Barriers towards integrated product development — Challenges from a holistic project management perspective

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Abstract

The basis for product development in many large industrial companies is a traditional project management method positing non-overlapping phases, independent activities, and a dedicated project team. Research findings indicate that the use of integrated product development methods increases performance compared to traditional methods in contexts of complex problem solving, which are disruptive and non-linear. Even though integrated product development has been the focus of a large number of research studies, these studies mostly focus on identifying success criteria and improving performance, while the requirements for implementing integrated product development remain under-researched. This study takes a more holistic project management perspective and identifies both the challenges and the requirements of successful implementation through an in-depth case study. It was found in a chosen case company that successful implementation requires awareness and skills of integrated product development in senior management, as well as a set of cross-organizational project governance structures.

Keywords: Integrated product development; Project management; Project governance; Case study method

1. Introduction

Product Development (PD) can be a crucial competitive lever in the global marketplace (Browning and Ramasesh, 2007). In most of today’s industrial manufacturing companies, PD is still conducted using traditional project management methods following linear process models (Haque, 2003), even though this is identified as a main cause of low PD performance and market failure (Browning and Ramasesh, 2007). The alternative to traditional PD is found in the well-established research area of Integrated Product Development (IPD), which represents the most dominating paradigm in PD research today (Gerwin and Barrowman, 2002). Integrated Product Development (IPD) is a managerial approach for improving product development performance through managing the overlapping, parallel execution and concurrent workflow of activities (Gerwin and Barrowman, 2002; Naveh, 2005). In contrast to traditional sequential PD, IPD regards overlap and interaction of certain activities as highly important (Duhovnik et al., 2009; Gerwin and Barrowman, 2002; Takeuchi and Nonaka, 1986). Furthermore, IPD research has taken up a more holistic view on managing PD by including several other performance-affecting elements than the PD process itself. These elements include project management (Danilovic and Browning, 2007), project governance (Winch, 2001), organizational structure (Mengu and Auh, 2010), and human resource related aspects (Knudsen, 2007; Lee et al., 2008; Martins and Terblanche, 2003; Ojanen and Hallikas, 2009) among others. IPD environments are characterized by a high degree of uncertainty, whereas traditional PD is based on the assumption of a low uncertainty environment (Buijs, 2003; De Meyer et al., 2002). Uncertainty in PD stems from assumptions about activity dependencies, the need for information exchange within and between domains, and the people needed to solve problems in product development. Managing all of these aspects requires approaches to aid the understanding of multiple domains working simultaneously and in an integrated way (Danilovic and
Browning, 2007). Therefore, it is argued that a holistic IPD approach is necessary to increase PD performance, since it acknowledges the complexity involved (Takeuchi and Nonaka, 1986; Tracey, 2004) and includes more aspects than the PD process itself (Tan and Tracey, 2007).

Despite prescriptive research on IPD improvement and IPD success, implementation of IPD in companies is still not adequate, and old problems such as poor communication and integration of functions are still rampant (Griffin, 1997; Haque, 2003; Tracey, 2004). There is a need to investigate the current challenges in PD from a holistic viewpoint and to examine why suggestions for performance-enhancing solutions in IPD research are not implemented in practice (Gerwin and Barrowman, 2002; Haque, 2003).

Hence, the aim of this research is to investigate the current challenges in integrated product development and which requirements are necessary for the successful implementation of IPD from a holistic viewpoint.

The paper is structured as follows. Firstly, a literature review on PD project management and holistic IPD elements is presented and summarized through a holistic IPD framework in the Theoretical background section. Secondly, the method is described, including an overview of the elements of the in-depth case study. Thirdly, the results are presented, analyzed, and discussed. Finally, suggestions for further research and the concluding remarks of the paper are presented in the Conclusion section.

2. Theoretical background

First, it is important to distinguish between the notion of a process model, a process, and a project. In this paper, a process model is regarded as a generic view of the main activities of a project divided into phases, while the process itself is the unique series of interconnected activities involving several stakeholders across functions and organizations. The project is the temporary organization working to accomplish a certain, inter-subjectively determined task (Packendorff, 1995).

In this section follows a literature review on relevant research, including PD project management, PD process models, project governance, the IPD framework, improvement of PD performance, and challenges in PD.

2.1. Product development project management

A project is generally understood as a series of tasks with clear goals, limited time and resources, and inherent uncertainties (Nicholas and Steyn, 2012). Projects are viewed as different from permanent business processes, since projects are characterized by discontinuous personal constellations, lack of organizational routines, short-term orientation, and trans-disciplinary integration of internal and external experts (Muller et al., 2005). The traditional understanding of projects being a means to an end is changing towards projects being viewed as temporary organizations (Bakker, 2010; Packendorff, 1995) which is also the underlying understanding of a project in this paper. This change in perception has altered the focus in project management research from evaluation of project tools towards a more holistic approach, including project governance, employee/team interaction, organizational constructs, and human resource management (Packendorff, 1995).

A holistic approach is broadly characterized by the belief that the parts of something are intimately interconnected and explicable only by reference to the whole (Oxford Dictionaries, 2013). A holistic approach to PD including a project management perspective was first proposed in 1986, when Takeuchi and Nonaka called for a change from the linear approach to an integrated approach called the ‘rugby approach’ (Takeuchi and Nonaka, 1986). They argue that executives must realize that the sequential traditional product development method is insufficient to stay competitive. They derive a list of six characteristics for successful cross-organizational project management in large industrial organizations. These include built-in instability, self-organizing project teams, overlapping development phases, multi-learning, subtle control, and organizational transfer of learning. Takeuchi and Nonaka (1986) argue that the goal is to combine these characteristics to improve internal collaboration on product development, and to increase not only efficiency but also innovativeness and product performance. The holistic approach has since been supported by numerous IPD research studies (Balachandra, 2000; Jayaram and Malhotra, 2010; Knudsen, 2007; Koufteros et al., 2010; Naveh, 2005; Rauniar et al., 2008; Tracey, 2004; Un et al., 2010). Through these studies, researchers have found that successful implementation of IPD is determined by how organizations are able to manage the interplay of a set of IPD characteristics (Danilovic and Browning, 2007; Duhovnik et al., 2009; Gerwin and Barrowman, 2002). For instance, Duhovnik et al. (2009) find three characteristics to be cornerstones in IPD: parallelness of activities, standardization of IPD process, and integration of processes.

2.1.1. Process models

Process models are used as project management tools to frame project tasks (Nicholas and Steyn, 2012). Many different process models exist. However, most are activity-based process models, visualizing the flow of activities during the project period. The two dominant models are the sequential and iterative process models (Browning and Ramasesh, 2007). The sequential model is the most broadly used model within PD project management (Griffin, 1997; Grönlund et al., 2010; Ovesen, 2012). It is often referred to as a stage-gate model, inspired by the stage-gate™ model introduced by Cooper in 1979 (Cooper, 1979; Griffin, 1997). Here, project tasks are divided into a number of sequentially dependent stages with well-defined gates in between (Nicholas and Steyn, 2012). The main challenge of the sequential model lies in the rigidity of its nature (Browning and Ramasesh, 2007). Due to the sequential interdependency of the stages, the sequential model does not allow for any tasks to bypass the gates nor to repeat former tasks. Hence, in more uncertain projects, this model is not the most appropriate choice (Cunha and Gomes, 2003; Minderhoud and Fraser, 2005).

In complex problem solving, defining requirements and analyzing the setting are often necessary more than once (Stabell and Fjeldstad, 1998; Zhang, 2013). In these cases, an iterative model is more applicable than a sequential model, conceiving
product development as a set of planned iterations through all of the major project stages (Browning and Ramasesh, 2007; Minderhoud and Fraser, 2005). The iterative model is primarily used in projects with a high level of uncertainty where, for instance, it is necessary to review the requirements several times as the project progresses (Browning and Ramasesh, 2007; Stabell and Fjeldstad, 1998). Recently, iterative models and methods from software development have been applied and found adaptable to industrial product development settings (Ovesen, 2012; Sandmeier, 2008; Schwaber, 2009). Such models and methods include SCRUM (Schwaber, 2009) and Extreme Programming (Beck and Andres, 2004) among others.

### 2.1.2. Project governance

Project governance is an area of increasing attention within project management research (Sanderson, 2012). Project governance from a temporary project organization perspective is broadly defined as a set of management systems, rules, protocols, relationships, and structures that provide the framework within which decisions are made for project development and implementation to achieve the intended business or strategic motivation (Bekker and Steyn, 2007). The aim of project governance is to enable efficient and effective project decision making (Garland, 2009). For structuring the governance of large capital projects, Bekker and Steyn (2007) identify four categories: project steering committee, cost estimating/control, project reviews, and ethical conduct. In addition, Klakegg et al. (2008) find that governance functions include designing the decision making process, setting clarity in priority, making resources for planning available, and quality control of documents. Resource management is also identified as a central element in project governance through other research studies. For example, resource management in IPD can be included in portfolio management (Killen et al., 2008). Implementation of portfolio management is positively related to better inter-functional integration (Perks, 2007), alignment of projects in the portfolio with business strategy, including a better balance in the portfolio (Killen et al., 2008), and for managing project uncertainties (Petit, 2012). According to Miller and Hobbs (2005), governance of large complex projects requires dynamic governance that can change and adapt to the context. Hence, portfolio management alone is not sufficient for IPD governance, but must include categories for adaption and change of governance constraints.

In summary, IPD governance includes three main categories:

- **Portfolio management** — including strategy development, prioritizing, performance management, and resource management.
- **Knowledge management** — including continuous learning and improvement of decision making.
- **Project ownership** — including cost control, quality control, reviews, and ethics.

### 2.2. Holistic integrated product development framework

A holistic IPD framework has been developed from the findings in the literature review. This framework is presented in Fig. 1. The perspective taken here includes viewing IPD from both a hierarchical perspective and a network perspective, which is in line with Klakegg et al. (2008). This has resulted in a model where project management is the core in IPD beneath project governance in the project organization hierarchy. The influencing elements (network aspect) external to the IPD organization are the basis organization, the involved human resources, and the external stakeholders. The core of IPD includes an iterative, concurrent project model and the project team. This is supported and enabled by project governance including portfolio management, knowledge management, and project ownership. Grounded in existing literature, IPD is based on seven characteristics: parallelism of activities, standardized IPD process, process integration, built-in instability, self-organizing project teams, subtle control, and multi-learning. The framework will be used as a frame of reference when analyzing the case study.

### 2.3. Improvement and challenges

Improving efficiency in product development has been an area of interest for both practitioners and researchers for decades and is sought to be accomplished through various measures, including optimizing the process model (Govers, 1996; Piedras et al., 2006; Rogers et al., 2004; Yamashina et al., 2002; Zirger, 1990), implementing information technology solutions (Durmusoglu and Barczak, 2011; Jiao et al., 2007), and restructuring the organizational structure (Gokpinar et al., 2010; Graber, 1996; Wang et al., 2009) among others. Implementation of IPD and the subsequent benefits that were achieved has been investigated in several case studies (Brookes and Backhouse, 1998; Duhovnik et al., 2009; Riedel and Pawar, 1991; Shina, 1993). However, little attention has been given to the actual challenges experienced by practitioners in managing and implementing IPD in practice (Haque, 2003).

Product development efficiency can be improved by implementing project management standards (Nicholas and Steyn, 2012). However, traditional project management methods, still promoted by the dominant project management standards, fail on several counts (Turner et al., 2010):

- Processes: the processes are formal and often bureaucratic.
- Procedures: the procedures encourage specialization and formal decision making.
- Structure: roles are well defined and traditional project management stifles innovation.
- People: traditional project management is focused on systems rather than people.

The most reported limitations and drawbacks of existing project management methods are that they are inadequate for complex projects and unable to model the “real world” (White and Fortune, 2002). The two most dominating project management standards in PD are the Project Management Institute’s (PMI) “A Guide to the Project Management Body of Knowledge” (PMBOK) (PMI Standards Committee, 1996), and The Association for Project Management’s (APM) “Projects In Controlled Environments version 2” (PRINCE2) (Office of Government Commerce,
PMBOK is the most applied method in the US, while PRINCE2 is the most applied method in Europe. The content of PMBOK describes thoroughly what a project manager should know (PMI Standards Committee, 1996). This is in contrast to PRINCE2 that does not describe what the project manager should know, but instead describes what should be done (Kousholt, 2008). The basic tool in PRINCE2 is the stage-gate process model (Office of Government Commerce, 2002), and thus the core of PRINCE2 is a sequential process model supported by traditional project management methods.

In 2003, Haque (2003) conducted a comparative case study on the problems experienced in concurrent product development in three industrial companies, which all had implemented a version of the stage-gate process model. The main problems that were identified in the IPD were poor coordination of the process, lack of clear strategy, poor transition between stages, lack of or poor use of technology, and poor integration of concept design. The main barriers to successful implementation of IPD were found to be the strength of the functional organization, poor coordination and collaboration, and poor supplier involvement. Even though IPD has been present for many years, this comparative case study shows that ‘old’ problems such as weak matrix structure, lack of communication, and lack of coordination are still eminent management issues (Haque, 2003). The case study, however, does not investigate how the companies responded to the identified challenges, and therefore, it does not provide an answer as to why companies do not improve their practices according to the prescriptions in the IPD literature.

To narrow the scope of this paper, we choose to focus on IPD in companies within technology intensive industries with a dedicated product development process and a proven product record, following the argument by Muller et al. (2005) that these companies have a high project orientation and that their success is strongly dependent on innovation. Based on the literature review, two research questions have been developed:

Q1: What are the challenges in Integrated Product Development in the technology intensive industry from a holistic viewpoint?

Q2: What are the requirements for the implementation of Integrated Product Development?

3. Method

In order to gain an in-depth understanding of the challenges of the product development projects, a longitudinal case study of a market-leading European wind turbine manufacturer has been conducted. This enhances the possibility of acquiring a rich understanding on the challenges of the product development projects, thus allowing greater depth and clarity (Yin, 1994). The value of using qualitative methods for developing systemic models for project management has been highlighted as an important supplement to the dominating quantitative research tradition (Edkins et al., 2007; Williams, 2003). Data collection was divided into three phases. First, stakeholders from all three hierarchical levels of the project organization were interviewed in a cross-sectional study using a semi-structured interview guide. These interviews included seven project managers, four line managers (members in steering committees) and six project employees (group interview). Project managers and project employees were selected with the aim of obtaining a broad organizational representation in the interview study. Thus, the study included PD project managers from the organizational functions of software development, electronic manufacturing, product upgrades, and new product development at two different locations in Europe. Project employees covered the functions of software development, electronic manufacturing, technical service, and purchasing at the business units’ headquarters. The four line managers were responsible for the functions of manufacturing, supply chain management, new product development, and business improvement, respectively.

The single-person interviews had an average duration of 1 h, and the group interview lasted 2½ hours. The interview guide
was developed on the basis of the IPD framework (Fig. 1), including open-ended questions on each element. Inspired by the method used by Haque (2003), the respondents were asked to identify challenges and barriers to IPD both internal and external to the projects, process context of problems, and possible improvement initiatives. Each interview was recorded, transcribed, and transferred into a document for further analysis. The document was structured as a conceptually ordered display (Arbnor and Bjerke, 2008), where the interview questions were conceptually clustered according to the general theme they were exploring. This document was compared to extensive notes taken during two interviews in a joint iterative research process between theory building and data analysis (Eisenhardt, 1989).

The second phase was an observation exercise to investigate the requirements for IPD implementation in practice. This phase included observing nine evaluation committee meetings during a six-month period. Recording during committee meetings was prohibited, and therefore extensive research notes were taken instead. The notes were combined in one document for analysis and grouped according to subjects. PowerPoint files, models, and figures presented during the meetings were available for analysis, and were used for data triangulation to the research notes to increase internal validity (Yin, 1994). The last phase was an evaluation of the improvement initiatives implemented as a result of the committee’s directions. The research team conducted a 2½-hour group interview with 11 project managers one year after the first interview round to examine the results of the implementation. As in the first interview study, a semi-structured interview guide was used, including open-ended questions. The interviews and observations are depicted in Fig. 2.

The interview data was analyzed for each project resource group (line managers, project managers, and project employees) to identify the dominant challenges experienced in each group. This was done through pattern matching in the transcribed interview data. The collected and categorized interview data was then analyzed using a problem matrix combined with identification of cause and effect relations (Riis, 1992) to identify the relations between challenges and root causes. Through the problem matrix analysis, the identified problems for each internal IPD element (project governance, projects, and human resources) were mapped. Arrows were placed between related problems with intermediate problems forwarded to other areas in the direction from the causing problem to the effect. For instance, lack of portfolio management from line managers generates a project manager problem of executing projects without management prioritizing. Through this process, the root problems, which cause or enhance the related challenges, in each area were identified. An IPD requirements framework was developed through an analysis of both the longitudinal study and the evaluation study in combination with the results from the initial interview study. The analysis included a listing of similarities and differences between the identified challenges in the interview study. Furthermore, the progressing work and final result of the improvement committee were compared with the final evaluation study. The analysis revealed a relation between successful IPD implementation and specific human related requirements and project governance requirements. The IPD requirements framework emerged through an iterative research process between analysis of the rich data set and revisions of the results between members of the research group.

3.1. Case company description

The case company, here named Alfa, is a large European industrial manufacturer of wind turbines, employing more than 20,000 employees worldwide. The company was chosen due to their market leadership and vast experience with conducting technology intensive new product development of highly innovative products. They are organized in four separate business units, each one responsible for a part of the final product. In product development projects, the business units collaborate across functions and units on interdependent product parts. This research study was conducted in the business unit responsible for electronic equipment including software, and has about 400 employees at three cities in Europe and a production facility in China. The electronic equipment has the highest degree of interdependency of product parts both internally and at the other business units. The organization was studied in a time where improvement of project performance was debated among top management. The company established an evaluation committee consisting of six senior project managers to evaluate the current setup and ultimately propose and implement a solution to improve the overall project performance. Project management in Alfa was based on the company’s sequential project model, which was a customized version of the PRINCE2 project model. The project managers were certified in PRINCE2, which was chosen as the official project management approach of the company.

4. Results and discussion

In this section, the case study results are presented using interviewee statements to highlight and support the major findings. An overview of the identified challenges is introduced

![Fig. 2. Overview of interviews and observation.](image)
in Table 1. A detailed presentation of the results is provided in the following subsections, including project context and problem consequences, project challenges, project governance challenges, and human resource challenges.

4.1. Project related challenges

Project managers struggle to keep the projects on track and meet project deadlines. In Alfa there is a lack of systematic guidelines and practices regarding project planning: ‘We have a generic project model, but it is not operational in detail. From our level and down, it is up to the individual project manager how to manage it. We work on trying to synchronize it, but we are in an initiating phase. We have just talked about it, and a program has been bought to solve the planning issues. But it does not solve the structural and organizational problems’ (Project manager B). ‘We are at a very low level of project standardization. Then, it is individual achievements instead of a combined achievement’ (Project manager A). ‘I think the project model ought to start defining what a project is and when it is ordinary work. For instance, if things are repeated over and over again, are they then projects?’ (Line Manager A). Hence, there is a general lack of support for projects and project management in the organization.

Formally, delivery of projects from one business unit to another takes place between phases of the project model. The handover is conducted officially according to a set plan, but internal deadlines are pushed without changing the end-date: ‘The time demand is constantly changed by other departments. We can never trust the time estimates they give us. They change portfolio is currently not managed systematically: ‘Currently, it is the one shouting the loudest that gets their projects through, and that is not always a good idea. When we have no overview, we cannot prioritize, which means that some people work on projects that might not be the most important to us’ (Line Manager C). ‘We need management to be very sure of what they prioritize, because if it is the one who shout the loudest who gets what he wants, then it will not work. It must be aligned from top to bottom’ (Project manager E). ‘I think it is a matter of maturity. Right now we have left the teenager with the credit card. It is a matter of teaching the organizations the rules. They need to follow the rules and the frames of the vision and the strategy. They should not define the strategy themselves. Then we have a

| Table 1 Challenges in IPD related to each of the three project organization elements. |
|-----------------|---------------------------------|---------------------------------|
| Projects | Project governance | Human resources |
| Line managers | Inadequate project model | Poor resource management | Poor project culture |
| | | Lack of knowledge management | Unclear roles and responsibilities |
| | | Lack of portfolio management | |
| | Poor collaboration between line and project organization | |
| Project managers | Poor standardization | Lack of management prioritizing | Unclear roles and responsibilities |
| | Inadequate project model | Poor knowledge sharing | Lack of meeting and learning culture |
| | Not following project model | Lack of project office | Lack of engagement and passion |
| | Lack of steering committee | Lack of portfolio management | Lack of employee education |
| | Lack of project tools | Poor resource management | |
| Project members | Lack of structure | Poor prioritizing | Unclear roles and responsibilities |
| | Poor project processes | Poor knowledge sharing | Lack of project manager education |
| | Not following project guidelines | Lack of alignment of priorities between departments | |
mature organization that is ready for bottom up. We are not there at the moment. The leadership needs to step up and set the direction. They must provide the strategy and prioritize the projects. This is the most important thing to me’ (Project manager D).

Line managers argue that portfolio management would be an important management method to improve this situation. Such method should include an overview of the project idea-base, current portfolio, and projects status: ‘If we had the tool, it could be a more controlled situation. We would like to know which projects we have, what they cost, and how many hours they [the projects red.] have. We need the overview in one, common tool […] it would provide an overview and a basis for a dialog with my managers on what they should spend their time doing. And also work as a follow-up tool’ (Line Manager C). ‘They [factory managers red.] have a more or less authorized list on who works with what. This is interrupted when other projects come ‘dropping from the sky’, because we have to participate in, for instance, product upgrades. We have no choice, because we have to participate in these projects, and the other projects are downgraded. Therefore, it would be great to have a common tool and use the same models, so we could tell what our departments do’ (Line Manager D).

Currently, there is no structured knowledge sharing, and employees express concern about their lack of knowledge on what goes on in other projects: ‘There is a general assumption that if people get information, they abuse it. So, sometimes you get just what you need to know, or sometimes even less than you need to know. I have attended meetings where I was told that the information was restricted from my manager. That is problematic. Our culture comes from the belief that our wind turbines are unique. So we protect ourselves in every aspect we can think of. I don’t know. Maybe we are unique; I have a hard time believing it. And if someone wanted the information, I think they would find it anyway. We have already restricted people with their contracts. Then, please let the information flow internally’ (Project manager C).

To summarize, project governance challenges includes poor resource management, lack of and reluctance to sharing knowledge between projects, lack of portfolio management, and poor alignment of priorities between business units.

4.3. Human resource challenges

Unclear roles and responsibilities within the projects are identified as a major challenge within human resources: ‘In the large projects, we have not talked about roles and responsibilities at all. I have an idea of what I probably should do, since I am from a specific department, but the exact interfaces to the other departments, I do not know. I could ask about it, but I guess not even the project manager knows about it’ (Project employee E). ‘…everyone here are proud to work at [Alfa red.], but nothing is done to help you understand where your place is in the machinery, and how you add value. It is important to do something about this’ (Project employee C). Project managers also have issues fulfilling their role as project managers: ‘The team concept, to empower people, to motivate. This I feel disconnected from, and this frustrates me the most. I can attend meetings with my team, and tell what I need and explain the importance of the project. People seem to understand and are motivated, but when they must deliver they have not done a bit work on the project, because back in their line department they were told differently. I feel it is a waste of time’ (Project manager A).

Some employees are overloaded with project tasks, and they relate this to low efficiency and instances of burnout: ‘Another thing that is dangerous in this is, that we find out who to contact ‘beneath the surface’, but then this person is overloaded with tasks and becomes a bottleneck, and then people find another person to exploit, until this person is also a bottleneck and burns out. We burn people out because the pressure is not on the entire surface, but on the individual person.’ (Project employee B) Currently, time registration is only conducted in projects and not in the line organization. This is identified as a challenge related to exploitation of some employees: ‘It is a riddle to me why they currently check resources on some projects but not on the line organization. Why don’t they have interest in checking the line organization for efficiency’ (Project manager A).

The final challenge identified within human resources is a lack of internal education of project members: ‘There has been done a lot of work educating the project managers, and that is great, but they are not the ones who carry the project. It is the project members, and they have not received any education, and as long as they don’t know what a project is and how you should be in a project, it cannot work. They need an understanding of the project and that the projects are as important as the operational tasks in the line organization. They need to understand that if they stall their project tasks, they stall the entire project, and that has a much larger impact on the organization than they know’ (Project manager E).

4.4. Problem consequences

Product development projects in Alfa are large, involving people from multiple departments across a functional organization: ‘We often have more than 50,000 hours in the project. Many people are involved, about 60 people in total. They [the projects red.] usually run for more than six months. That is why it is important to have a proper organization around it. We work much with it. We want to turn away from the present situation with dividing into departments where the line managers control many people and decide what they should do, and a project manager that tries to tie it together. We are somewhere in between right now’ (Project manager B). As outlined by the project manager, they are aware of challenges in the current situation. However, there is no formal overview of the financial loss related to the existing challenges, and, as stated by a line manager, ‘…the top management group does not have an overview on what kind of projects are running here. No one has’ (Line Manager A). The line manager further argues that running projects are often canceled, because there are two or more similar development projects running in parallel in other parts of the business unit. Another strong indication of substantial
financial loss can be found at assembly and erection of the wind turbines. Customer implementation of wind turbines has a set date. Yet, project development activities often exceed this date, and therefore, on-site construction and erection are initiated while product parts are still under development: ‘… we could not finish programming before erection of the wind turbines had started on site. In the end, not one of the wind turbines had the same electronics, because we had continued working on it. It required a lot of rework from the maintenance department’ (Project employee A). The pre-set end dates on projects have a negative effect on project management: ‘The deadline cannot be changed because of [the other business unit red.]. They have a delivery date to the customer, and they pull all orders through the value chain. In [Alfa red.] we do not push deadlines, but it puts a pressure on people’ (Project manager F). Hence, there are strong indications that current challenges decrease product quality, increase development cost, and decrease employee performance.

4.5. Analysis and discussion of challenges

The results of the interviews form a picture of a product development organization in crisis. At all organizational levels, employees express concern about project management and performance. To analyze the relation between the identified challenges, a problem matrix is used. The matrix is built upon the three challenge areas: projects, project governance, and human resources. The challenges are sorted as internal, imprinted, or forwarded problems within each of the three areas. The relations between the challenges are shown as arrows. This way, the relations between challenges can be identified along with the internal root challenges within each of the three areas. The process of developing the problem matrix relations has been iterative both during and after the interview study. The final relations have been discussed both internally and externally with fellow researchers. The model shows the most dominant relation between challenges and does not comprise interdependencies. For instance, we find that low motivation is caused by low efficiency in the projects, however it can be argued that these factors are interdependent, and a negative relation between the two creates a downward spiral of decreasing motivation and decreasing project efficiency. However, for the sake of simplicity, we have chosen that arrows in the chart only point in the dominating direction identified through the interviews. The problem matrix is presented in a simple form in Fig. 3.

Fig. 3. Problem matrix analysis of relation between identified challenges.

Through the problem matrix analysis, four root challenges creating or increasing other challenges are identified:

- Lack of resource management.
- Lack of knowledge management in project governance.
- Lack of fitting project model in projects.
- Lack of education and training of human resources.

It was debated whether portfolio management is internal or imprinted. However, since line managers argue that they need input from projects in order to develop the portfolio, the inadequate project model is viewed as the root cause of this challenge, keeping in mind that a sufficient project model alone will only enable but not generate portfolio management. Through the problem matrix analysis, we have answered our first research question, Q1, identifying the challenges in integrated product development in a technology intensive industry using the holistic framework and understood the challenges’ complex relations and sorted them accordingly.

In Section 4.2 we will return to these challenges, as they are the key to implement a solution to improve IPD in Alfa, which is investigated to answer Q2. Firstly, the actual implementation project is presented which was conducted in Alfa to solve the identified IPD challenges.

4.6. Company solution

After the interview study, a committee in Alfa assessed the challenges and implemented a solution to increase project performance during a six-month period of time. The committee generally pointed at similar challenge areas as the ones identified through our interview study. Especially, challenges related to the use of the project model were deemed of major importance by the committee. They found that the necessary initiative to improve project performance would be to support project managers with a modified sequential project management model to fit their product development setup. Debates during the meetings were
heavy and consensus was hard to obtain by the committee manager, since opinions of viable solutions spanned from ideas of implementing a project management office, time management across the entire organization, agile project management, to adopting a project model from another business unit. The committee initially agreed to examine all proposals. Eventually, however, several of the ideas were abandoned, primarily due to lack of follow-up on the ideas from the assigned senior project managers, who gave lower priority to this project than to some of the product development projects. Furthermore, the committee manager initiated each meeting with the same slideshow of the manager’s personal ideas of a project management solution (see Fig. 4), which was described as a PRINCE2 solution that had been implemented in a candy factory by the manager in his prior position a few years ago. During some of the final meetings, this solution was dominating and was accepted at an executive board meeting. With this solution, the committee chose to support project managers by offering a project management toolbox at the intranet site. Tools for portfolio management were included as one of the elements additional to the project management toolbox. An overview of the committee’s solution is presented in Fig. 4.

The committee spent six months on refining and developing a detailed sequential project management model and implementing it as an IT-tool on their intranet site. The model was, like their current model, based on PRINCE2 but more detailed, fitting product development stages and gates in their business unit rather than the generative model provided by the headquarters in Alfa. The committee generally expressed confidence in this new model.

Resource management challenges were addressed by presenting possible IT portfolio management tools to the executive board. The executive board did not make any final decisions on how to solve these challenges in the duration of the case study. Unclear roles and responsibilities were acknowledged as a challenge, and the committee solution to change company culture was to implement a tool for assigning roles and responsibilities in the intranet toolbox for project managers. No initiatives directed at targeting cultural change were initiated.

The final part of the case study was a revisit by the researchers and an evaluation of the implementation efforts. Meanwhile, the market share, which Alfa held internationally, had declined. During the past six months they had stopped all hiring at a global scale and future firing rounds were probable. At the revisit, project managers expressed a high degree of frustration towards the solution that had been adopted, since they did not experience any improvement in their work. The new project model had been developed and coordinated with the other business units. Project managers had been instructed in the new project model and started using it. Yet, time schedules and project handovers were still not followed, and project efficiency continued to be low due to lack of both resource management and knowledge management within the basis organization and the other business units. The intranet toolbox for project managers was viewed as a nice yet unnecessary feature, and only few had visited the site and used any of the tools in practice. Project managers had already called for top management to assess the situation once more. Now, project managers expressed a joint concern about the situation as well as the future of the company.

5. Requirements for implementation

Even though Alfa made an effort to solve their challenges during an entire year, including the evaluation and implementation of a new project model, the challenges endured. In this section, we aim at clarifying why the company continues to struggle with poor project performance by comparing the initiatives at Alfa with the IPD characteristics presented in the IPD framework in Fig. 1. Based on this, a set of requirements for IPD implementation is proposed.

The solution implemented by Alfa was based on PRINCE2, which is a traditional project management standard, including pre-definition of time periods and resource consumption in a
business case specification, and requires a dedicated project team (Office of Government Commerce, 2002). The sequential stage-gate method in PRINCE2 is optimized for project management involving simple projects (Snowden and Boone, 2007; Stabell and Fjeldstad, 1998). The misfit between the applied project management standard and IPD characteristics provides an explanation for the lack of improvement experienced by project managers. Using traditional project management methods for IPD has proven to decrease project performance in similar cases, and improving IPD performance by implementing a traditional project model can be predicted to fail (Browning and Ramasesh, 2007). In other words, the company rightly identifies that their project management maturity is low. However, they chose to improve their traditional project management tools, which do not fit their need for IPD methods. The core of the IPD approach is a complex problem solving process, and the key to managing this process is to understand that management of complex problem solving is different from managing simple processes (Browning and Ramasesh, 2007; Gerwin and Barrowman, 2002; Stabell and Fjeldstad, 1998). The implemented solution should have enabled IPD, including parallelness and iteration of activities, while supporting process integration across departments and business units.

The question “why a market leading company with years of experience in product development of highly complex products failed to implement an IPD solution?” then remains. What prerequisites and elements were missing? Through the analysis of existing personnel skills, we found that the committee members responsible for the solution proposal were all certified in PRINCE2. During the committee meetings they discussed previous successes with implementing PRINCE2 in other companies, and they, especially the committee manager, wanted to apply these experiences in the current setting. Hence, based on their education and previous experience, they did indeed implement the best solution available. They did not realize that complex problem solving of IPD differs from simple product development in their previous companies, where product development was based on a set of simpler characteristics. Furthermore, PRINCE2 basically advocates for a process-based tool approach, which is exactly what the committee solution entailed. Given the knowledge of the tool-oriented perspective versus the temporary organization perspective, this case indicates that the committee members have taken on a tool-oriented approach. Hence, their solution does not embrace the complexity of the temporary organization and its many facets, which are included in the holistic IPD framework. Without the awareness and skills for IPD, it is not possible to implement the appropriate governance structures and project management methods, and without this, project managers spend their resources battling the restraining structures. Therefore, our answer to why implementation of IPD failed in Alfa is the implementation of a wrong solution due to a combination of lack of IPD skills and awareness of projects as temporary organizations.

The issues related to resource management were not properly addressed through the solution, and these issues continued to inhibit project management practice afterwards. The researchers found that cross-organizational resource management is a prerequisite within project governance for IPD implementation, since limited, shared resources are a constraint for IPD projects. In IPD research, a dedicated team is typically either an initial prerequisite (Gerwin and Barrowman, 2002) or a proposed solution including organizational changes to include a dedicated team (Duhovnik et al., 2009; Sandmeier, 2008). When a dedicated team is not available, which is the case in many industrial companies (Haque, 2003), cross-organizational resource management is an essential project governance mechanism.

After implementation of the solution in Alfa, project managers still experienced challenges related to knowledge sharing across projects and business units. Knowledge management is essential in IPD due to the interdependent activities, including continuous learning and improvement of project procedures. Since activities span across both departments and business units, knowledge management in IPD is necessary throughout the entire organization in order to avoid redundancy, while managing design oscillations, and engineering change orders (Wright, 1997).

Hence, the main requirements for IPD implementation are found within project governance, including portfolio management, cross-organizational resource management, and cross-organizational knowledge management. In our originally proposed IPD framework, resource management is viewed as part of the portfolio management. Yet, due to the need to coordinate and prioritize activities together with the basis organization, resource management is required at the cross-organizational level, and it therefore entails more than the project portfolio. During the analysis, portfolio management challenges were identified as related to missing project structure and overview within the projects. However, the portfolio management challenges were enhanced rather than generated by this challenge. Furthermore, the inherent governance mechanisms, including strategy development, performance management, and prioritizing up front are not dependent on project structure, and could therefore be viewed as governance structures themselves. Hence, portfolio management is identified as one of the three central project governance requirements for successful IPD implementation. Based on the empirical findings, we propose a requirements framework for implementation of IPD, which is presented in Fig. 5.

Obtaining IPD skills can be accomplished through cross-organizational education and training and/or hiring skilled human resources. Knowledge of IPD is related to IPD performance (Knudsen, 2007), which can be influenced by training and education (Edum-Fotwe and McCaffer, 2000). An IPD training program should support the IPD characteristics, including the learning activities across the project organization. Furthermore, the training program should include a shared IPD project management model and portfolio management method (Killen et al., 2008). Skills and awareness of IPD are requirements for development of an appropriate governance structure, which is necessary for IPD implementation and increased product development performance.

Through the IPD requirements framework, we have covered the central findings of the case study and answered our second research question identifying the requirements for implementation of IPD. However, the framework has yet to be tested for generalizability and context dependencies. We recommend that
deeper research into the requirements for IPD implementation in practice should be undertaken across more industries. Especially, we propose to examine the generalizability of the identified relation between project governance requirements and IPD implementation through larger quantitative studies. Additionally, we recommend further qualitative research on coordination between IPD projects, the basis organization, and across business units. Case studies of successful IPD implementation already exist (Duhovnik et al., 2009; Kumar and Wellbrock, 2009; Wang et al., 2009), yet current research tends to focus solely on the implemented IPD solution and performance improvement. Only few articles include research on iterative IPD models in industrial settings (Duhovnik et al., 2009; Ovesen, 2012; Sandmeier, 2008). Further investigation of the application of iterative project models in IPD is also recommended. This is also proposed for general project management in related recent literature (Pinto, 2013). This includes studies on the effect of iterative models on IPD performance, and studies on how companies implement and use such models in practice.

6. Conclusion

Traditional project management methods, including linear process models, are still used by many industrial manufacturers even though this is identified as a main cause of low PD performance and market failure. An alternative to this approach is provided in the well-established research area of IPD, offering solutions to increase performance by a holistic mindset, viewing product development project management as management challenge of a temporary organization rather than having a tool perspective. The aims of this case study were to identify the challenges in product development in the technology intensive industry from a holistic viewpoint, and to identify the requirements for integrated product development implementation. We used a single in-depth case study as the method, and followed the improvement of product development project management at a now former European market leader within the international wind turbine industry during one year. First, we identified their existing PD challenges, which were afterwards sorted and grouped using a problem matrix analysis. Four root challenges were identified: lack of resource management, lack of knowledge management in project governance, lack of fitting project model in projects, and lack of education and training of human resources.

The company chose to implement a solution based on a traditional project management standard, which did not give the expected improvements in project performance. Our analysis of the implementation showed that the involved senior project managers did not have sufficient awareness, the necessary skills, or a set of project governance structures for implementation of IPD. Based on the case study findings we propose a set of IPD requirements that includes skills and awareness of IPD, and three IPD governance elements (portfolio management, cross-organizational resource management, and cross-organizational knowledge management).

Our findings resonate with existing research on IPD. A general lack of PD governance is also identified in three other case studies by Haque (2003), including the challenges in applying linear process models, which is also supported by IPD research studies (Browning and Ramasesh, 2007; Minderhoud and Fraser, 2005). Regarding the proposed IPD framework, all three recommended IPD governance requirements are identified through independent research as significant requirements for IPD. Portfolio management is highlighted as crucial for inter-functional integration in three case studies by Perks (2007) and for managing project uncertainties by Petit (2011). Cross-organizational resource management has been recognized as an important element in project portfolio management, increasing alignment between projects, and alignment to the business strategy (Killen et al., 2008). Finally, cross-organizational knowledge management is established as a requirement for complex product development in networks by Lee et al. (2008) and (Knudsen, 2007). Hence, our findings are in line with similar findings in other studies, yet our findings are unique in proposing a joint IPD requirements framework.

Since our findings are based on a single case study, we will not attempt to generalize them. Rather, our findings can serve as a basis for future studies on integrated product development, testing the results for generalizability, for instance, across different types of organizations and industries. The results have implications for senior managers that can use the findings to reconsider the skills and awareness of employees, along with required governance mechanisms, in their own organizations prior to launching any large PD performance improvement project.

The case company is now approaching the edge of collapse. Several rounds of layoffs have devastated the company, and they are still unsuccessfully trying to solve their product development challenges. The few project managers promoting integrated product development have left the company, seeking career opportunities elsewhere. Recently, the company has set up a global taskforce to evaluate product development across the entire company and to investigate options for a more integrated project management approach including a company-wide governance structure.
References


