Value Creation in Project Management: The Effect of Project Lifecycle Management Measures in an Aerospace Company

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Abstract. *The aerospace and Defense (A&D) companies have recently increased their efforts to ways in which they can create new values out of innovative product development processes. In this study, I began with summarizing the generic methods of collaboration by considering the ways in which value can be created, networked or diffused in a Project Lifecycle Management (PLM) environment. Then, I looked at the most widely used value enhancement measures with regard to PLMs in the aerospace industry and considered where this approach yielded similar results comprised of a strategic network (SN) and strategic planning models. And finally, I proposed that the A&D companies may sustainably create value by building-up SNs by optimizing and transforming their risk management approaches within an exploration project management perspective. The study concluded that the value creation in A&D companies may be positively associated with the intense realization of PLM efforts among technology roadmaps and networks of actors.*

Keywords: *aerospace; value creation; project lifecycle management (PLM); exploration project; project management; technology roadmap.*

Introduction

Today, the economies of the leading aerospace and defense (A&D) industry companies are driven by innovative projects. Networking across innovative projects creates a high potential for a collaborative environment; requires fine-tuned strategies on the values and performance features that will sustain sustainable economic growth while meeting the requirements defined at the product level. According to these sector-specific strategies, defense companies have sustainably improved their value chains by applying Project Lifecycle Management (PLM) approaches and by optimizing/transforming their project management processes to be more cost-competitive and requirement-based.

Since current business practices are increasingly becoming more and more networked and interconnected, the growing rate of collaboration in defining the new levels of technology has also paved the way to increasingly complex needs in project management and supply chain management. In these specialized new approaches of the project management, the strategic networks are required to be managed; large budgets to be decreased and new systems to be designed based on the competencies of companies (Green & Sergeeva, 2019). For that, Williams and Samset (2010) highlighted the importance of divergent goals and factors affecting project management in each stage. Each actor processes the available information and knowledge through network structures to make sense of the surrounding on which they base their decisions and organized action (Weick et al., 2005). We empirically propose that new approaches of efficient and innovative ways of R&D project management specialized in supply chain management are required so that large budgets to be decreased, intricate PLM systems to be designed and R&D contracts to be scaled according to the company's competencies

From a different perspective, strategic approaches of PLM are being challenged by a network-centered view (e.g. Cova & Salle, 2007; Lee-Kelley & Sankey, 2008; Söderlund, 2004), where project networks require the creation of interconnections for the exchange of knowledge and experience among network actors in a continuous and interactive process. The primary concern of this article is to evaluate value creation out of projects. Hence, I tried to summarize the approaches and aimed to revisit the topic in the literature "value creation and project management" through the perspective of the companies operates in the A&D sector. I also tried to *conceptualize the* process and the relationships between the constructs of project management in the aerospace company presenting the *applied* evidence from the perspective of project management approaches involved to create value out of *innovative* product projects. The second section of this article

reviews different, simplified and related bodies of literature with respect to the explicit research question. The third section describes my methodology that is based on a PLM approach in order to create values out of projects. The fourth section presents the description of processes and networking about the applied phases of project management in an aerospace company. My contribution is expected to identify several key attributes of PLM (Section 5). The sixth section elaborates on the concept of strategic management and organizational ambidexterity. The last section, Section 6, is on the conclusions and comments highlighting future research.

Value creation and collaboration in projects

Value creation may be considered as the primary focus of the research of a project, program and portfolio management. The concept of project management as a means of added value was also studied previously (see, for example, Winter et.al. 2006; Williams & Samset, 2010). Moreover, value creation can be expressed and defined in many different ways.

Value creation in project management is often discussed through the creation of new capabilities such as learning to achieve sustained competitive advantage in a supply chain network. In the defense industry, the research to determine the mode and structure of project management arises from *complex* requirements and the needs of multiple suppliers participating in project networks (e.g. Ruuska et al., 2011). From this perspective, aligning goals according to the technology roadmaps are considered to be an important determinant of value creation in the project network (e.g. Ahola et al., 2013; Morris, 2013)

In a search for such networks, the relationship between value creation approaches and PLM directs research through the modes of joint innovation formulation with the sub-contractors (e.g. Edkins et al., 2013; Davies, 2004). These approaches in the current project management literature are contained in PLM models. For example, there are academic studies that propose *iterative* lifecycle models for defense projects (e.g. Morris, 2013; Artto & Wilstrom, 2005).

Innovations, project requirement identification, and work definition are structured through different types of collaborations in the supply chain networks (e.g. Hietajärvi et al., 2017; Kokkonen & Vaagaasar, 2017) Moreover, collaboration in supply chain networks enable the firms to facilitate the collaborative exchange to create value. Different forms of collaborations like goal-oriented (Integrated Product Teams (IPTs), supply chains, etc.) to more long-term strategic networks (long term subcontractors, clusters, business ecosystems, districts, etc.) may be distinguished along the supply chains. Parung and Bititci (2008) propose five main value generators in networks: physical assets (buildings, tools and laboratories in the network), financial assets (the cash spent on innovative projects), human capital (skills, experience, education, knowledge, commitment to the project), organizational capital (product performance, organizational culture and innovation technology) and finally relational capital (maintaining performance). Moreover, the notion of value creation is highly related to the success in knowledge sharing, learning and innovation (Kogut, 2000), which can be labeled as *strategic supplier networks*.

In strategic supplier networks, companies explicitly require to create a link between innovative product development and PLM to achieve success in innovation. The concept of project management based on a life cycle approach has been dictated by most of the companies in the defense industry with regard to the strategies covering all aspects of product and process life-cycle under the notion of Technology Roadmaps (TR)

Hence, an understanding of value creation in strategic supplier networks is essential for diffusing the *result* of innovations in the defense industry. But, a *gap* still exists in the literature between the project life cycle and the value creation. The present study therefore specially provides a *framework* of the essential factors that characterize value creation in the process of innovation. Here, the notion aims to optimize the group of projects, allocating scarce resources as a function of each project's requirements, targets and strategic alignment with the firm's formulated strategy (like Technology Roadmaps - TR) showing that the overall value creation principle is more like a management of resource allocation as to balance the risks and opportunities between diversified technology requirements. (e.g. Maniak & Midler, 2014)

Project management to enhance value

In many studies, it was suggested that the pre-feasibility (or *pre-contract*) stage of a project is a strategic project definition stage, in which the goals, requirements, and expected value of the project are defined (see, for example, Edkins et al., 2013). In this stage, the basis of collaboration is also defined. Therefore, successful alignment of the goals and the formulation of agreeable project definition are the key value-creating outcomes of the *pre-contract* stage (e.g. Morris, 2013). Hence, I propose that value creation is derived from high levels of collaboration within multiple actors in order to manage challenges of project environment (e.g. Williams & Samset, 2010) describing iterative management approaches like project lifecycle models (see Koen et al., 2001; Nobelius & Trygg, 2002).

For that, mapping various needs of different project actors is required to form a suitable project concept to be implemented in the project lifecycle stages (see Williams & Samset, 2010; Aaltonen et al., 2015).

On the other hand, project value can be generally considered as the result of a trade-off between the cost and benefits. In this study, value is defined from a project management perspective where all determinants of projects are sustained. Hence, additively, *I propose that the collaboration among project actors is a necessity in order to deliver value by reducing project cost and/or increasing the project target benefits.*

Typically, many organizations set up a Project management Unit at the structural level (or Project Management Office – PMO) to manage projects and to provide benefits including standardization and learning. Benefiting, however, is defined as a set of processes that ensure that projects, programs, and portfolios embed the requirements of business strategies into business in order to create value (Serra, 2013). Here, I underline that value creation approach begins at the project selection stage, where business owners and project professionals collaborate to identify the potential benefits of projects (PMI, 2016). Target benefits are then formulated and stated in the business case of each concerned project for approval by the project funder (Chih & Zwikael, 2015; Jenner, 2015). These target benefits are subsequently tracked, reviewed, and aligned with the needs of relevant stakeholders during the course of the project (PMI, 2016). Finally, the benefits are realized or value is created (Morris, 2004), which may occur during the project life cycle (Breese 2012; Thorp, 2001).

Consequently, PLM involves several different actors and a high level of integration and networking is needed (e.g. Gibson & Birkinshaw, 2004). By this way, each company specialized in the production of specific goods or services collaborate through network relations to obtain a final product (Busby and Fan 1993) Here, the application of a specific PLM approach and a *specific* system may build networking channels through supply chains in which information and knowledge that can be exchanged through; and as stated in strategy documents like technology roadmaps, etc. to define levels of specifications, drawings, and contracts. Hence, I propose that:

Hypothesis – Technology road mapping (product based) throughout the collaborative networks (like supply chain networks) is a contingency factor that can help to mitigate the risk of missing /lesser value creation

Figure 1 and Table 2 summarize 5 (five) main life cycle phases in a project that have been proposed (revised from Buttrick, 2000). Furthermore, a generic description in this article may be promising because it integrates both alignment with a predefined technology roadmap and strategy, and it increases adaptability to new information through innovation projects that arrives during the activity.

In the next section, I present few insights about the application of the contextual structure of project management from a perspective, which could help to better understand the mechanisms of the creation of value and how it embodies a coherent path towards defense products.

Strategic Planning and Organizational Ambidexterity

In project management literature, there have been many research constructs and frameworks to create an empirical basis for strategic project planning. As stated earlier, projects are often evaluated as a part of strategic planning processes. Recently, the focus on strategic management trade-offs in organizational research has been on exploration/exploitation theory. Exploration includes things captured by terms such as search, diversity, adaptability, risk-taking, experimentation, flexibility, innovation, and long-term

orientation. Exploitation, on the other hand, involves refinement, alignment, control, constraints, efficiency, and short-term orientation (Andriopoulos & Lewis, 2010; March, 1991). Andriopoulos and Lewis (2010) have also defined *contextual* ambidexterity in organizational settings when there is a capability to simultaneously and synchronously pursue exploration and exploitation within a business unit or work during strategic planning. It is therefore important to discuss how contextual ambidexterity can be utilized at the strategic project planning level.

From the PLM point of view, contextual ambidexterity *may* be a viable solution for planning subsystems with scarce resources (Beckman, 2006). Contextual ambidexterity is achieved by defining a set of requirements or processes that enable subsystems or subcontractors conflicting demands for exploration and exploitation; then, the project targets are therefore evaluated according to incentive systems, organizational settings, and risk preferences. Thus the project enters an exploration process first and foremost characterized by exploitation. One of the research focus may, therefore, be how the *exploration* projects are managed.

In this perspective, Eriksson (2013) defines five characteristics of *exploration* projects that will define the levels of analysis for exploration situations of project management (see Table 1)

Table 1. *Characteristics of Exploration Projects*

Characteristic	Definition
Emerging	• Strategic ambiguity • Strategy is formulated prior to the project's implementation • Different strategies imply different priorities
Proactive	• No explicit demand on the part of customers • Blurry identified market • Legitimacy of the project • Inability to secure project resources
Complex results	• Project goals should be used to develop product concepts and to create knowledge • Four different results: o Concepts become commercial products. o Concepts adjourned due to lack of time or resources. o New knowledge that are used during the exploration can be re-used on other products o New knowledge that has not been used during the exploration can be useful for other products.
Exploration of new knowledge	• Exploration projects make use of a technical innovation, a new practice, a new business model, etc. • The project team will have to explore and develop new knowledge through networks • Lower probability that innovation will *ultimately* succeed • Knowledge management entails exploring innovation as quickly and as effectively as possible.
Specific temporality	• Hidden urgency and multiplicity of time horizons • New product development (NPD) is limited by commercial necessity • Innovation processes must be integrated into development projects. • Project focus in the short term must be related to the introduction of the first version of the products/services developed • Other aspects that need to be explored, an exploration that relates to subsequent projects and/or research initiatives

(Revised from Eriksson 2013)

Similarly, I may depict that value creation out of exploration projects is dependent on the management and *optimization* of the above-described characteristics as well as network actors' capability to share resources and knowledge to restrain project requirements properly. The state of collaboration among project actors also dependent upon the technology roadmap associated with different levels of involvedness of actors (sub-contractors) and/or project targets.

Project Management and Value Creation in an Aerospace Company: PLM Approach

PLM demonstration in a defense industry company is conceptualized to deepen our understanding of different stages of project management and networks with regard to value creation. Shortly, my case was exemplified in the lights of different exploration projects showing the same characteristics in a Turkish aerospace and defense company, founded in 1973 under the auspices of the Ministry of Industry and Technology in order to reduce the foreign dependency in the defense industry of Turkey. With the decision of meeting the combat aircraft requirement of Turkish Air Force (TurAF) with F-16s, company was re-established by Turkish and US partners in 1984 for a period of 25 years in an aim to realize the manufacture, systems integration and flight tests of F-16 that would be delivered to TurAF. Restructured in years 2005 and 2014, the company has become the center of technology in design, development, modernization, manufacturing, integration and life cycle support of integrated aerospace systems, from fixed and rotary wing air platforms to UAVs and satellites.

Nevertheless, project management theory and practice offer a number of methods, tools, and techniques supporting project management. In our conceptual process definition, in the phase of conceptual design, it is possible to use the Feasibility Study (Hapanova & Al-jiburi, 2009), the Cost-Benefit Analysis (Cambell & Brown, 2003), the financial analysis and assessment of the economic effectiveness of a project (Mian, 2011) to define a project as precisely as possible and to assess its benefits.

Hence, for our company, the development phase of a project may be exemplified as in Figure 1.

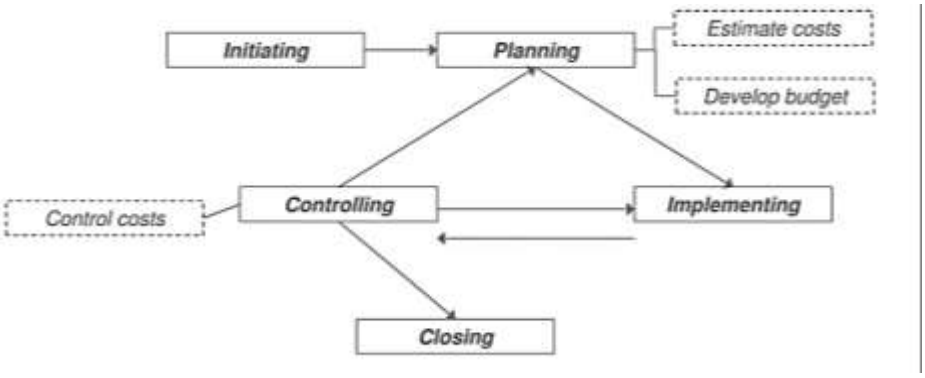

Figure 1. *Main Phases of Project Management*
(Own construction)

In the phase of planning of an *explorative* defense project, within the entire project life cycle, the scope of a project and its time course can be precisely specified according to the Operational Requirements List (ORL) with respect to the Product Breakdown Structure (PBS), the Work Breakdown Structure (PMI, 2008), a network analysis method (the Critical Path Method, etc.) (Hillier and Lieberman, 2005), the Gantt chart (PMI, 2008)

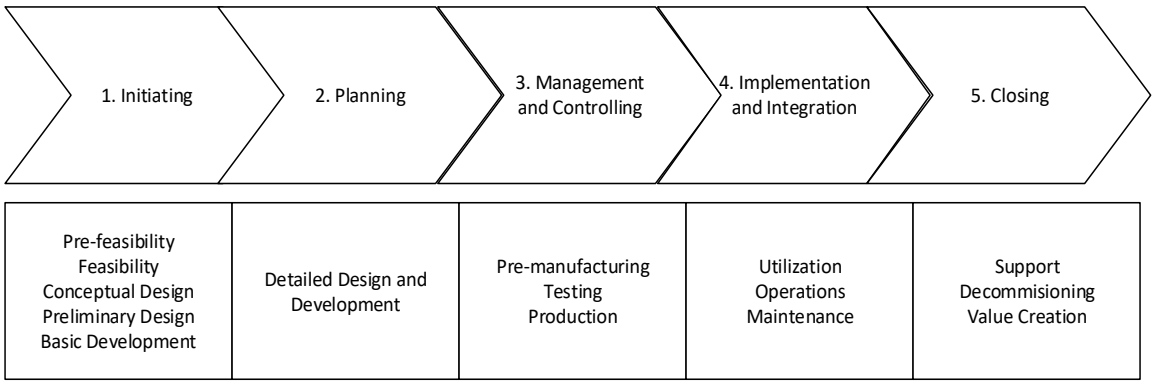

Figure 2. *Main Phases of Project Life Cycle Management (PLM) in the Defense Industry*
(Own construction)

In Figure 2, I explained the notion of basic phases of the project life cycle in an aerospace company. For instance, in order to plan human resources, the project manager makes use of the Resource Breakdown Structure (RBS) and Responsibility Assignment Matrix (RAM) (PMI, 2008).

It is also important to identify any potential project risks in the planning phase, where it is possible to use the Risk Breakdown Structure (RBS) (PMI, 2008). To propose the time, the project manager prepares a Schedule Plan (SP). In the project implementation phase, it is important to monitor the course of project implementation. The Earned Value (EV) Management (e.g. Solanki, 2009) is a method used in our company that makes it possible to assess the course of action of a project. When a project is finalized, the project manager makes an assessment of the project using EV approach for example, the Lessons Learned (Carrilo et al., 2013; Jugdev, 2012). To simplify, I constructed a phase definition table with regard to the PLM perspective (see Table 2)

Table 2. *PLM Phase Definition Table*

Process	Other Definition	Main Phase	Explorative Characteristic	Outputs	TRL to be expected	Brief Description of phase
Idea generation	• Proposal • Concept Initiation • Idea Creation	Initiating	• Emerging • Proactive • Complex results • Exploration of new knowledge • Specific temporality	• Pre-Feasibility • Concept Definition	TRL 1	In this phase, the idea for a new project is generated and the initial proposal that describes the business and technical needs must be prepared.
Pre-Feasibility	• Initial assessment • Preliminary investigation • Concept Research • Cost benefit analysis	Initiating	• Emerging • Proactive • Complex results • Exploration of new knowledge • Specific temporality	• Pre-Feasibility • Conceptual Definition • Requirement Definition	TRL 1-2	The aim of this phase is to evaluate the existing proposal in terms of financial, operational and technical viability as well as against the company's strategy.
Feasibility	• Detailed Concept Definition • Cost benefit analysis • Evaluation	Initiating	• Emerging • Proactive • Exploration of new knowledge	• Feasibility Analysis • Conceptual Design requirements • ORL • Preliminary Design • Pre-WBS • Pre-OBS • Pre-RBS • RAM	TRL 1-2	The definition of product design and solution to address the operational requirements must be identified and defined w.r.t. risks involved.
Development and execution	• Detailed Design • Implementation Phase • Production Phase	Planning	• Emerging • Proactive • Complex results • Exploration of new knowledge • Specific temporality	• PBS • ORL • WBS • OBS • RBS • SP • Gantt Chart	TRL 2-3	This phase involves design, development, creation of the project life cycle. Documentation and business processes must also be defined.
Commissioning	• Test Validation • Pre-manufacturing	Management and Controlling	• Proactive • Specific temporality	• PBS • OPL • SP • Testing • Integration Planning • Operations requirements validation	TRL 3-5	In this phase the solution is tested in an operational environment. The purpose is to validate the acceptance and capabilities of the solution

Process	Other Definition	Main Phase	Explorative Characteristic	Outputs	TRL to be expected	Brief Description of phase
Launch	• Release • Implementation • Acceptance • Utilization • Operations	Implementation and integration	• Emerging • Proactive • Complex results • Specific temporality	• PBS • RBS • SP • Production Plan • Integration Plan	TRL 5-7	The project is handed over to the business units and thus released to the operational environment during this phase. This phase also marks the beginning of operational support
Post Implementation Review (PIR)	• Business review • Project audit • Post project review • Value Added Review • Earned Value Management (EVM)	Closing	• Proactive • Complex results	• RBS • Lessons Learned • Earned Value Assessment	TRL 7-9	The project should be assessed to determine if the benefits were delivered and what the impact of the project was on the business. Lessons learned should be captured for future reference.

(Own construction)

At this stage, I tried to summarize and combine the findings of the literature and regulatory context in the company as tools for proper project management. In terms of innovation projects, my company follow up the same methodology and also the results. Nevertheless, the synthesis and program differ according to the main groups involved.

In Figure 3, I have described the additional progress that my company follows up during the PLM phase of multi-partnered innovation projects in the company.

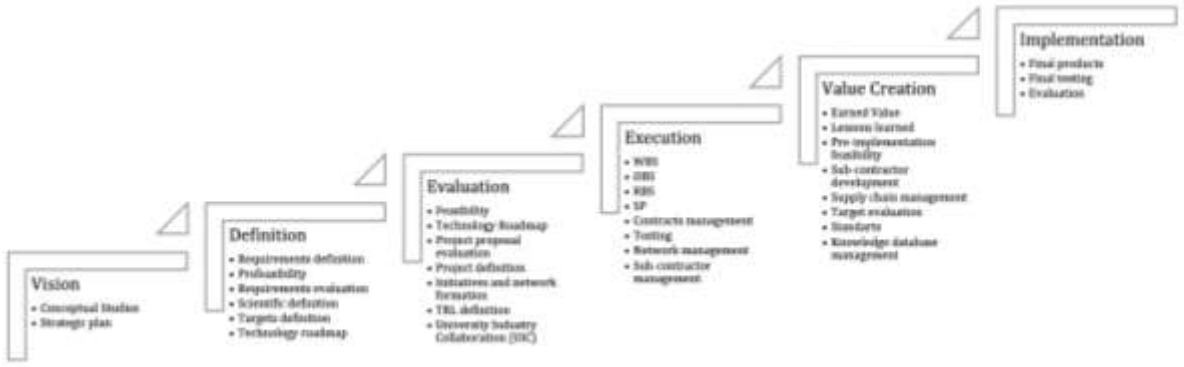

Figure 3. *Phases of project management of innovative projects: Life Cycle Approach*
(Own construction)

Within the above described PLM discipline, the company sustains indigenously designed end-products and sustains the connection between strategic mission and implementation phases through asset values; orienting the market needs. Briefly, the evaluation of projects, with the increasing support of universities and other partners, company triggers networking among actors and industrial positioning toward innovative technology development projects. However, all these considerations are taken into account regarding the Technology Roadmap (TR) to refine the value creation through technological-economic evaluation of the project. Below, I have constructed a simple process definition chart in order to explain the importance and usage of TR during the project management processes (see Figure 4).

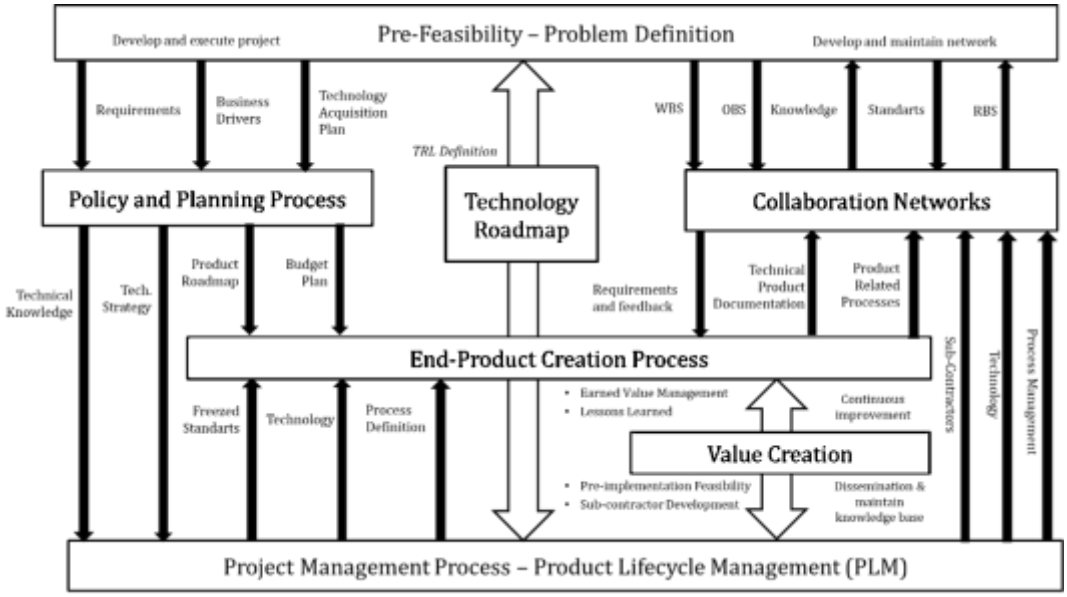

Figure 4. *Applied PLM process*
(Own construction)

Hence, in an aim to explain the processes described above, first, project managers (PM) start to develop and define pre-feasibility processes from the beginning phase to the entire life cycle, and, consequently, to distribute the project expectations (targets) along with the different project life cycle phases. In accordance with project targets, PMs use different evaluation and management methodologies to sustain technological and economic gains in relation to indigenous products. The *explorative* results in this article reveal how PMs create value deviated from best practices and previous empirical findings. Table 3 summarizes my empirical findings for value creation including insights from the main phases of project management. In this perspective, the results are presented in detail for each phase indicated in Figure 4, showing the various illustrative quotes from the perspective of project management and how PM influence the effectiveness of value-creating practices.

Since I *cannot* explain details in advance based on the Technology Roadmap Acquisition Plan, I may depict that our company facilitates "EV Management" and "Lessons Learned" approaches in order to deepen the knowledge first internally and then sustain knowledge flows with the applicability of collaboration approaches for sub-contracting. Lessons learned outcomes are also spread internally and are to be directed to different future research according to the requirements of products.

Table 3. *Risk definition and Value Creation*

Main Phase Definition	Empirical insights	Risk Definition	Value Created
Initiating	• Feasibility • Transparency for product specification • Strategy definition	• Time shortage • Mis-defined milestones • Missing requirements • Implementation possibility • Missing technical expertise and knowledge • Conflicting demands	• Technology definition • Feasibility Report • Pre-defined project Plan • Strategy document • Exploration of technical knowledge • Networks

Main Phase Definition	Empirical insights	Risk Definition	Value Created
Planning	• Reporting • Detailed design • Project teams • Networks • Prioritization of requirements • Cooperation (collaboration and cooperation)	• Wrong design specification • Mis-definition of design and/or production processes • Mis-matching market requirements • Missing capabilities in the strategic network • Wrong foresight • Risk preferences • Disabled subsystems or subcontractors	• Product and process standard definitions • Product roadmap • Technology roadmap • WBS / OBS • Freeze project plan • Budget plan • Technology acquisition plan • University Industry Collaboration (UIC) • Technology sub-contractors
Controlling	• Standardization of design and production processes • Fitting of requirements • Team management	• Missing production capabilities • Newly added requirements • Hidden urgency • Team disformation • Missing incentive systems	• Technical product documentation • RBS • Freeze product and process standards • Pre-implementation feasibility report • Sub-contractor cooperation
Implementing	• Relying on engineering experience • Application of standards • Relying of project plan • Sub-contractor management • Relaying on technology roadmap	• Missing production tools and infrastructure • Less transparency • Wrong subcontractor planning • Weak organizational settings	• Core production knowledge • Sub-contractor network • Earned value management • Product specific processes • Supply chain management • Close cooperation with sub-contractors
Closing	• Relying on budget and Project plan • Probability of defining innovations	• Dissemination of knowledge • Weak serial production planning • Ill-defined business strategy • Missing innovation evaluation process	• Strategic benefits • Lessons learned • Earned value • Continuous improvement • Knowledge database • Updated technology roadmap • Exploitation of knowledge • Strategic collaboration

(Own construction)

Conclusions and discussions

In this study, we summarized a view of the main approaches for sustainable project development. In the first part of the paper, the most recent approaches were summarized in the context of value creation. Here, particular attention was given to the concepts of the project life cycle based on the notion of strategic management. Then, in the next section, from the strategic planning perspective, I have evaluated organizational ambidexterity focusing on the phase of project management concepts in an aerospace company. Subsequently, the approaches and tools used in PM were examined in a value added perspective.

Form the strategic point of view, this study also has implications for the analysis of value creation evaluated with some risk definitions in project management process and the tailoring of PM. The question is, what should be considered in tailoring the project management processes in light of how value creation is available since it is highly crucial for stakeholders trying to establish or improve an *explorative* project management system. Moreover, the explorative findings presented in this paper were affected by a number of limitations. First, the empirical insights might have been biased by the company experience. Second, primarily PLM literature was investigated and thus there may be other aspects within more general PLM to which the empirical findings do not apply to or that cover these topics differently. Hence, this study could be conducted in a broader context.

Nevertheless, the central idea of the paper is devoted to summarize the most relevant approaches emerging from the literature, distinguishing the methods deriving from Project Management approach. Hence, I may propose to follow up the exemplified phases in exploration project management procedures considered in relation to the project life cycle phases and to use tools directed to the reduction of risk and uncertainty elements of the project, with particular attention to cost benefit analysis. Finally, as a future research, we may denote that specifically in complex innovation projects with different functions, the focus may be extended on the conjoint use of project monitoring and control approaches and financial analysis with regard to market risks, requirements and strategies pre-defined. In conclusion, this article aimed to show that the value creation in A&D firms may be associated with firms' intense realization of technology roadmaps and *collaborative* project management efforts, own funded co-opetition efforts in R&D projects and intensive realization of PLM. Moreover, I aimed to show that the value creation of the aerospace firms may be positively associated with firms' possession, co-opetition efforts and intensive realization of innovative projects among internal networked knowledge resources.

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