Integration practices for generating alternatives in portfolio management of new product projects

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Abstract

The purpose of this study in portfolio management is to identify and understand the practices of integration among development projects and their interaction with the operation. The main point is that project's restructuring allows the generation of project alternatives that promote synergy and increase portfolio value. It is a cross-sectional qualitative study of selected Brazilian companies. Eight semi-structured interviews were conducted with key professionals from these companies applying content and discourse analysis to the responses. The cases reveal different integration practices among projects chosen to fit each company's operations, product scope, customer and market interaction, and management models. Research data shows that the flexibility in the product development process and operations enabled more effective changes in the original design, providing new alternatives for the portfolio process. This study highlights the existence of two types of practices that support the generation of projects' alternatives: (i) organisational practices, such as informal manager meetings, client participation in the product design and validation, centralisation of the product decision, formal meetings focused on project interfaces; and (ii) technical practices such as visual and participative methods for product definition and validation, demonstrative or demo product development, presentations of product use cases to those affected, diagrams of infrastructure and competing systems and use of a flexible production line. Although the

reports indicate that these practices support better alternatives, more studies are needed to investigate these findings better.

I. Introduction

Traditionally, a portfolio of product projects is a mix of managed initiatives through a well-known process. These firms use similar practices for projects' evaluation, selection, and control (Cooper, 2009). This process involves several stakeholders and aims to enable and achieve strategic results.

With portfolio management, organisations are trying to increase performance and efficiency (Müller et al., 2015) to improve the long-term value of new product development investments – NPD. Cooper (Cooper, 2009) emphasises that, in many firms, the evaluation and selection only aim for financial results. However, he stresses that having a focus on the strategy can promote better sustainable results.

Managing multiple projects in a portfolio requires managers to have a broad view of the organisation to control internal and external factors and influences. This overall perspective requires a structured, adaptive, and proactive management process that allows an uninterrupted project aggregation and review (Amaral & Araújo, 2009; M. Voss & Kock, 2013). In addition, this systematic process enables integrated planning, mediating conflicts, and facilitates technology knowledge transfer and sharing information across different areas and projects (Clark & Wheelwright, 1993).

Environmental dynamics requires organisations to have a flexible structure, process, and manufacturing (M. P. Miles et al., 2000) and develop them based on their environment (Agrawal, 2014; Jansen et al., 2009; Saeed et al., 2020). Therefore, organisational flexibility is a necessary adaptive capability (Saeed et al., 2017).

The rate and volatility of changes in the external environment (Cingöz & Akdoğan, 2013; Jansen et al., 2006; Michael Zhang, 2006) make project evaluation and selection a complicated task.

Proposing a new vision, minimising the effects of these constraints on environmental dynamics, and using the concept of flexibility in the stages of evaluation and selection, Sharpe and Keelin (Sharpe & Keelin, 1998) showed that the recombination of elements of projects in the same platform allows a new phase of generation of alternatives where each project scopes may be expanded and add value to the portfolio.

Cooper and most other authors assume that projects are closed and immutable packages ready for selection in projects' evaluation and selection. However, to add more value, projects must be opened and reviewed to reduce negative interactions and expand synergies. Nascimento (P. T. de S. Nascimento, 2010) suggests that redefining or recombining the aims, scope, and projects' attributes will promote a higher value portfolio.

This vision encourages research to identify the organisation's internal practices that integrate portfolio projects through their review and recombination and find value synergies or negative interactions among projects.

This research will present a brief literature review, analyse four companies' product development portfolios, discuss their relevance and characteristics, and describe their processes and practices to reveal practices that promote integration among projects, aka review and recombination.

II. Research problem and objective

This research aims to identify and understand the integration practices among projects and interaction with the operation that allow the restructuring of projects to generate project

alternatives that promote synergy in using resources and increasing portfolio value. This research directs the following research questions:

- What are the integration practices among projects used to increase the product development projects' portfolio value?
- How are interactions found in the projects portfolio, and what may be done to expand synergies or mitigate negative interactions?

III. Conceptual framework and methodology

Case study research has been recognised as suitable for examining how and why questions (Robert K. Yin, 2016). Miles and Huberman (M. . Miles et al., 2014; M. B. Miles & Huberman, 1994) suggest constructing a conceptual framework that underlies the research. Such a framework explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs, or variables – and the presumed relationships amongst them.

Figure 1 - Research Framework (source: Author)

These frameworks show that the integration among the projects of a portfolio, that is, to make changes in the characteristics of the projects and their objectives stated in the initial scope, aiming at the best competing resources, can expand the operational synergy, the use of the infrastructure or even modify and expand the target market, increasing the portfolio's financial results.

This research proposes to validate this framework by a cross-sectional study suggesting investigating some well-established companies in the market, complex and large operations,

and infrastructure, acting primarily in local and national contexts and internationally. Eight semistructured interviews were carried out with critical professionals, and they were evaluated based on a qualitative methodology, using content analysis and discourse analysis elements.

The use of multiple interviews in each case is one of the triangulation methods used to research data and results validation. The selected cases, interviewees, and general product characteristics are shown in table 1.

TABLE I. *Cases selected according to the defined methodology (Source: Author)*

Company /Sector	**Interviewed**	**Product design decision**	**Typology and quantity of products**
Alpha / Chemistry	Director of Products in Industrial Solutions Polyurethane Marketing Director	Brazil and Global	More than 1000 products. Develops various chemicals, such as polyurethanes
Beta / Telecom	R&D Director Systems Integration Management	Brazil and Global	More than 500 active products. Develops hardware and software for telecommunications infrastructure.
Gamma/ Insurance	Program Manager Manager / Responsible for project management methods	Brazil	More than 28 sectors with different products. Develops products and services based on software and processes.
Delta / Food	Manager Responsible for R&D and Operations Product Development Consultant	Brazil	Variable quantity. Develops food products for 80% of aviation operators in Brazil.

All companies were named in Greek letters to facilitate the presentation, identify, and maintain companies' anonymity.

IV. Analysis of results

Description of the data

Table 2 summarises the new product development projects' characteristics in each of the evaluated companies, and Table 3, presenting the leading practices that support the integration and reformulation of projects. The flexibility of operations and internal processes are shown to be an essential condition to enable the creation of alternatives for a new portfolio. In intensive capital projects, any project change was only feasible before the product testing and development phase. In companies with higher investment balance during the development phases, integrations and revisions of the portfolio projects were feasible during most of the development process.

Alpha company - Chemical manufacturing

The Alpha company develops innovative products, such as polyurethanes, solvents, and surfactants, in global development centers, through projects lasting an average of 5 years.

The Alpha company's project portfolio management process is managed with formal milestones. New opportunities identification and project modelling are the first two milestones that define a formal and structured project proposal. This proposal has to present elements that support the portfolio value, be prepared and aligned to long-term market scenarios and strategic planning, and include the interactions and restrictions among products and operations

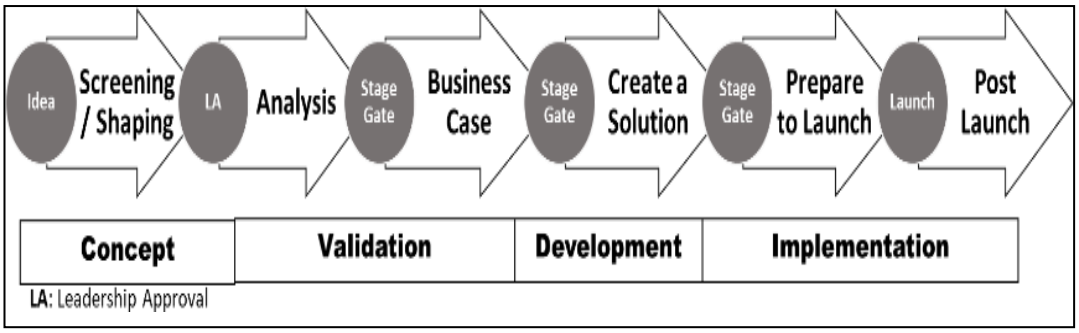

Figure 2- Alpha Company – Chemical Stage-Gate Project Development Processes (source: author)

These initial proposals undergo a first screening and idea shaping; this first stage focus on market evaluation, search and formalise the development opportunities to validate the first idea with the customer. After the leadership approval, the defined project proposal moves on to a new stage of detailed assessments to analyse and assess economic and financial viability.

The information and analysis are raised and defined, enabling a detailed business plan that presents the production volume, sales, and operation model analysis, including logistical requirements up to the plan to launch with the customer.

The business plan validation enables the development of the product's first version in a laboratory environment, ensuring the client's proof in a controlled environment. Based on this preliminary validation, the product will be subjected to a field test at the customer's factory, allowing minor adjustments to the real production conditions and a gradual increase in production.

During the stabilisation of the implantation and production, the product will be officially launched and monitored throughout its life cycle to evaluate results and bring improvements and new developments.

Beta Company - Telecommunications

Beta develops a wide range of products and systems to operate and manage telecommunications networks through physical products or hardware (hw) and systems or software (sw). Physical product projects, such as network cards and radio base stations, have a higher development cost, are standardised with national and international standards, and involve several global stakeholders that influence and validate the project.

Software projects, also called digital projects, develop and implement telecommunications network management systems that are customised according to each

client's business and infrastructure needs, so it has a more complex and interactive management process.

TABLE II. *New Product Development Projects Characteristics (source: Author)*

Company / Sector	Development	Product Nature	Characteristics of Product Projects
Alpha / Chemistry	Global and local	Physical-Chemical	Design: Marketing Team Adaptations: Customers and Infrastructure. Main Decision Maker: Marketing Manager Management Model: Sequential Management - Sequential
Beta / Telecom	Global and local	Physical - Telecom Hardware Software - Applications and Firmware	Design: Marketing Team Adaptations: Clients and Financial Valuation Key Decision Maker: Global Product Manager Management Model: Hardware – Sequential Model – Software - Agile Model
Gamma / Insurance	Local	Software - Applications and processes	Design: Business area Adaptations: Customers and Product Manager Main Decision Maker: Product Manager Management Model: Agile Management
Delta/ Food	Local	Physical - Catering meals	Design: R & D Area Adaptations: Client and R&D Main Decision Maker: R&D Management Model: Sequential Management - Sequential

TABLE III. *Mechanism, Practices and Expected Results with The Reformulation and Integration Among Projects (Source: Author)*

Company / Sector	Mechanisms for Integration among Projects/Products	Results Observed
Alpha / Chemistry	Directions: Informal meetings among managers Relevant factors: Manufacturing and production balancing Financial Evaluation: Product Profitability Knowledge base Process Flexibility: Little	Market expansion Production cost reduction
Beta / Telecom	Directions: Formal meetings of managers Relevant factor: Use of instruments, such as Demos and Use Cases Financial Evaluation: Product Profitability (P&L) Process Flexibility: Medium	Market expansion Increased product life cycle Decrease financial risk
Gamma / Insurance	Directions: Formal and informal team meetings among managers Relevant factor: Product reviews with Active Customer participation, Standardisation of Suppliers, Uses of infrastructure map and systems Process Flexibility: High	Rational use of infrastructure Portfolio simplification Increase in product added value
Delta/ Food	Direction: Formal meetings among client and R&D Relevant Factors: Product reviews with Active Customer participation, Supplier Standardisation Process Flexibility: High	Improved customer service Rational use of inputs Reduced operating costs

These rapid development interactions occur with several business and technical areas and customers interested in this new product. This group participates in essential stages such as initial planning of the exchange and validation of the results. This agile management process allows for continuous adjustment of projects, allowing for review of requirements, integrations, and search for synergies among products or adaptations of tasks and projects to have more outstanding adhesion of new customers and expand the market.

Figure 3 presents the management models in operation in physical products and digital products. Despite the perceptibly similar stages, the constant participation and interaction among clients, development teams, and other areas in most development processes allow flexible management for software projects, enabling changes throughout the process.

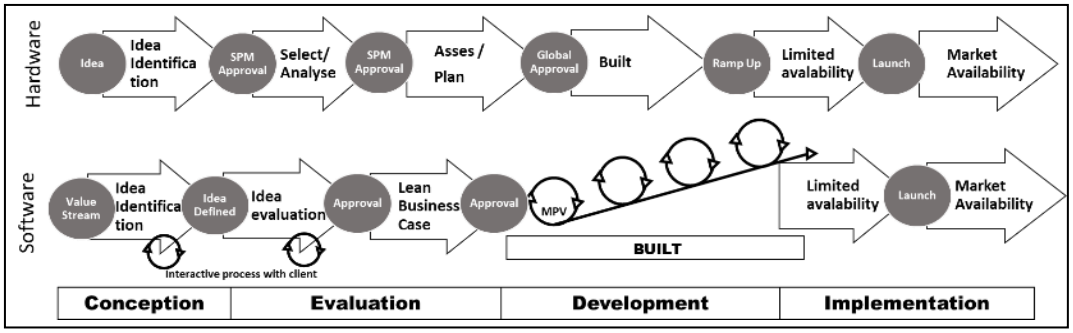

Figure 3- Beta Company -Telecom HW e SW Project Development Processes (source: author)

Notwithstanding, changes and integrations during the planning and control stages in the network products (hw) are less viable due to management constraints, little manufacturing flexibility, international standardisation, and the decision-making process's rigidity.

Due to the frequent client and internal product validations and the supporting tools, as demos (simplified product models) and use cases (description of the product's use by the customer),

any change in the original scope of a software project is feasible if it does not impact the project deadlines or any financial statements.

Gamma Company - Insurance

Gamma project and portfolio management processes are based on a product-centric organisational structure based on a specialised product development team called squads, with total autonomy to define and develop new products.

Figure 4 exhibits the macro-process used to manage product development projects. It shows a vital process characteristic of interactions among impacted areas, technicians, and customer representatives in the project's various phases.

This initial phase, represented by a value stream (VM) meeting, aims to promote innovative solutions. This meeting focuses on defining how to deliver more value to customers by identifying and understanding the various opportunities and determining an initial but well-defined product conception to all stakeholders and clients impacted.

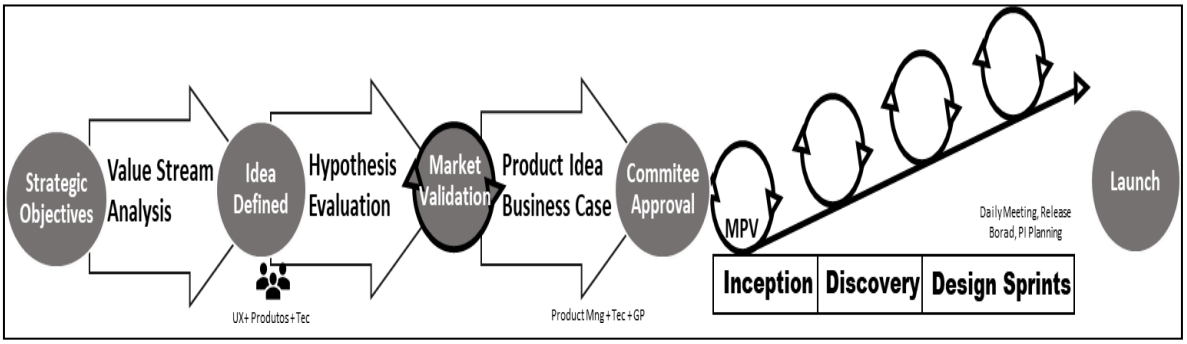

Figure 4- Gamma Company - Insurance Project Development Processes (source: author)

The VM meetings occur with technology, development, systems architecture, customer experience teams, product manager, and project managers. The product manager evaluates all project opportunities, discusses with the project´s team, and validates with the client.

After internal validation, the technical team starts designing sprints, developing the planned tasks, focusing on the minimum viable product (MVP) planned because of the sprint's series. Each sprint adds new elements and greater complexity to the final product, ensuring that the constraints, interdependencies, and scope changes that occurred during this period are included.

Gamma's product development management characteristics have short development periods, effective stakeholder participation in the products' definition and validation stages.

Delta Company – Food

Multiple products are designed for each Delta´s customer demand. The R&D executive manager led the product development process is led by the R&D executive manager with support from the head of products and operation manager.

Figure 4 presents the product development process used in the Delta company. These eight stages involve the R&D, supply, and operations areas that evaluate the client's requirement and negotiate the final validation and acceptance.

A critical factor in the Delta company's development process is the management team's extensive market experience and understanding of the client's business. This information and knowledge enable a continuous innovation cycle by searching for new technologies, materials, new suppliers, and inputs.

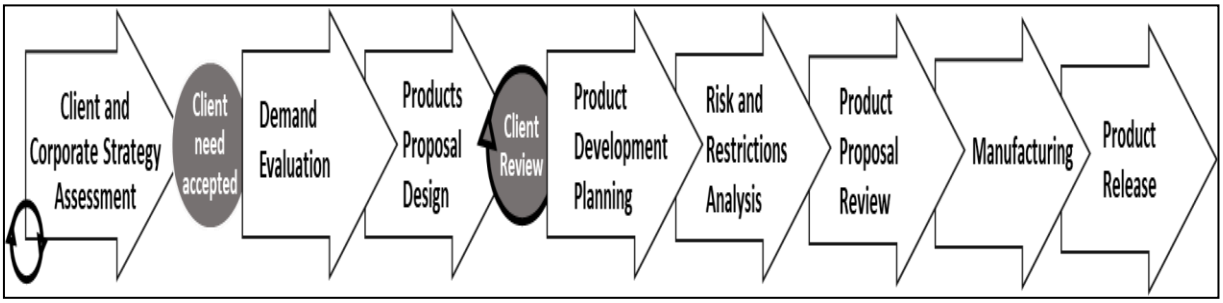

Figure 5- Gamma Company - Insurance Project Development Processes (source: author)

The product selection and development process begin with customer demand. Next, a preliminary study is carried out by the R&D team assessing the requirements for defining the new products, the production schedule, and the infrastructure available in the impacted units. This evaluation determines a first proposal for viable products under the analysed conditions.

The initial proposal is validated through the evaluation and test of a small batch of products. This test assesses the components quality, product design, and exclusivity for the premium customer's products and cost evaluation for the economic classes.

Validation can take place through several test rounds. Each test provides new ideas and requirements for product suitability. The changes are negotiated to maintain financial results, satisfy the end customer, and restrict operation resources. Due to the autonomy of the R&D team and the availability of resources, the customer's validation cycles can occur several times on the same day.

The Delta management model enables projects and operations to integrate or modify from product development until market releases. This integration is possible because their priority is to have fully trained managers and operation teams in the new technologies. And open accessing for production management and control systems, product datasheets, and production planning.

V. Discussion

The debate initiated by Sharpe and Killen and expanded by Nascimento gave rise to the development of this research that focused on growing this debate. The four cases presented companies that operate in different markets and develop distinctive products and projects. Despite each company's peculiar management model, leadership style, and operation, this research brings

to light the integration practices among projects used to increase the product development projects' portfolio value.

All selected companies structured their project portfolio to meet strategic goals, such as market expansion, reduction of operating costs, rational use of internal resources, and financial results. To improve the portfolios' expected results, they carry out some manoeuvres among projects to reinforce integration, increase synergies and reduce negative interactions.

The cases studied presented products, operations, and the target market with different features that guided their management processes in product development projects with specific formal procedures, approvals, and practices.

The cases presented products, operations, and target markets with different characteristics that guided their management processes in product development projects with formal processes, approvals, and specific practices. However, despite the differences in their methods and procedures, some organisational elements made it possible to use internal practices to achieve integration effectively, among them:

- Active leadership close to the customer
- Agile decisions and management
- Adaptive operation and processes

The cases presented two main categories of practices that supported the restructuring and integration among the projects. First, the (i) internal technical practices, i.e., use of tools, assessments, analyses, and second the (ii) internal organisational practices, such as leadership, communication, and management processes used to manage projects in the portfolio.

The most relevant internal technical practices were:

1. infrastructure assessments,
2. isual maps of systems architecture, platforms, and interfaces among products
3. intermediate products design and validation,
4. demo products and use case presentation,
5. flexible operations and production line,
6. organisational information systems.

All cases showed internal organisational practices in different intensities. These leading practices were:

1. specialised development teams,
2. client and team interactions,
3. formal meetings focused on project interfaces,
4. informal management negotiations.

Using this set of practices allows managers and project teams involved to assess the impacts among projects and have sufficient and necessary information to propose reformulations in projects aiming at integration with other existing projects and platforms, reducing negative interactions and expanding synergies in the use of resources.

The dynamics of project management and control processes differ among the studied companies. Linear or sequential development processes, discussed by authors such as Khurana and Rosenthal (Khurana & Rosenthal, 1997), Wheelwright and Clark (Wheelwright & Clark, 1992), Cooper (Cooper et al., 2001), are used in the Alpha Company and Beta's network products.

Alpha and Beta companies established time-consuming and complex management processes, demanding detailed and formal documentation with rigorous approval assessments due to the high investment required to develop new products. Also, present few interactions among the project's technical and management teams with other companies' internal stakeholders and the late client validation milestone.

Projects managed by Gama, Delta, and the system product line from Beta company, on the other hand, present similar models endorsing the research developed by Beck, K. (Beck et al., 2001), Koen et al. (P. Koen et al., 2001), Sommer A.K. et al. (Sommer et al., 2015) or Cooper & Sommer (Cooper & Sommer, 2016). These companies present recurrent and nimble management cycles based on a daily or weekly schedule routine. In addition, they integrate the management, development, and production teams' efforts to define and develop intermediate products, thus providing better interdependencies visibility among projects, products, and operations to all impacted stakeholders and obtaining clients intermediary validations.

Regardless of the management model, some practices were essential and commonly used to support the managers' decisions and facilitate change in the design and product features under development. For example, specialised and centralised global information management systems allow analytical analysis based on customer relationships, market scenarios, and product technical features information, supporting management and technical decisions throughout the development processes. Other tools such as simulators, prototyping, and testing demo products facilitated product understanding and advocated a more flexible customer validation.

Adaptive operations and processes proved to be a critical prerequisite in all cases studied and a key to appropriate project planning. Researched companies that presented Adaptive operations and processes had clear procedures and tools for evaluating and understanding the

constraints existing in operations and infrastructure, such as production plants, available materials and suppliers, human resources, and equipment available in the organisation. However, the lack of operation knowledge, interdependence among projects, and operation visibility entangle leadership (Sharpe & Keelin, 1998).

Interviews in Gamma and Delta companies showed that technical practices such as: (i) simplified financial control tools, (ii) maps to facilitate the visibility and knowledge of the interface among products, and (iii) project and production management systems enabled the development and approval of new proposals.

In the opposite direction, the Alpha company's managers report that financial control tools and operations and systems maps are practices with little influence on project integration due to complex internal processes, rigid approval procedures, global stakeholders influence, and extended product development time others evaluated companies. They also developed other specialised tools for their model, such as tools for monitoring the product life cycle, a global information base with customer perceptions, more advanced simulation systems, and technical and market data analysis, allowing project proposal reviews to expand synergies to gain scale or develop new markets.

Organisational practices strengthen management, expand the relationship among areas, reinforce the team's knowledge and behaviours to minimise internal conflicts, reduce complexity and bottleneck, and proactively propose improvements and adaptations in projects to increase the portfolio's value.

Centralising product development management in a resource or department, such as the product manager or the R&D area, facilitates more agile decisions, an open and lean communication flow, and creates a more solid focal point with the customer.

Ensuring the team's knowledge of the various stages and technologies facilitates participation in product development, brings different perspectives, and increases the control of negative interactions among projects, allowing informal and participatory team control.

Assessing portfolios based on initial project proposals are ineffective due to the impacts of ongoing interactions among projects and operation (P. T. D. S. Nascimento, 2013). Without visibility and knowledge of interactions and constraints, it is impossible to assess the portfolio's real value or decide on the most appropriate alternatives.

VI. Conclusion / contribution

In short, the present work shows that the integration among projects may help to create a more attractive portfolio; this requires formal and informal internal practices, which are visible when there is flexible and dynamic management of operations, development processes, and production resources.

This conclusion defines an additional element in the original framework. In our initial framework, integration among a portfolio's projects can expand operational synergy, use the infrastructure, or even modify and expand the target market, increasing the portfolio's financial results. However, the conclusion brought in by cases shows that organisational flexibility moderates the relationship between integration among projects and the synergy among projects and portfolio value, as presented in figure 6.

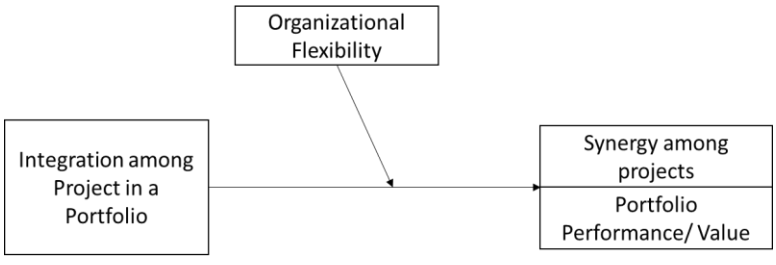

Figure 6 - Research Framework Reviewed (Source: Author)

Although this research shows that different companies can use other practices to support project redesign, promote integration and better use of integration, and better use company resources, some are common and can be readily used by managers. As shown, the viable and standard practices in organisations were:

Technical Practices:

- infrastructure assessments,
- visual maps of systems architecture, platforms, and interfaces among products
- intermediate products design and validation,
- demo products and use case presentation,
- flexible operations and production line
- managerial information systems

Organisational practices:

- specialised development teams,
- client and team interactions
- formal meetings focused on project interfaces
- informal management negotiations

The generation of a portfolio of NPD projects transcends the selection of static and immutable projects since the search for increasing synergy among projects and reducing negative interactions occurs in all cases, regardless of the market, product, or technology used in the project.

Identifying interdependencies among projects and existing operational constraints gives the leadership and the project team the basis for generating new alternatives that add value to the portfolio before freezing a project's requirements and specifications and making the final decision.

In any case, this research reinforces that it is not enough to define and select individual projects to obtain the best portfolio of projects. Instead, identifying and evaluating the interdependencies among projects will be necessary to find why and how to redefine initial proposals into better alternatives.

Although this research covers relevant companies in the market, showing the existing trend on portfolio management and project integration, future studies should address a larger sample of companies, including those with products of different nature and from other industries.

This study's contributions include identifying practices that integrate and redefine projects based on interactions, interdependencies, and operations. This study may contribute to the advancement of the academic debate in project portfolio management. It provides subsidies to project portfolio managers to expand their portfolio assessment and management model.

The present study also sheds light on a field that is still little explored in our context. We brought new data based on leaders' vision from leading companies regarding the integration among the processes of creating projects, practices, integration, and expected long-term results.

Some limitations of this qualitative study include the lack of objective and numerical key performance indicators. In fact, future follow-up studies could integrate accurate data with qualitative information to provide more consistent data in a long-term perspective.

In the managerial view, the practices discussed in this research are easier to adopt by companies that adapt their management model and develop teams with autonomy. However, managers who work with companies with strict internal processes, bureaucratic approvals and

validations will encounter more significant implementation challenges and little cross-functional and cross projects communication.

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