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Sustainable Development in Project-Based Industries—Supporting the Realization of Explorative Innovation

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Received: 26 January 2018; Accepted: 1 March 2018; Published: 2 March 2018

Abstract: Both exploitative and explorative innovations are needed for sustainable development in any industry, but balancing the two types is a delicate matter, and exploitation tends to be strongly prioritized in many industries. This is typically evident in project-based industries (PBIs), which are characterized by a fragmented supply chain and the delivery of one-off solutions in business projects. Realizing explorative innovations in this context is complex due to the need to transfer new knowledge between the organization developing the innovations and actors in inter-organizational business projects. The aim of this paper is to highlight areas in the management of explorative innovations developed outside business projects, to increase the understanding of where the specific market setting of PBIs might necessitate an adapted approach for successful realization. A case study of three innovation projects in organizations operating in PBIs have been conducted. The findings confirm that the major challenges lie in the transition between development project and business project. We highlight three aspects linked to this transition that require a flexible management approach: the assignment and acceptance of suitable responsibilities and roles, flexible support for the innovation process, and system acceptance. The findings may provide guidance for actors in PBIs strategically seeking to promote sustainable development, and provide foundations for further research to develop support for explorative innovation.

Keywords: sustainable development; explorative innovations; systemic innovation; project-based industries

1. Introduction

To meet rising global pressures for customized solutions, organizations have widely-recognized needs for streams of technological innovations. Moreover, effective management of innovation projects is regarded as crucial for their competitiveness, financial success, and sustainable development [1,2]. To attain sustainable development, both exploitative innovations (based on current knowledge) and explorative innovations (requiring new knowledge) are needed [3–6]. The former involves meeting the needs of existing customers or markets by incrementally improving products and processes using existing knowledge, while the latter involves exploration of more fundamentally new designs, the creation of new markets, and/or the development of new distribution channels [7]. Balancing the two types of innovation is a delicate matter, and exploitation tends to be strongly prioritized as short-term measures, meeting the demands of existing customers, and the ease of measurement are dominant concerns in many industries [8–10].

This prioritization of exploitative efforts is typically evident in project-based industries (PBIs), which are characterized by a fragmented supply chain [11] and delivery of one-off solutions in

inter-organizational business projects [12]. Due to the emphasis on delivering solutions and meeting customer demands, most development is handled within business projects. These short-term efforts leverage exploitative innovations, usually focused on improving performance or solving problems that occur in existing processes to deliver unique solutions efficiently to customers. However, it is often very difficult to realize more explorative innovations in individual business projects since such innovations frequently require coordinated changes by multiple stakeholders throughout the fragmented supply chain [13,14]. Thus, they require systemic changes for successful implementation. Further, contractual settings govern many aspects of business projects and, thus, often constrain systemic innovations. Hence, attempts to develop explorative innovations must be made in isolated development projects, often by an organization, such as a supplier or consultant, and then transferred to business projects for implementation [15]. Therefore, the specific market environment strongly influences these explorative innovation attempts, because no actor owns the entire supply chain in PBIs. However, while realization of exploitative innovations in PBIs has been intensively researched [16–18], realization of explorative innovations (which are often more radical and systemic) has received far less attention. Nevertheless, the limited extant body of knowledge highlights the complexities involved in realizing explorative innovations in PBIs due to the required transfer of new knowledge between organizations developing the solutions and actors in inter-organizational business projects with fragmented supply chains and short-term objectives.

Innovation management studies have also identified various factors influencing the successful management of innovation projects [19–21], mostly in analyses of traditional manufacturing industries. However, some authors have claimed that their importance is context-dependent [12,22], suggesting that the importance and roles of factors in different settings, such as PBIs, may require specific attention in focused studies. Thus, the aim of this paper is to highlight areas in the management of explorative innovations developed outside business projects, to increase the understanding of where the specific market setting of PBIs might necessitate an adapted approach for successful realization. This is addressed by analyzing three innovation projects in organizations operating in Swedish PBIs, using success factors identified in the innovation management literature as analytical tools. The findings may provide guidance for actors in PBIs seeking to promote sustainable development and foundations for further research to identify effective support for attempts to develop and implement explorative innovations.

2. Development in Project-Based Industries

Organizations in PBIs are often fluidly structured to deliver unique and complex solutions to their customers in specific business projects [23]. Business projects are executed by order of a specific external customer and each project encompass development and production of customer-unique solutions. These are also the projects that generate income for the supplying organization. A delivery usually consists of customized products or systems integrated in a business-to-business arrangement bounded by a contract between a customer and a supplier [14]. Due to the uniqueness of each delivery, the supplier has their (internal) production knowledge as main competitive asset [24], and development therefore traditionally occurs within specific business projects, where practitioners from a variety of organizations collaborate, to enable efficient delivery and adequate outcome of the customized solution(s) [25,26]. However, explorative, often more fundamental and multi-purpose, innovations often require more structured development in isolated development projects within an organization prior to implementation in business projects [12]. Development projects are aimed at developing innovations that provide new solutions for a range of customers with the objective to implement these solutions in a variety of business projects. Whereas business projects focus their efforts on direct outcomes, development projects conducted within organizations facilitate project-to-project learning processes which are important to achieve sustainable development. These types of projects do, however, involve greater risks since they most often start with only a loosely-defined goal [27]. Thus, PBIs must accommodate two distinct types of projects: business projects and development projects [12].

Thus, innovation may arise via either exploitative problem-solving in business projects or explorative development projects in specific organizations followed by implementation in inter-organizational business projects [28], as illustrated in Figure 1.

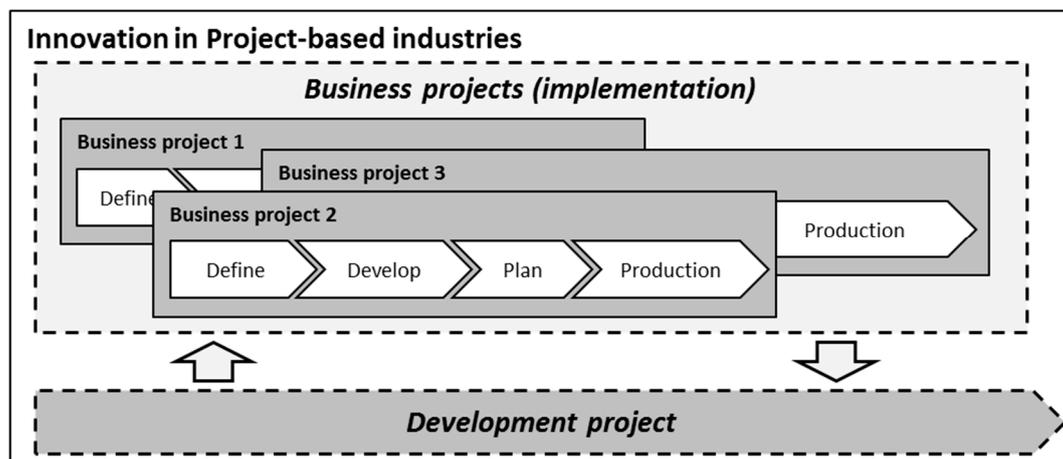


Figure 1. Development in project-based industries.

Therefore, coordinated changes by multiple stakeholders throughout the supply chain and, hence, systemic changes [6] are often required for development and implementation of explorative innovations in PBIs [13]. The new knowledge needed for these, often pioneering, innovations are sometimes only available externally. Thus, the approach to innovation must be more open than typically required for exploitative innovations. In traditional manufacturing industries, openness, and inter-organizational collaboration with familiar partners are essential for achieving competitive advantage and sustainable development [29–34]. This could be particularly important in PBIs, due to the high requirements for systemic changes and, hence, collaborative approaches, in the implementation of explorative innovations in PBI settings. However, these implications have been scarcely considered in the PBI literature.

Business projects usually offer unique solutions to each customer in arrangements bounded by contractual agreements [35]. The customers normally initiate projects, define their specifications, provide financial resources, and benefit from the end deliveries [35]. Previous relevant PBI studies have primarily focused on innovations and performance within business projects [18,28,36]. Thus, they have mainly considered innovative approaches aimed at the successful realization—in terms of budget, schedule, quality, and (hence) short-term efficiency—of individual business projects. The rationale for this is that business projects in PBIs are strictly regulated by institutions, such as norms and regulations, since investments are often vast and expensive [6,15,37]. Any failure may have fatal consequences. Therefore, realization of innovations in PBIs usually occurs during the daily development and production in individual business projects. The institutions involved are often considered to lack long-term vision [6], thereby reinforcing the prioritization of exploitative innovation (at most) within business projects. Further, project management and control have often been emphasized as important aspects of business projects [12,38]. Due to the consequences of failure, project managers are generally reluctant to even consider developing or implementing innovations in their business projects and the success of such innovations is limited by the rigid control systems [37]. The control systems also hinder realization and support of explorative innovations, developed independently of business projects, since any implementation occurs in these projects, regardless of the innovations' origins.

The early phases of either independent development projects or business projects involve high levels of uncertainty, which are gradually reduced by knowledge acquired through various activities [39]. At the end of these development phases (if successful), the solution can be implemented

into its intended context. Development poses fundamental challenges to project management, and managers (who oversee this development) must maintain a sufficiently broad perspective to handle the constant shifts in knowledge, aims, and other issues associated with any innovation process [39].

Understanding of the intricate and dynamic phase of implementation (during business projects in PBIs) is essential for the introduction of new products, services or processes, which is a difficult and highly uncertain process. According to [40], the major steps (which are important for gaining competitive advantage) when implementing innovations in business projects are: providing suitable resources, supplying tenders and planning inputs, and gaining experience and widespread acceptance. Various stakeholders play vital roles in this process, and any who are overlooked will be disengaged and unable to contribute to success [41]. Thus, excluding stakeholders from key early decisions, or ignoring their views at important gates, in business projects could have a devastating effect on the process. The stakeholder championing innovation must, therefore, act as an integrator (rather than as a delegate for stakeholders) who engages stakeholders, shares knowledge, and maintains the focus of the process. Consequently, implementation is especially difficult in PBIs, where customers often initiate or enter the implementation process early, typically assuming the role of champion, and requiring solutions customized to their needs in individual business projects. Business projects in PBIs involve multiple stakeholders and inter-organizational interaction [28] so explorative innovations always have a systemic nature, as they affect multiple stakeholders throughout the supply chain. Therefore, the project manager assigned by the customer to lead a business project plays a vital role in integrating necessary stakeholders and sharing knowledge between them during the implementation [42,43].

3. Research Method

In exploratory investigations, case studies have widely-recognized value, as they can provide rich information, offer insights regarding complex interactions and behavior, clarify poorly-understood aspects of processes, and identify novel elements of focal phenomena [44]. Thus, they seemed highly appropriate for the analysis presented here, since innovation projects are influenced by numerous factors that have not been definitively established, and they have high levels of complexity, diversity, and uncertainty [45]. Nevertheless, there are some limitations related to the chosen method; first it is often problematic to analyze the vast amount of collected data and to present it in a readable way; secondly, and more importantly, is that conclusions from case studies are often argued to be limited to the studied cases [44]. Despite the limitations related to generalizability, it seemed that a multiple case study of innovation projects from three different PBIs was the most suitable method to capture data and increase understanding of the complex phenomenon.

3.1. Sample

We collected data regarding innovation projects in three organizations, operating in contrasting PBIs: aerospace, bridge construction, and house building. However, these PBIs share several important characteristics, particularly the production of one-off solutions tailored to customers' requirements, in accordance with the increasing global importance of PBIs for effectively meeting rising demands for customized B2B products [14]. All three of the selected organizations rely strongly on production innovations to maintain competitiveness, and sites of their main R and D and production activities are in Sweden, although their products are sold in international markets. Moreover, all three organizations have a project-oriented structure, in which each business project's manager generally has substantial strength and responsibility for delivering the tailored products to customers.

The three organizations and innovation projects were selected because they appeared to offer considerable scope for acquiring rich information, and the projects have induced substantial changes in the organizations' internal processes. Brief summaries of the studied organizations and innovation projects are presented in Table 1.

Table 1. Summaries of the three focal organizations and innovation projects.

	Case A	Case B	Case C
PBI	Aerospace	House building	Construction
No. of employees	>250	<250	>250
Annual revenue (2016)	USD 740M	USD 70M	USD 580M
Project aim, develop new method for producing:	Rocket nozzles	Bathroom floors	Precast bridges
Duration (Idea-Implementation)	1996–2020 (planned)	2003–2005	2011–2013

3.2. Data Collection

We collected some of the data regarding the cases through observations and examining secondary sources. However, we gathered most of the information through interviews (semi-structured) with key respondents (Table 2) in efforts to acquire detailed insights into a wide range of practitioners' perceptions of the innovation projects. Respondents associated with Case A were interviewed in a late stage of the studied project, while those associated with Cases B and C were interviewed retrospectively in attempts to capture information regarding the implementation of solutions (business projects), as well as the development projects.

Table 2. Roles of interviewees in the studied cases and lengths (in minutes) of the interviews.

Respondent	Case	Role	Length
1	A	Project manager (R and D)	74
2	A	Business development & marketing manager	120
3	A	Production developer	107
4	A	Process Engineer	70
5	A	Chief Engineer (Nozzles)	115
6	B	Factory manager	116
7	B	Academic representative	66
8	B	Production manager	90
9	C	Department manager R and D	97
10	C	Department manager (Bridge)	46
11	C	Bridge engineer	46

In efforts to collect data consistently and coherently, we used an interview guide that included items covering potentially relevant background information and six major themes: triggers and outcome, innovation realization, collaboration/actors, knowledge utilization, important decisions/actions, and challenges. However, deviation from the questions was allowed to enable pursuit of pertinent insights raised during the interviews, which were audio-recorded to permit investigator triangulation [46]. We obtained complementary data regarding the three organizations, and their respective market environments, from observations during site visits, sources available to the public, technical reports and internal presentations. Secondary information was clarified, if necessary, during the interviews and/or observations. The use of multiple sources enabled both the acquisition of rich, complementary information and data triangulation; an important contributor to construct validity in case studies [46].

3.3. Analytical Factors

Previous studies on innovations (defined in various ways) have identified diverse factors that putatively influence their success [21,47–49]. No consensus has been reached regarding a set of requirements for successful innovation management, despite intense and extensive efforts [20]. However, several factors have frequently-stated importance in reviews, including: a structured innovation process, commitment of senior management, key individuals' engagement, external collaboration, internal cooperation, and customer orientation [21,50]. These key process-related factors, presented in Table 3, were identified and characterized in an overview of meta-studies on new product development [19,21,50–53] and PBIs [12,20].

Table 3. Sources of data used to characterize success factors addressed in the case studies.

Project-Level Success Factors	Description	Sources
Process structure	Structured process for innovation, ranging from strongly formalized to a flexible approach	[12,19,21,50,52,53]
Senior management commitment	Active support, engagement, and subtle control from senior managers throughout the process	[12,19–21,50–53]
Key individuals	Involvement of roles which entails a certain combination of cognitive, behavioral, or intellectual attributes, and position, i.e., responsibility and/or power base	[12,19,21,50,51,53]
Internal cooperation	Cooperation between functions and departments throughout the process, often through cross-functional teams that facilitate bridging boundaries and generating learning opportunities, improvements, and ideas	[12,19–21,50–53]
External collaboration	Collaboration and communication with external parties, exploiting technical and scientific know-how, in order to complement internal knowledge	[12,20,21,50–53]
Customer orientation	Ensuring that innovations meet the needs of customers through identification of customer requirements	[12,19,21,50–52]

We limited our analysis to process factors, because our primary objective was to explore the organization and management of the realization of individual innovation projects. Thus, we mainly considered effects and interactions of these factors in project-based contexts in our case studies. We could have addressed various other types of potentially influential factors—for example, corporate structure, characteristics of products, technological aspects and business strategies—that have been raised and discussed in the cited literature and other studies [53]. Furthermore, other factors may have been covered if a strong rationale for including them had emerged when we analyzed the collected data. However, we did not intend to identify and consider the effects of all potentially significant factors (which would probably be impossible in a few case studies), and we believe our analysis of the six highlighted factors has provided illuminating insights. There is no full consensus about the key success factors in the reviewed meta-studies. For example, [50] concludes that a controlled process structure is important to promote explorative innovation projects, while others, e.g., [51], favor a more contingent approach. However, both stress the importance of a process structure of some kind. A brief explanation of each success factor is provided in the discussion section together with empirical findings from the case studies.

Careful management is widely regarded as crucial for the success of innovation projects in order to handle their characteristically high levels of uncertainty, diversity, complexity, and interdependence [45]. Paradoxically, however, if uncertainty and complexity levels are high, there will likely be low levels of predictability and, thus, low capacity to define requirements for successful development and implementation of innovations. Furthermore, defining and measuring success within contexts of innovation projects is difficult as it is a multi-faceted concept that may heavily depend on both expected and unanticipated outputs [48,54]. Two classes of success parameters have often been recognized and applied in product innovation studies [55]: project performance (e.g., cost, time, and process quality) and market performance (e.g., profitability, sales, and market share). As the innovation projects examined in our case studies primarily focused on production processes, for which common objectives are to reduce lead-times and raise productivity, some of these success parameters (e.g., market share and sales) were irrelevant. Thus, here we simply regard success as the effective, efficient realization of the innovation project, leading to the implementation of the innovation in business projects (the crucial value-creation phase).

3.4. Analytical Process

Our analytical procedure followed widely-recognized steps for qualitative research [56]: reduction of data, data display and, finally, drawing and verification of conclusions. Initially, we summarized interview responses and transferred the summaries to a database in order to reduce, focus, and organize the information. In a thematic analysis we then coded the data into categories, based on the six highlighted success factors, to increase the data's manageability and meaningfulness, and tabulated the coded data to aid interpretation. We applied iterative sequences of consideration of data related to each case study, emerging results, and theory in efforts to consolidate conclusions as they developed [44]. We also conducted follow-up sessions with the respondents to increase the validity of the analysis and confirm the conclusions we drew [44].

4. Case Study Findings

All three of the focal organizations are operationally active in PBIs, but they have substantially differing approaches to realization of innovations. The following sections present each case in terms of specific market conditions, triggers, and outcomes of the development and management of the innovation process.

4.1. Case A—An Innovation Project in the Aerospace Industry

The objective of this project was to develop a new method for producing space rocket nozzles, by welding metal sheets in a sandwich-like structure providing channels for a cooling fluid instead of welding tubes together into a cone. Anticipated benefits included improvements of production procedures, designs and processes in terms of flexibility, cost, reliability and lead-times of both development and business projects. *"We need to reduce the lead-time from years to months"* (Respondent 2). Various technological advances developed in sub-projects during the course of the project have been incorporated into the production method as new requirements have emerged, some of which have been transferred to (or from) other products.

Organizations in the aerospace industry are strongly dependent on technical innovations and require high R and D investments. Hence, the organization in Case study A has abundant experience of development projects. However, the studied case was unusual due to its magnitude, as explained by respondent 2: *"We had technical examinations where customers stated that this is the biggest innovation in 20 years"*. The business unit involved is recognized internally as having an innovative environment characterized by freedom to express ideas, creativity, and commitment to the development of new technological solutions that (in conjunction with targeted investments) promote competitiveness.

The focal project lay dormant for several periods, when solving a failure of the currently-produced nozzle components had higher funding priority, and when a political decision caused a temporary shift in rocket fuel specifications and, thus, both rockets' engines and nozzles. However, deeply engaged members of the project team, who have maintained a strong belief in the new nozzle's potential, have provided the drive and commitment required to resume development and attempts to implement the solution into business projects once it was possible again. In addition, a cross-functional team with engineering, production, and business representatives has been engaged during its development. This team has also fostered collaboration with carefully-selected partners (from industry, research centers, and academia) that have complementary technological knowledge in order to fill gaps in the internal knowledge base and participate in the new nozzle's development. Commitment from senior management gradually increased during the development project as results started to show great promise. Moreover, following patent protection, presentations at aerospace conferences have raised external awareness of the new approach and its reliability. Generally, the industry has seen the technology's potential, but customers have been reluctant to be the first users of the novel design, preferring to rely on proven technology. Thus, intense effort has been expended in assuring the market, characterized by few strong customers and competitors, of the new technology's reliability. Potential

customers want full-scale tests which are difficult to do: *“The customer wants everything: it has to be cheap, good and almost flightworthy. It was a challenge specification-wise, what the customer wanted and what we thought reasonable to do in a demonstrator [test project] almost like entering a business project”* (Respondent 5).

4.2. Case B—An Innovation Project in the House Building Industry

Organization B manufactures prefabricated housing. This is part of the construction sector with rather diverse customers and a moderate level of competition. Moreover, it is substantially less mature and rigid than most of the sector, so it tends to be relatively highly innovative and frequently progresses rapidly. The objective of the project in Case B was to develop a novel method for bathroom floor production, involving the installation of a polyester basin, prefabricated with an integrated drain, rather than using a levelling compound, primer and waterproofing layer as in the traditional production method. The triggers for this innovation were the possibilities it offered to decrease transport-related problems, damage during installation, and a bottleneck identified in the traditional production processes (which entailed excessive waiting times for production lines, with tightly coordinated steps, such as those used in factory-based building production). The idea underlying the innovation emerged during informal conversations between the factory manager and owner of a supplier of materials, both of whom recognized clear business potential. Moreover, the former was a senior manager in the focal organization, enabling a decision to initiate a development project shortly after discussions with knowledgeable associates.

The focal organization lacked a structured process for executing innovation projects, and the process applied in practice had strongly iterative elements. However, it was regarded as fairly efficient due to the committed involvement of the senior (factory) manager, acting as innovation champion and project manager, with sufficient power to make decisions and ample technical knowledge. Moreover, collaboration with the material supplier fostered an innovative climate during the development project, and strong connections with academia (established in an early phase) aided the acquisition of complementary technical information and enabled access to essential test facilities. Other human resources, such as plumbers and architects, have contributed to the project when necessary, and staff with production knowledge have helped to establish an appropriate working environment and production flow. Moreover, rigorous documentation of the innovation project has been maintained, frequently by an academic collaborator, as all the tests have been conducted at a university site. This was essential, as the new flooring’s production mode is so novel that it had to meet strict quality norms to acquire certification for market introduction.

Following certification, market introduction of the innovation was straightforward, as the building manufacturing company has a real estate development division that administered the first attempts to implement it. These were initially limited to buildings of a selected type, so implementation of the internal production processes was also incremental. The reliance on internal resources in the first attempts to produce the innovative flooring strongly facilitated effective feedback, as explained by respondent 7: *“Continuous improvements were driven by various forces, often from the production line”*. However, alterations of the solution late in its implementation phase, in business projects, had adverse consequences for the supplier of materials that had contributed throughout the innovation’s development. The supplier did not sufficiently grasp that any changes affecting the innovation had to be documented and verified due to the required certification. Moreover, the supplier lacked sufficient capacity for full-scale production, which respondent 8 noted was a problem: *“they had difficulties maintaining production quality, they were used to R&D rather than being suppliers . . . it was a completely different business”*. These two problems resulted in the formation of a new organization from the original material supplier, with a tailored production line to meet requirements for the innovative flooring.

4.3. Case C—An Innovation Project in the Bridge Construction Industry

The objective of this project was to develop a novel way to construct bridges, using components and structures prefabricated from stainless-steel. Thus, the innovation incorporated advanced technology and a novel construction approach that could potentially improve both the cost-effectiveness and productivity of bridge construction processes.

Innovations in the construction industry are traditionally more incremental, local and slowly accepted than in various other industries [16]. The generator of the innovative production idea in this case, an experienced consultant bridge designer, presented the idea to organization C's bridge R and D manager (who recognized its business potential), via a mutual acquaintance. This shows that explorative ideas do not always arise through structured idea-generation, but sometimes from seizing opportunities. As respondent 9 noted: *"Balls come bouncing by and sometimes we happen to grasp one"*. The R and D manager and a bridge engineer from organization C considered supporting documents (including the idea generator's calculations and drawings), the organization's senior managers were consulted, and the decision to initiate the development project was taken.

Organization C lacks a structured go/kill process for handling innovation projects. In the studied case an iterative process was applied, in which a small, internal development team continuously handled decisions, often largely using gut feelings. There has been low centralization, the project has not been rigorously documented, it has received little attention from senior managers and, thus, minimal resources have been allocated to it. The R and D manager has been the main driver, acting as both the project manager and a deeply-engaged innovation champion with decision-making power. The idea generator (acting as a supporting expert) developed the concept jointly with the knowledgeable internal bridge engineer mentioned above. During the innovation's development, the project group also collaborated with a supplier of steel materials, which often revised proposed solutions to improve compatibility with its production systems. No production personnel were involved during the early developmental phases, hence, there were weak connections with the production department. Customer requirements were considered, in regulatory terms, but no customers actively participated in the innovation's development. Thus, it was not accepted before its introduction in business/construction projects, where acceptance by customers is essential.

The innovative approach is only applied in full-scale bridge construction projects, because no test environments are available or could be feasibly created without enormous expense. Nevertheless, it has been applied to meet requirements of both private and public customers. The production process was not sufficiently rigorous in the first attempt to construct the concept because of a lack of sufficient production knowledge. However, knowledge of problems that arose was subsequently applied to improve the robustness of the production process. This has been recognized as an important lesson, as noted by respondent 9: *"We will develop some sort of database for [i.e., to facilitate] handling and production of the bridge"*. Problem solving in business projects is something that construction firms are used to since they have a strong belief in short-term exploitative "innovations" as described by respondent 10: *"We have great faith that this will resolve itself in production"*.

Acceptance, internal and external, has been impaired by the lack of documentation during development, due to the need to convince customers and relevant authorities that the innovative approach offers better outcomes than previous methods. It was first applied in a construction project for a private customer, because public sector customers, e.g., the Swedish Transport Administration (a major player in the Swedish construction sector), demand more thorough documentation, and apply stricter norms and rules. The idea generator was nominally in charge during an early phase of the construction project, when the product was designed in accordance with local settings and customer specifications. However, he did not adequately understand his new role as an expert adviser and communicated insufficiently with the production staff. An external consultant was recruited in subsequent attempts to realize the concept, because of a lack of internal capacity to manage strict requirements associated with design procedures stipulated by the public customer. However, the external consultant failed to grasp the concept appropriately, and seemed to find less

incentive to please organization C than the customer, resulting again in insufficient communication and collaboration. Following these difficulties in collaborating with external consultants in business projects, the developing organization expanded its design department, in efforts to increase internal knowledge sufficiently to handle all the development and design requirements for future construction projects.

4.4. Summary of Case Findings

A summary of the case study findings in relation to previously studied success factors is given in Table 4. This summary gives a clear overview of the findings that underlie discussion and conclusions.

Table 4. Summary of case findings.

Project-Level Success Factors	Case A	Case B	Case C
Process structure	Process structure for both development and business projects exist separately.	Process support exists for business projects, but not for development projects.	Process support exists for business projects, but not for development projects.
Senior management commitment	Senior managers' commitment grew gradually during the project.	Senior manager extremely involved.	Low commitment from senior management, insufficient allocation of resources.
Key individuals	Strong core team including business manager and project manager with appropriate attributes.	Project manager with appropriate attributes and position in organization. Strong idea generators involved.	Project manager with appropriate attributes and position in organization. Strong idea generator involved.
Internal cooperation	Cross-functional team representing business, production, and engineering.	Cross-functional team representing production, R and D, and design.	Only design and R and D represented in the small team. Representative with production expertise was lacking.
External collaboration	Strategic collaborations with academia, research centers, and industry partners.	Collaborations with academia and main supplier/idea generator. Craftsmen (carpenter, plumber) involved occasionally.	Material supplier and external idea generator involved occasionally.
Customer orientation	Potential customer involved to a high degree in later stages (e.g., testing).	Only internal customer (own real estate company) involved, no external customer interaction during development.	No interaction with potential customers during development.

5. Discussion

Diverse putatively-important success factors for innovation projects have been identified and considered by previous authors [20,21], and contextual aspects have been raised as possible explanations for divergences in the factors' significance [12,22]. Thus, a heterogeneous industry setting, such as a PBI, can be concluded to need specific attention and focused studies. The effects and interactions of the identified success factors on cases of explorative innovations in PBIs are discussed in the following sections, highlighting areas that require an adapted approach for this particular context.

5.1. Process Structure

All three of the case organizations lacked a process structure formally intended to facilitate the progress of innovation projects with an explorative nature from idea, through development to implementation. Organization A had separate processes for development projects and business projects [12,13], while organizations B and C only had support for business projects. Several problems arose from the lack of appropriate process support, in all three cases, during both the development and subsequent implementation of the innovations.

The studied organizations vary substantially in their prioritization of and investment in R and D. The organization in Case A is strongly committed to R and D, is experienced in handling development projects, and has a process structure for doing so. However, the explorative nature of the development in Case A made it difficult to fully comply with the installed process. The organizations in Cases B and C focus more on short-term performance through efficient execution of business projects, in which exploitation is the most common type of innovation. This is consistent with expectations as

the construction sector tends to develop and adopt innovations more slowly than high-tech sectors, such as aerospace, and competitiveness within it depends more on performing specific business projects successfully than on driving industry progress through new solutions. Thus, there is relatively low experience of explorative developments within the construction sector, generally.

There is an inevitable shift in project management when development projects reach the phase of implementation in business projects. In business projects, the customer is responsible for providing process support, hence, the implementation of innovations needs to be coordinated with the customer-controlled process, which is often strictly regulated by norms and regulations in PBIs. When a new explorative solution is implemented, multiple actors throughout the supply chain are affected, so it has systemic impact. Control of the system lies with the customer in settings where multiple actors are involved in inter-organizational business projects [11]. Thus, the developer needs a more flexible innovation process structure than in traditional manufacturing industries, where the whole process is often controlled by the same (innovation-developing) organization.

Indeed, in some cases, the process structure could conceivably hinder innovation, so a proposal is to maintain high flexibility in such processes, in recognition that no organizational structure can be optimal in all circumstances. Moreover, flexibility will be especially important in late phases of development, as implementation is controlled by the project-specific constellation of customer and other suppliers. Innovation literature often claims that innovation processes become increasingly structured as they progress, and more variables are set, e.g., [50]. However, in PBIs where the innovation process inevitably consists of two separate projects (development and business), this traditional approach is not completely transferable and a more flexible approach, allowing more fluidity and customization of variables, may be required as the process enters the implementation in the business projects phase.

5.2. Senior Management Commitment

Support from senior management has been emphasized as important for the success of innovation projects [21,50,51]. However, numerous factors affect managers' commitment, inter alia cost-benefit analyses, senior managers' technical competence, perceived failure risks, and risk aversion levels of shareholders, boards, and managers [19,49]. There were high levels of uncertainty in all three of the focal projects, due to the explorative nature of the innovations. Consequently, senior management prioritized business projects, and other activities posing less risks due to the application of known processes or technology in Case A (where senior managers' commitment rose gradually during the project), and Case C (where both the allocated resources and commitment were minimal).

The sense of urgency in the three studied cases strongly varied. In Case B the innovation project was triggered by a need to solve a problem, in Case C it was initiated by perception of a possibility to seize a vaguely formulated opportunity, and in Case A there were multiple drivers, including both new business opportunities and a production problem. The sense of urgency, and associated factors, also influenced the level of support from senior management. Hence, like a process structure, while the commitment of senior managers may often be clearly beneficial, it is equally clearly not crucial for project execution. However, to establish a sustainable approach to development within an organization, senior management must be sufficiently open to high-risk explorative innovation attempts and not focus solely on exploitative refinements within business projects.

5.3. Key Individuals

Numerous authors have highlighted the importance of engaging individuals with the commitment and ability to play key roles, such as innovation champion and heavyweight project manager, in innovation projects [19,21,50,51]. Such individuals were identified in all the studied cases. There was variation in the combinations of roles, but in all three development projects an individual served as both the project manager and inspired innovation champion, in accordance with assertions that key individuals who strongly believe in an innovation are essential to drive progress towards it, e.g., [45],

and do not seem to be specific for PBI or differ in any sense. However, interactions among factors are also important, according to comments by respondents in all cases. For example, the momentum provided by key individuals may have compensated for deficiencies in commitment from senior managers in Cases A and B. Furthermore, our findings clearly suggest requirements for flexibility not only in process structure but also in roles of the key individuals.

For example, involvement of the idea generator continued too long, into the implementation phase of the innovation process, in Cases B and C. In these phases, excluding the idea generators, and/or engaging someone with the expertise, attributes and authority required to impose structured processes may have been beneficial. During the transition from development project to business project, the role of key individuals' shifts as the project and role of the developing organization changes, from owning the process to delivering solutions and support in the customer process. These shifts may have profound consequences for both the project's success and specific actors, as demonstrated by the supplier of materials in Case B. Despite collaborating strongly in early stages of the innovation process, this company eventually lost business instead of benefitting from the innovation, through failure to adapt to its new role following the transition from development project to business project.

5.4. Internal Cooperation

Broad internal collaboration between both functions and departments, often involving multi-functional teams, has widely recognized importance in innovation management studies [12,51,52]. Hence, successful realization of explorative innovations, such as those examined here, requires acceptance by several internal departments (and external stakeholders) to succeed, as they have systemic impacts both internally and externally. Earlier PBI literature describes a tendency to use the same resources in development projects as in business projects, which are more operationally oriented. No such tendency was present in the cases addressed here, which was detrimental in Case C, as it hindered implementation of the innovation because no staff with experience of business projects and production knowledge were involved during the development project. In conclusion, organizations must be prepared to allocate resources from business projects to development projects in order to promote sustainable development, despite the incentive to prioritize business projects due to their importance for generating current and short-term income. Organizations in PBIs are adapted to deliver unique business projects—to some extent like an organization in traditional industries is adapted to run operations. However, gains of operational development projects are beneficial for ongoing operations while, in PBIs, if resources are re-allocated from a business project to a development project, any gains will be beneficial for future, rather than current, business projects. Thus, there will be pain with no short-term gain. For these reasons, a shift in perspective from short-term deliveries in business projects to more long-term goals is needed, and greater perception of long-term benefits of providing resources for development projects, in order for organizations to foster more sustainable development.

5.5. External Collaboration

In all three examined cases, external collaborators participated in the innovation process, but there was substantial variation in both the strength and duration of their involvement: some engaged in the innovation process at a single stage, while others were strategic, long-term partners. These observations suggest that there may be needs for appropriate combinations of collaborators, external and internal, with required sets of attributes and expertise during specific phases (possibly with the exclusion of some collaborators when their inputs would be unhelpful), due to the need to acquire new knowledge that is outside the core competence of the developing organization. The participation of external strategic partners has widely-recognized importance in innovation projects, for the acquisition of crucial knowledge lacked by internal collaborators [20,21], but it also poses challenges, especially for explorative innovations in PBIs (with systemic effects). Due to the customer being in control of contracted suppliers during business projects, supply chains in environments of organizations

operating in PBIs are fragmented, depend on the customers' preferences, and often change from one business project to the next [18,28]. Establishing joint goals in projects to develop explorative innovations is not straightforward, particularly with external collaborators. This is partly due to the transitory nature of many partnerships and partly because the partnering organizations may have different objectives (as exemplified by the differences in goals between the external consultants and developer in Case C). The solution is primarily tuned to provide leverage for the developing organization, but the entire innovation system may need to adapt, so the needs of other actors that will be affected in the system must be considered, as any implementation in business projects requires external collaboration (or at least acceptance) for success. Thus, external collaboration is generally considered beneficial, if not essential, for implementation of an innovation [20,21]. However, the fragmented supply chain in business projects clearly inhibits external collaboration in two ways. Firstly, the advantages of tight long-term external partnering, built on trust and understanding, is difficult to achieve due to the constant shift in actors between different business projects. Secondly, external collaboration also increases the risks as it involves selling or sharing internal knowledge, which is the main competitive asset for the supplier and difficult to protect.

5.6. Customer Orientation

According to various product innovation scholars, it is important to involve customers throughout a development project [21,48,51]. For example, organizations with strong track records of successful innovation reportedly involve customers actively in their development processes, while less successful competitors rely on traditional marketing strategies [21]. Moreover, customer involvement is supposedly important for both discerning market gaps and maximizing product development processes' effectiveness [21,48]. However, there was a wide range of customer involvement in the three innovation projects considered here, from no interaction with possible customers during the development project to strong involvement in late phases. Moreover, customer involvement could conceivably exacerbate problems, for example, participating customers could clearly desire innovations to meet their specific needs. Thus, they may nudge innovations' development towards those needs, instead of general requirements of actors in the marketplace, thereby impairing rather than promoting sustainable industry-level development.

Since explorative innovations in PBIs often affect the whole system, they must consider not only internal recipients, but also external actors, especially the customers. This is because the product offerings in business projects are often affected, although the solutions are primarily intended to improve internal processes, such as production, as in our studied innovation projects. The innovation may often involve changes not only for the internal production personnel and other resources of the developing organization, to deliver the solution in business projects, but also (inter alia) material suppliers and consultants responsible for certain deliveries in individual business projects.

A developed solution must be proven to meet all relevant criteria (e.g., regulatory specifications) before it can be transferred to business projects for procurement by customers. Without acceptance from customers, the new solution will not exist, except as a concept, until any implementation occurs in business projects. The uniqueness of each business project also limits the possibility to compare a previous implementation to an upcoming one, e.g., in Case C. Hence, organizations implementing explorative innovations usually need to market them based on a notion that "this WILL BE good" instead of "this IS good". Testing possibilities are also limited as solutions are often vast and expensive. PBIs are often highly regulated and, in many cases, customers treat explorative solutions cautiously because of the potentially fatal consequences of product defects, e.g., a ruined building or exploded rocket. No customer wants to be the first to try an unproved solution and risk costly failures.

Hence, to elaborate our conclusions concerning customer involvement, it may have little or no importance during exploitative innovation realization in PBIs, because only the developing organization may be affected. However, as found in Cases A and C, customer involvement appears essential for external market acceptance of explorative innovations that, despite having the main

objective to enhance internal processes, also involve innovative product offerings. Previous studies concerning factors that influence the success of innovations in PBIs have neglected this aspect [12], stating that customer involvement is less critical in the development of innovations in PBIs, since developers are thought to have sufficient knowledge of their potential customers through previous business projects. However, our findings contradict this and instead indicate that customer involvement may be even more important for realization of explorative innovations in PBIs, since new offerings need broad market acceptance throughout the supply chain before any implementation in business projects is likely to occur.

6. Limitations

We believe that the presented study generated several insights that warrant attention, but several limitations should also be noted. A major initial concern was that focusing on just three cases of innovative projects in Swedish PBI settings may provide too limited a scope to identify and meaningfully address the influential factors. However, there was a recognized need for explorative, rather than confirmative studies, due to the limited previous research on explorative innovations in PBI. Thus, the number of cases seems sufficient to highlight aspects that require further attention. All three studied organizations operate in rather stable markets and larger studies covering more organizations and other contexts are needed to confirm the generalizability of the findings in PBIs. The fact that PBIs are often strictly controlled by regulations and norms that differ between countries and cultures also highlight the need for further investigations in other countries and contexts with different regulatory frameworks to assess the generality of the tentative findings reported here. The investigation of these issues will further enhance the insights regarding specific features of innovation management in PBIs provided in this paper, and characteristics of explorative innovation projects in general. Finally, the fact that data were collected in different phases of the studied projects hinders, to some extent, the determination of whether anticipated challenges identified by the respondents emerged during the complex transition between development and implementation. Hence, views of representatives of both developers and customers involved during the transition phase should be elicited in follow-up interviews, from both the developers and customers, involved during the transition phase should be conducted, to increase knowledge of the challenges perceived during further attempts to implement the explorative innovations.

7. Conclusions

Customers in modern society are more aware and demanding than ever before, and more often expect customized solutions. This has led to a transition towards a project-based setting in many markets. Project-based industries (PBIs) are characterized by the delivery of one-off solutions in inter-organizational business projects that are usually controlled by the customer [12]. Business projects are bounded by contractual arrangements and institutions, such as control systems and norms, which often limit innovation attempts to exploitative projects within business projects [16]. However, innovations of an explorative nature are also needed for sustainable development of any industry [6]. This need for explorative efforts drives organizations in PBIs to conduct separate development projects from the business projects [12]. This differentiates innovation processes in PBIs from those in traditional manufacturing industries, since it divides the innovation process into two distinct, but heavily linked, kinds of projects. Moreover, explorative innovations often have systemic impact, affecting multiple actors in the system. Thus, the major challenge to realize explorative innovations in PBIs lies in the transition between the development project and business project due to their different characteristics. Based on this insight and the aim of highlight areas in the management of explorative innovations developed outside business projects, to increase the understanding of where the specific market setting of PBIs might necessitate an adapted approach for successful realization, we suggest that the following three areas warrant particular attention:

1. Differences in characteristics between development projects and business projects highlight a need to identify and assign suitable responsibilities and roles. Development projects in project-based organizations do not differ significantly from traditional development processes in manufacturing industries. However, the customers control the business projects where innovations are implemented, which significantly affects the transition between development and implementation phases. From being the driving force in development, the developer ends up providing management support for the customer during implementation. This affects both what roles should be assigned to the developer during business projects, and their responsibilities. It would be highly beneficial for senior managers and team members in the developing organization to have the capacity and humility to identify phases not only when they can, but also when they cannot, positively contribute. An understanding of the shifting roles of both individuals and the developing organization is consequently needed for successful realization of explorative innovations.
2. The transition between the two types of projects also entails a shift in process structure. Although there are many similarities between development projects in PBIs and traditional development projects, there is a fundamental difference in the transition of the innovation process into implementation, which occurs repeatedly rather than merely once. The innovation process support needs to facilitate adaptable implementation since each business project requires customized development of the new solution to fit unique customer demands and control systems. High flexibility is needed regarding the solution, per se, allocation of resources, and organization of the innovation-supporting process structure, rather than a rigid one-size-fits-fit all approach, especially towards the transition (late in the development project) as any business project in PBIs is characterized by individuality and variation—e.g., in partners, customers, control systems, and norms.
3. For exploitative innovations, customer interaction may not be necessary as they are implemented internally in the developing organization (as [12] suggests), but for explorative innovations that have systemic impact, integration of potential customers and other important actors is vital even during the development project to acquire the required system acceptance before the solution reaches business projects. The value of involving customers (current and/or potential) and implications of market conditions (current and predicted) require careful assessment during any development project. Most PBIs are also subject to strict regulations and security demands since their activities and products are complex, and failures may be catastrophic. Moreover, the regulations are generally designed to maintain adequate control of standard procedures, and approval for explorative innovations generally require the adjustment of current regulations, or even the formulation of new regulations. This process is often long and complicated, so there are rarely enough time and resources in individual business projects and, hence, the solutions must be accepted and approved before the implementation phase starts.

The findings presented above extend the limited knowledge of the complexities involved in realizing explorative innovations in PBIs. Thus, they may help organizations seeking to manage explorative innovations and, hence, promote both their own sustainable development and that of the wider industry. They may also help companies to shift from a short-term to a long-term focus. Nevertheless, further studies are needed to improve the understanding of effective strategies for organizations to address the highlighted aspects. The paper also contributes to the literature on innovation management, specifically within the context of PBIs, extending work by, for example [12,14,18]. We believe that this paper provides a step towards understanding the complex phenomenon of realizing explorative innovations in PBI settings, and hope that it stimulates further studies.

Acknowledgments: The authors would like to acknowledge Svenska Byggbranschens Utvecklingsfond (SBUF) and the strategic innovation program Produktion2030 supported by VINNOVA for their financial support.

Author Contributions: The different knowledge and experience of each author has equally contributed to the development and final version of the article. L.L. and J.L. conceived and designed the case study, performed the data collection, analyzed the data and wrote the paper together and with equal responsibility.

Conflicts of Interest: The authors declare no conflict of interest.

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