical security of the final products. The aim is to find the best compromise between cost, time and scope (iron triangle) (Martinsuo & Killen, 2014). They are also not as technically complex as the project at the Beta division. The Beta division's projects are usually much smaller and longer in duration. These are technically advanced projects.

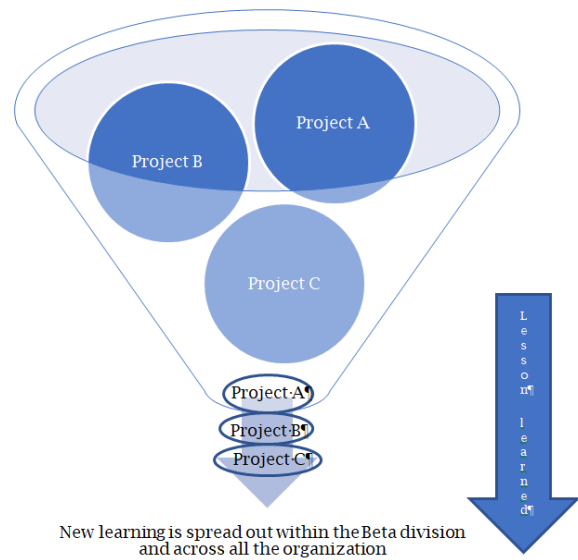
Also, the uncertainty of the projects differs. In the Alpha division, uncertainty is primarily due to the problem of what to produce, i.e., creating products that meet the fast-moving market demands, before competitors. The project success is measured by the iron triangle, which analyses the best compromise among cost, time and scope (Martinsuo & Killen, 2014). The uncertainty of the projects in the Beta division is due to the customer's needs. This uncertainty is caused by high project complexity, which requires a high level of organizational complexity (Jerbrant & Karrbom Gustavsson, 2013).

The fifth difference is related to the selection and the management of the project portfolio. On the one hand, the Alpha division has a large project portfolio (on average 50 projects). The selection process is based simultaneously on quantitative indicators as well as qualitative ones (strategic fit) related to the project. The projects are completely different and related to the end markets addressed and the uncertainty (high/low). The new project proposals can come from various sources, such as the customer, the marketing manager, the regional marketing manager and so on. On the other hand, the Beta division handles a smaller project portfolio (at least 4 projects), addressing one end-market (personal electronics). The projects developed are of the same types, with a high degree of innovation to satisfy the needs of one customer. Thus, while the project portfolio of the Alpha division is interdependent in the choice of the projects, both with respect to human resources, technology; the project to be developed is assigned by the customer based on its needs. This means that in this division no quantitative models are employed for the selection of the project to be included in the portfolio, but the strategic customer influences the portfolio decisions and, therefore, the structure of the portfolio (Morgan & Strong, 2003; Talke, 2007).

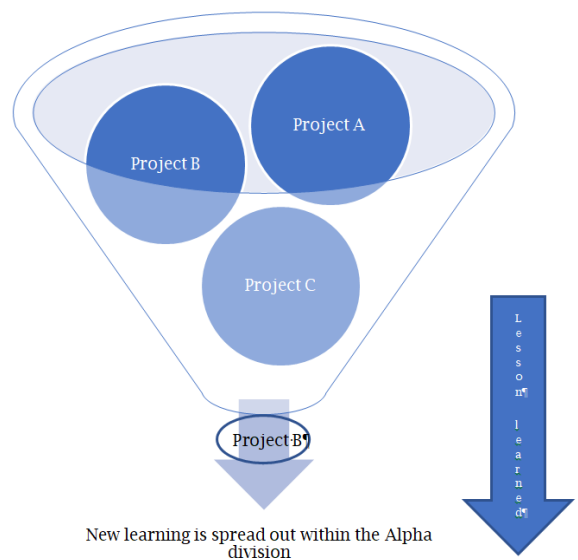
Taken together, the differences illustrate that the two studied divisions differ in many aspects. Still, there are similar actions performed by the division manager when managing the lessons learned from past projects. The process followed to perform the lesson learned is the same (Figure 1). However, the Alpha division carries out lessons learned only on some projects, such as the most important projects or the projects that went wrong; while the Beta division carries out the lesson learned on all developed projects.

Newly acquired knowledge is spread out in different ways based on the division's competitive strategy. The Alpha division spread out the new knowledge within the division, enabling the development of future projects. The learning collected from the Beta projects is spread out within and across the company because Beta's exploratory projects will provide higher opportunities for learning than non-exploratory projects. In Beta's projects, instead, team members are often allowed to think outside the box; try out a new way of doing things and develop completely new architectures, new knowledge and design spaces, new technological component and a new way of marketing products and services. Furthermore, the strategic alliance with the customer requires collecting as much information as possible from previous projects, because the repetition of the same mistakes is not acceptable. If the Beta division does not operate in this way a negative impact on the strategic relationship with the customer may occur, then the customer could decide to reduce the number of new projects to assign to the division until removing the division from the supplier list. In other words, the division's strategy requires a major focus on learning from previous projects. This attitude is completely different in comparison to the Alpha division, which follows a mass market strategy and in which learning plays a different role (see Figures 4-5 below).

**Figure 4.** Learning process in Beta division



**Figure 5.** Learning process in Alpha division



Given the complexity of the management project portfolio, it is likely that learning collected and business strategy are crucial in the selection process of the new products, to include in the portfolio (Meskendahl, 2010; Morgan & Strong, 2003; Talke, 2007). However, the knowledge acquired needs to be captured and reused. To this end, specific software could be fostered the collection of the lessons learned by making tacit knowledge explicit and storing it for future projects (Kock et al., 2020). Digitalization, therefore, would support knowledge transfer, promoting the new learning acquired from mistakes and successful projects (Kock et al., 2020). All these differences are grouped in Table 3.

**Table 3.** Summary of the main findings.

<i>Project portfolio</i>	<i>Case "Alpha division"</i>	<i>Case "Beta division"</i>
Structure	Execution of a vast array of different types of projects with different background and for different final devices.	Execution of a limited array of similar types of projects with similar background and for the same final devices
Technical interdependencies	Low	High
Portfolio management system	Quartely meetings and informal methods	Weekly meeting and formal/informal methods
Portfolio selection process	7-indicator rating Matrix and learning	Customer's choice
Project portfolio management system	Standardized	Non-standardized
Portfolio learning management	Post project review on some projects (most important project and projects went wrong)	Post-project review on each project
Steering committees	Project portfolio, division level	Project portfolio, customer level

## 6. CONCLUSION

Organizations always face the challenge of selecting a portfolio of appropriate projects that is suitable for the organizational development strategy (Bai et al., 2022).

Project portfolio management is a powerful strategic weapon (Cooper et al., 2001; Cooper et al., 1998; Koskinen et al., 2020.) However, the lack of a link between strategy and portfolio selection is one of the major problems in portfolio management (Cooper et al., 2001). Despite the abundant amount of literature on R&D project evaluation and selection (Chu et al., 1996), earlier research has not exploited the potential of learning even if it may generate significant opportunities (Martinsuo et al., 2014).

The aim of this paper was to deepen the knowledge on how a learning process could favour the selection and management of projects to include in the portfolio, considering the relevance of strategic orientation.

A case study conducted from May to November 2021 in the semiconductor industry has been presented in this paper to demonstrate how the role played by learning in the project portfolio management changes when we consider different strategic contexts.

The learning process described in this paper can be followed in the project portfolio selection process in which strategic achievements of each potential project portfolio can be calculated and ranked, and the best project portfolio can be determined. The results show that the role played by previous learning can provide very useful information for division managers in the company to pick up the best project to include in the portfolio, which meet business strategic priorities. To implement an organization's strategy and strengthen its competitive advantage, companies must select the best project portfolio based on the candidate projects that meet their strategic criteria.

The contribution of the study is twofold. First, this study contributes to the project portfolio management literature. We respond to the call for more detailed examinations of the learning influence on the project portfolio (Martinsuo et al., 2014). Especially, the findings identified the link between strategy and portfolio selection (Cooper et al., 2001), confirming that the different dimensions of the strategic orientation of business support the relationship between project portfolio structuring and its success (Meskendahl, 2010). We show how

the project selection process implemented was completely different in the two contexts analyzed. In the mass market context, a scoring system and a learning method are employed, while in the customized business model learning played a crucial role to be selected as a supplier by the strategic customer. The findings revealed that the co-development strategy assigns a higher value to the learning acquired from previous projects. These findings are confirmed by the different approaches to conduct the lesson learned. In a mass market division, the lesson learned are carried out on some projects, namely the most important projects or the failed ones. Then, the new learning is spread out within the division. Whereas, in the customized business, the lessons learned are conducted on all projects (successful or failed projects) and the new learning is spread out within the division and across all the other divisions, because the exploratory projects provide a higher opportunity for learning than non-exploratory projects.

Comparing the two different businesses analyzed we can conclude that different business strategies drive the selection of the projects to be included in the portfolio in different ways (Morgan & Strong, 2003; Talke, 2007) as we explained above. The successful use of the knowledge-based portfolio management system may help the two divisions analyzed to enhance their learning abilities, having the potential to improve the quality of their decisions during the selection process and the management of their projects (Eken et al., 2017).

Some benefits are related to the employment of the lessons learned such as promoting continuous improvement, providing an enhanced starting point for future projects; providing a consistent approach for identifying mistakes, boosting a collaborative environment; cost and time savings; increased application of best practices; reduce rework; increased profits and facilitation in knowledge dissemination.

Second, we contribute to the PC literature. The results contribute by showing qualitative evidence of the different ways in which the project portfolio is managed considering the different business strategies, it provides a better understanding of project portfolio management in practice. The approach chosen supported the investigation of how to use a learning method for analyzing the effect of change in selecting, prioritizing, and managing project portfolios related to different strategic contexts. PC approach involves

a reflective and interactive approach to the selection process, this means that it does not entail the use of a specific set of tools in the portfolio selection process, but projects are chosen in relation to the context analyzed.

The results provide very useful information for project managers, team members and division managers in the organization on how to choose the best project portfolio to meet the objective priorities of the organizations. Overall, the results provide some practical implications for managers who want to increase the performance of their project portfolio management. Firstly, the proposed model described in this paper can be used more effectively and efficiently in the selection process of the project portfolio to determine the best project portfolio. Software should be developed to enable organizations to use the proposed method more conveniently.

Our results show that the learning process positively affects the selection process in the portfolio management context, but these processes need to be clearly defined to be in line with business strategy. Managers should, therefore, be cautious in trying to implement a learning method to support the selection process or expecting too many benefits if those processes lack the necessary maturity. Our analysis of co-development suggests that learning should be considered a key element in a customized strategic context. Then, the actors involved should promote a learning process within the organization and in an inter-organizational context, and the process employed should promote synergies and the transfer of acquired knowledge.

The methodological choice to conduct a single case study in one industry has an impact on

the generalizability of the results achieved and could be considered a limitation. Indeed, the empirical research was carried out exclusively on the semiconductor industry, analyzing only two divisions of the company chosen. This choice was justified by the aim of the research, which was to gather a rich set of data from actual practice to gain in-depth knowledge on the phenomenon investigated rather than aim at the statistical generalization (Eisenhardt, 1989; Yin, 2009). Despite these benefits, case studies have received critiques. According to Yin (2009), case study research is often criticized because of lacking rigor, using a small number of or only one, providing very little basis for scientific generalization. Moreover, case studies are often described as too long, challenging to carry out and producing a large amount of documentation. However, in order to boost the validity of the findings and to study the generalizability of our findings, further research could employ a multiple-case study approach. The basic idea behind our choice of a multiple-case study is that we expect variations between companies and that the use of multiple cases makes it possible to develop typologies that could guide practice and future research within this area of study. Multiple-case design enhances and supports the previous results achieved in this study, helping to raise the level of confidence in the robustness of the method. In addition, the current study has demonstrated the need for more research on learning in the NPD portfolio context, going deeply to investigate the interaction between team learning and digital tools in an NPD context, highlighting how digital tools may support project-to-project learning.

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