



INTEGRATION IN PROJECT BUSINESS

Mechanisms for integrating
customers and the project network
during the life-cycle of industrial projects

Johanna Liinamaa

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*“Some ships sail East, and some sail West,
In the selfsame winds they blow;
’Tis the set of the sails, and not the gales,
That takes them where they go.”*

~Ella Wheeler Wilcox

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Turku, June 2012

Johanna Liinamaa

ABSTRACT

This thesis focuses on integration in project business, i.e. how project-based companies organize their product and process structures when they deliver industrial solutions to their customers. The customers that invest in these solutions run their businesses in different geographical, political and economical environments, which should be acknowledged by the supplier when providing solutions comprising of larger and more complex scopes than previously supplied to these customers. This means that the suppliers are increasing their supply range by taking over some of the activities in the value chain that have traditionally been handled by the customer. In order to be able to provide the functioning solutions, including more engineering hours, technical equipment and a wider project network, a change is needed in the mindset in order to be able to carry out and take the required responsibility that these new approaches bring. For the supplier it is important to be able to integrate technical products, systems and services, but the supplier also needs to have the capabilities to integrate the cross-functional organizations and departments in the project network, the knowledge and information between and within these organizations and departments, along with inputs from the customer into the product and process structures during the life-cycle of the project under development. Hence, the main objective of this thesis is to explore the challenges of integration that industrial projects meet, and based on that, to suggest a concept of how to manage integration in project business by making use of integration mechanisms. Integration is considered the essential process for accomplishing an industrial project, whereas the accomplishment of the industrial project is considered to be the result of the integration.

The thesis consists of an extended summary and four papers, that are based on three studies in which integration mechanisms for value creation in industrial project networks and the management of integration in project business have been explored. The research is based on an inductive approach where in particular the design, commissioning and operations functions of industrial projects have been studied, addressing entire project life-cycles. The studies have been conducted in the shipbuilding and power generation industries where the scopes of supply consist of stand-alone equipment, equipment and engineering, and turnkey solutions. These industrial solutions include demanding efforts in engineering and organization.

Addressing the calls for more studies on the evolving value chains of integrated solutions, mechanisms for inter- and intra-organizational integration and subsequent value creation in project networks have been explored. The research results in thirteen integration mechanisms and a typology for integration is proposed. Managing integration consists of integrating the project network (the supplier and the sub-suppliers) and the customer (the customer's business purpose, operations environment and the end-user) into the project by making use of integration mechanisms. The findings bring new insight into research on industrial project business by proposing integration of technology and engineering related elements with elements related to customer oriented business performance in contemporary project environments. Thirteen mechanisms for combining products and the processes needed to deliver projects are described and categorized according to the impact that they have on the management of knowledge and information. These mechanisms directly relate to the performance of the supplier, and consequently to the functioning of the solution that the project provides. This thesis offers ways to promote integration of knowledge and information during the life-cycle of industrial projects, enhancing the development towards innovative solutions in project business.

Keywords: project business; project management; systems integration; integration mechanisms; industrial projects; integrated solutions; life-cycle

REFERAT

Denna avhandling handlar om integration i projektverksamhet, d.v.s. hur projektbaserade företag organiserar sina produkt- och processtrukturer då de levererar industriella lösningar till sina kunder. Kunderna som investerar i dessa lösningar utövar sina verksamheter i olika geografiska, politiska och ekonomiska miljöer, vilket bör beaktas av leverantören då leverantören levererar livscykellösningar med allt större omfattning och mera komplexitet till dessa kunder. Det betyder att leverantörerna utökar sitt utbud genom att ta över delar av värdekedjan som traditionellt har hanterats av kunden. För att kunna leverera de fungerade lösningarna som inkluderar flera arbetstimmar, mera teknisk utrustning och ett allt mera omfattande projektnätverk, krävs en förändring i tänkesättet för att kunna utföra och ta det ansvar som dessa nya tillvägagångssätt medför. För leverantören är det viktigt att kunna integrera tekniska produkter, system och tjänster, men leverantören måste också ha förmåga att integrera tvärfunktionella organisationer och avdelningar i projektnätverket, kunskap och information mellan och inom dessa organisationer och avdelningar, tillsammans med input från kunden till produkt- och processtrukturer och värdekedjan i projektet under utveckling. Mot denna bakgrund är syftet med avhandlingen att undersöka utmaningarna för integration som industriella projekt möter, och att baserat på det föreslå ett koncept för hur man hanterar integration i projektverksamhet genom att använda integrationsmekanismer. Med integration avses den grundläggande processen för att utföra ett industriellt projekt, medan utförandet av det industriella projektet avser resultatet av integrationen.

Avhandlingen består av en sammanfattning och fyra publikationer, som baserar sig på tre studier i vilka integrationsmekanismer för värdeskapande i industriella projektnätverk och hanteringen av integration i projektverksamhet har undersökts. Forskningen är baserad på ett induktivt tillvägagångssätt där särskilt design-, kommissions- och operationsfunktionerna i industriella projekt har studerats beaktande hela projektlivscyklar. Studierna är gjorda inom marin- och energiindustrin där projektleveranserna består

av fristående produkter, produkter och teknik samt nyckelfärdiga lösningar. Dessa industriella lösningar vilka levereras som projekt innehåller omfattande insatser av teknik och organisation.

Genom att tillskriva påpekanden om mera studier om framträdande värdekedjor för integrerade lösningar, har mekanismer för värdeskapande mellan och inom organisationer i projektnätverk undersökts. Som forskningsresultat föreslås tretton integrationsmekanismer och en typologi för integration. Hanterandet av integration består av att integrera projektnätverket (leverantören och underleverantörerna) och kunden (den affärsverksamhet och miljö kunden är verksam i, samt slutanvändaren) in i projektet genom att tillämpa integrationsmekanismer. Avhandlingen bidrar med en ökad förståelse för industriell projektverksamhet genom att föreslå integration av element som relaterar till teknik och ingenjörsvetenskaper med element som relaterar till kundbetonande affärsprestationer i aktuella projektmiljöer. Tretton mekanismer för att kombinera de produkter och processer som behövs för att leverera projekt beskrivs och kategoriseras enligt det inflytande de har på kunskaps- och informationshanteringen. Dessa mekanismer relaterar direkt till leverantörens prestationsförmåga och följaktligen till fungerandet av den lösning som projektet levererar. Denna avhandling bidrar med ett förslag till att främja integration av kunskap och information i industriella projekt, vilket stärker utvecklingen i riktning mot innovativa lösningar inom projektverksamhet.

Nyckelord: projektverksamhet; projektstyrning; systemintegration; integrationsmekanismer; industriella projekt; integrerade lösningar; livscykel

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LIST OF PUBLICATIONS

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I. Liinamaa, J. (2008). Feedback control as a means for integration in industrial projects: industrial design and the human dimension, In: Minina, V., Wikström, K., Gustafsson, M. and Kosheleva, S. (Eds.) *New Challenges to Managing Organisations in Project Business*, St. Petersburg State University Graduate School of Management, St. Petersburg, pp. 186-205.
- II. Kirsilä, J., Hellström, M. and Wikström, K. (2007). Perspectives on integration in projects: a study of the commissioning process in industrial deliveries, *International Journal of Project Management*, Vol. 25, No. 7, pp. 714-721.
- III. Liinamaa, J. and Gustafsson, M. (2010). Integrating the customer as part of systems integration, *International Journal of Managing Projects in Business*, Vol. 3, No. 2, pp. 197-215.
- IV. Liinamaa, J. and Wikström, K. (2009). Integration in project business: mechanisms for knowledge integration, *International Journal of Knowledge Management Studies*, Vol. 3, No. 3/4, pp. 331-350.

The following paper functions as a pre-study for the thesis:

Kirsilä, J. and Hellström, M. (2006). Modularization as a means for integration in large scale capital projects, In: Blecker, T., Friedrich, G., Hvam, L. and Edwards, K. (Eds.) *Customer Interaction and Customer Integration*, GITO mbH, Germany, pp. 273-295.

CONTRIBUTION OF THE AUTHOR

The author is responsible for all the papers I-IV, in which the presented conclusions have been elaborated on and developed together with the co-author(s). The author has participated in the empirical work and in the analysis of the data, according to the following:

Paper I: The empirical work and the analysis were carried out with help of M.Sc. Päivi Haikkola, M.Sc. Thomas Westerholm and Professor Kim Wikström.

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Paper IV: For empirical work, see papers I-III.

In the paper functioning as a pre-study for this thesis, the DSM-studies were carried out by Dr. Magnus Hellström as part of his doctoral thesis.

ABBREVIATIONS

BA	British Airways
BAA	British Airport Authority
CAD	Computer-Aided Design
DSM	Design Structure Matrix
2D/3D	Two-/three-dimensional
EPC	Engineering Procurement Construction
HVAC	Heating Ventilation and Air Condition
INCOSE	International Council of Systems Engineering
IPMA	International Project Management Association
JIT	Just In Time production strategy
MERIKE	A national development program for the Finnish marine industry
PBI	PBI Research Institute
PMI	Project Management Institute
R&D	Research and Development
T5	London Heathrow Terminal 5
TEKES	Finnish National Technology Agency

I

PART I
EXTENDED
SUMMARY

1

CHAPTER 1 INTRODUCTION

In March 2008, London Heathrow Terminal 5 opened for passenger use. The \$8.5B brown-field infrastructure project – with a construction phase of 5.5 years, 16 main projects and 147 sub-projects, and despite having only one main entrance for transporting, at its peak, 8000 workers a day and nearly 250 deliveries of materials per hour – was delivered on time, on budget and with an exemplary safety record. However, the project encountered problems when it was handed over for operation. The terminal did not achieve full operation until 12 days after opening due to different issues, e.g. the baggage handling system did not function as planned. These problems resulted in the cancellation of 501 flights and cost the project user several tens of millions of dollars.

This project was successful regarding time and cost, which was considered an exceptionally rare event and a historic project case from a project management perspective. Why was it then so that a project that was executed exceptionally well prior to handing over and becoming operational, was not able to deliver a functioning and fully operating terminal, which was the expected outcome, of a project that was on time and on budget?

1.1 BACKGROUND

This thesis focuses on integration in project business. Integration in project business (Artto and Wikström, 2005) is examined through how industrial project-based companies organize their knowledge base when they provide various types of customized, high-capital, and engineering intensive solutions to their customers. To ensure functioning and high performing solutions for their customers to invest in, the project-based companies need to properly understand the end-use of the solution they provide. In other words, the project-based suppliers have to understand their customer's specific business needs including awareness of market development and the need for technical maintenance and upgrading activities. The relevance of

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achieving integration for the suppliers can be seen in the evolution of the value chain that these companies are part of when they are providing solution offerings with a life-cycle approach. For example, this approach means offering the 'best power supply' instead of the best engine, 'people flow in buildings' instead of elevators, and concepts for 'lifting businesses' instead of lifting equipment.

In the offers exemplified above, the aims are to provide solutions for an operation over an extensive time, often counted in decades, as the solutions aim to be in operation and to bring profit to the customer for many years. For the supplier a life-cycle approach including service providing implies "earning a growing portion of revenues by selling services that provide continuous streams of revenue, tend to have higher margins and require fewer assets than product manufacturing" (Davies, 2004 p. 731). As Davies (2004) further notes, for instance, Rolls-Royce sells 'power-by-the-hour' services by providing airlines with fixed engine maintenance costs over a certain time. Primarily, this value chain evolution refers to a new type of supplier perspective, in which the supplying company's vision and offering accomplish the relevance of its integration efforts. This in turn constitutes building new capabilities for providing value to customers and for establishing long term relationships with certain customers in the form of different business transactions when the solution is in operation. Examples of such business transactions are agreements for maintenance and upgrades, made with the purpose of extending performance and productivity, i.e. a profitable life-time of a solution.

Closely associated with integration, a growing number of theoretical and empirical bodies of literature argue for the importance of the project-based suppliers to accomplish more efficient processes during their project life-cycles in order to increase the profitability of their projects (Davies and Hobday, 2005). This is one of the aims that can be achieved by integration in project business, i.e. the process of joining together elements in the most optimal way to provide the most optimal value proposition (solution) to the customer. Faster innovation, product development, and design processes in the beginning of a project, and more cost effective manufacturing and installation cycles later in the project, are required for achieving projects in a shorter time. These processes and cycles refer to vertical and horizontal integration efforts that take place in the value

chain. The requirements, set by customers for the functioning and performance of the solutions are generally increasing, while costs and delivery times are required to decrease. Differentiation of tasks and resources in the beginning of a project, followed by integration of relocated tasks and resources later in the project are vital for meeting the above requirements. Differentiation and integration constitute the essential capabilities and mechanisms to carry out and manage projects according to the general management literature (Miles and Snow, 1992; Ghosal and Nohria, 1989; Martinez and Jarillo, 1989; Galbraith and Kazanjian, 1986; Abernathy and Clark, 1985; Mintzberg, 1983a; Child, 1977; Katz and Kahn, 1967; Simon, 1946). Moreover, integration and coordination have, for a long time, already been core matters according to researchers in the field of organization theory in various contexts. This includes such scholars such as Santos and Eisenhardt (2005), Carlisle and Dean (1999), Bonaccorsi et al. (1996), Cyert and March (1992), Martinez and Jarillo (1989), Mintzberg (1979), Galbraith (1977; 1973), Lawrence and Lorsch (1967/1986) and Thompson (1967/2008).

Within different disciplines such as engineering (e.g. INCOSE, 2004; Miller and Lessard, 2000; McCord and Eppinger, 1993), general management (Galbraith, 2002a; Thompson 1967/2008), operations management (Turkulainen, 2008), logistics (Christopher, 1998) and information technology (Laukkanen, 2007; Alvarado and Kotzab, 2001; Iansiti, 1998) integration varies as to its roles and meanings. In project business many of these disciplines are combined (Prencipe et al., 2003). However, it is important to note that integration should not be forced to take place in situations where it is not an efficient approach. As Cacciatori and Jacobides (2005 p. 1874) point out, the potential superiority of integration over specialization depends on the balance between capabilities and the demands enforced by the market. They contrast Christensen et al. (2002) who regard the superiority of integration. Cacciatori and Jacobides (2005) state that capabilities which are determined by scope affect industry transformation regarding shift in arising specialization, vertical integration, dis-integration and re-integration. The supplier capabilities and market demands mentioned above are in a prominent place in the transforming industries where solutions are provided.

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Industrial project business is one of the largest business sectors in the world (Acha et al., 2004; Skaates and Tikkanen, 2003; Miller and Lessard, 2000; Hadjikhani, 1996). Industrial projects tend to be large-scale and long-term artifacts with investments taking place in waves (Miller and Lessard, 2000). Projects have been carried out for centuries – the creation of the pyramids, the building of ancient cities, the labor behind the Great Wall of China (Morris, 1994), and the military projects during the last centuries and decades. Furthermore, also the more recent projects in various industrial contexts have established and formed the methodology for the classical project management principles that are known and implemented in industrial project business – focus on time, cost, quality, and use of resources. An overview of the project, matrix management, project organization, life-cycle management, project planning, project implementation, project control, behavioral dimensions and teamwork as well as the successful application of project management are referred to by Cleland and King (1988 p. V) as the “pivotal factors and forces surrounding project management”.

Moreover, in industrial project business there is a growing trend towards customer orientation, i.e. maintaining unique and detailed knowledge about specific customers’ performance and their business models¹ in order to offer the most suitable solution for their business needs (Wikström et al., 2010). For the project-based supplier this implies developing integration capabilities, as a factor for building competitive advantage through providing solutions (Davies et al., 2007; Whitley, 2006; Santos and Eisenhardt, 2005; Galbraith, 2002a; 2002b; Hobday, 2000; 1998; Hobday et al., 2000; Lawrence and Lorsch, 2000; McCord and Eppinger, 1993; Cyert and March, 1992). The “pivotal factors and forces surrounding project management”, combined with the evolving value chains and customer oriented business are central themes in this thesis. The themes above constitute and provide important elements for integration within the networks of project-based companies providing solutions for their customers. The themes represent both internal and external integration in organizations (c.f. Barki and Pinsonneault, 2005; Pagell, 2004).

As described above, in projects providing industrial solutions there are a high number of different technologies, components, systems,

¹ According to Shafer et al. (2005 p. 202) a business model is “a representation of a firm’s underlying core logic and strategic choices for creating and capturing value within a value network”.

processes and actors (and interfaces between them) present that should be equally addressed and coordinated. Therefore, industrial projects are a relevant context for research about integration in project business. These projects can be described in terms of high complexity and uncertainty, in association with the uniqueness of the solutions in which they result. According to Williams (2005) the complexity in projects is represented by structural complexity, referring to the size, the number of elements and the interdependence between the elements in the project. The uncertainty of achieving the project goals and the means to achieve those goals is another closely related central condition of these projects, as proposed by Williams (2005).

In line with what has been said above, complexity and uncertainty tend to be encountered throughout the project life-cycles: during pre-project activities, during project execution and post-project phases (when the project has already been handed over to the customer). It is when the operations start that the solution's technical quality and functioning i.e. the supplier's integration efforts are finally comprehensively tested and evaluated by the customer. When the operation commences that is the time when the solution can be considered to be either a success or failure. The functioning of the solution directly relate to the change in the vision of the supplier regarding its offerings, such as the examples of delivering the best power supply, people flow and lifting businesses, which were mentioned before. Based on this thought, suppliers strive to deliver to their customers the most optimal solutions, which presumably should be more than the customers dare to expect in terms of function. This is possible, if the supplier has profound knowledge and expertise regarding the customer's business purposes, end-use, development needs, and the future challenges that the solution should meet.

Given the discussion above about integration in general management literature, organization theory, and also within various disciplines (engineering, operations management, logistics, information technology), achieving integration seems to be an eminent feature of the industrial project-based solution providers.

1.2 RESEARCH CONTEXT

1.2.1 Integrated solutions

Following on from the importance of considering the project life-cycle as being integrated, and instead of examining the different phases and functions of a project separately or as stand-alone project phases and functions, an increased pressure can be recognized on the project suppliers' integration capabilities in terms of their customers' high expectations of receiving functioning solutions. This can be seen in the fact that at the same time as the performance oriented suppliers are increasing the scope of their supplies, they are also expected, by their customers, to increasingly provide high-quality solutions to solve specific problems. These solutions are also known as integrated solutions, which consist of combinations of products and services (Davies et al., 2001; Hobday, 2000; Frambach et al., 1997). This directly relates to the trend in which suppliers within the capital goods sector have been asked to take over some of their sub-suppliers' and/or customers' key capabilities in order to provide high-valued integrated solutions (Windahl, 2007; Galbraith, 2002b; Day and Wensley, 1988). In other words, suppliers create high-value customer specific solutions by integrating various products, systems, services, and sometimes even value chains, in order to solve a problem for their customer and thus to provide increased customer value (Miller et al., 2002; Foote et al., 2001). When a supplier takes over some of the ongoing operations of a customer (a part of the customer's value chain) to deliver a solution, value chain integration takes place.

As Windahl (2007) notes, developing and commercializing integrated solutions offerings is a challenging task for suppliers that have traditionally focused on selling products, spare parts and support services separately (see also Brown, 2000; Bowen et al., 1989). Furthermore, the pressure on the suppliers to create innovative solutions for their customers has lately risen significantly, indicating that suppliers are being asked to develop their knowledge base and integration capabilities rapidly. Indeed, and as Berggren et al. (2011 p. 4) note "knowledge integration is a vital part of the dynamics of the innovation process" in which well-established and newly generated knowledge bases need to be combined and integrated. Berggren et al. (2011 p. 7) further describe knowledge integration as "bringing together and combining all the different types of knowledge required for developing new products, systems, and solutions and generating the requisite complementary

knowledge”. Knowledge integration and innovative solutions are two important perspectives of the integration focus that this thesis takes.

As Magnusson et al. (2003 p. 2) exemplify, in environmental innovations, where the supplier aims at solutions with “superior environmental performance”, in which new technologies compete with existing technologies (e.g. replacement of fossil-fuel based energy supply with renewable energy) the supplier handles a large number of interface changes as well as intra-interface changes in a project (Brusoni and Prencipe, 2001a), due to different innovative approaches. These changes refer to the creation of new interactions and linkages between components/engineering disciplines in the so-called architectural² innovation and the focus and specialization regarding components and systems in the so-called modular³ innovation, which are later translated into design objectives. Magnusson et al. (2003 p. 22) argue that “environmental innovation almost inevitably will have to fight against established technological, organizational and social structures and that heavy restrictions are put on development projects”.

The integration exemplified above includes new ways for many suppliers to act. Davies et al. (2001), and Wise and Baumgartner (1999) point out that many suppliers have to change their focus and develop new capabilities (Flowers, 2007; Winter, 2003; Eisenhardt and Martin, 2000), to expand their definition of the value chain and re-consider their position in the value chain, in order to become leading solution providers. Furthermore, with regards to the development of the industry and innovative solutions (Gann and Salter, 2000; Henderson and Clark, 1990; Abernathy and Clark, 1985; Abernathy and Utterback, 1978), issues related to commitment and trust (Barnes, 1981) are also important to acknowledge when providing solutions. This is due to that trust and its relationship to forming expectations contribute significantly to the financial value a customer experiences during a solution project (Smyth et al., 2010).

To illustrate⁴ the role of integration in solution projects, in the following a case example reviews the construction of London Heathrow Terminal 5, in order to point out some of the attributes of integration in a large project. According to Davies et al. (2009) that this case review is based

- 2 *Architectural innovations mean the creation of new combinations (components and engineering disciplines).*
- 3 *Modular innovations mean that existing knowledge related to specific components is overturned by new core design concepts.*
- 4 *Siggelkow (2007) contends that for making a contribution cases can be employed for at least three uses: motivation (of a research question); inspiration (for new ideas) or as illustration (of concepts and causalities).*

on, megaprojects⁵ tend to have a poor performance record, despite their growth in number and thereby the opportunities which arise to benefit from a learning curve.

1.2.2 London Heathrow terminal 5⁶

The construction of London Heathrow Terminal 5 (T5), an infrastructure project, offers a perspective as to how a high number of components that are first differentiated, designed, and produced by many different contractors are later integrated into a functioning outcome with high performance (the solution). The T5 project was established in 1986 by the independent airport operator British Airport Authority (BAA) to design and build a new terminal for increasing the annual capacity at one of the world's busiest airports – Heathrow – from 67 million to 95 million passengers (within a budget of \$8.5B).

T5 is described as a 'system of systems', consisting of a cluster of different facilities, such as two large terminal buildings, an air traffic control tower, road and railway transportation links, an underground railway station, 13 kms of bored tunnels, an airfield infrastructure, a multi-storey car park with space for 4000 cars, and a hotel. The project life-cycle (Figure 1) that included four overlapping and concurrent phases required distinctive leadership and capabilities to manage the work process involving four main systems – buildings, rails and tunnels, infrastructure, and systems – which were divided into 16 major projects and 147 sub-projects. The supply chain included 80 first-tier, 500 second-tier, 2000 third-tier, 5000 fourth-tier, and 15000 fifth-tier suppliers. The planning phase included hundreds of planning activities, the design phase dealt with the changing requirements of customers and emergent events (such as natural disasters and tragedies like 9/11), and during the construction phase thousands of workers a day, at the site, and hundreds of deliveries of material per hour had to be transported through one single entrance to the site. Finally, the infrastructure also had to be integrated into existing operations at the airport.

5 According to Davies et al. (2009) a megaproject is an investment of \$1B or more to build the physical infrastructure that enable people, resources, and information to move within buildings and between locations throughout the world.

6 The case review is based on the following article: Davies et al. (2009). *Innovation in megaprojects: systems integration at London Heathrow Terminal 5*, *California Management Review*, Vol. 51, No. 2, pp. 101-125.

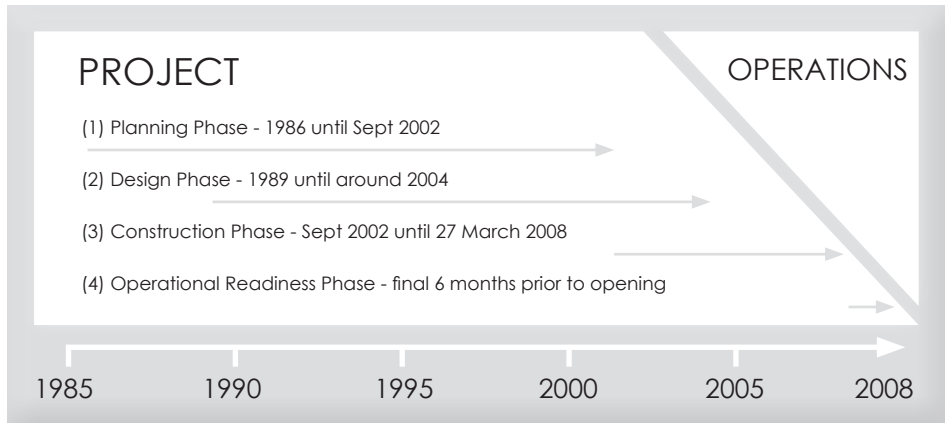


Figure 1. The T5 project life-cycle.⁷

Twenty-two years after start of the planning phase T5 opened on the 27th of March 2008 and experienced such difficulties that in the five first days the cost to the project user, British Airways (BA), was \$31m; the problems being within several areas⁸. For instance, due to problems within the baggage handling system 20000 bags were misplaced, which combined with the other problems lead to 501 flights being cancelled. Twelve days after opening the terminal achieved full operational capacity. Quoting Brady and Davies (2010 p. 151): “What should have been an occasion for celebration turned into a national disaster”. Although the T5 opening was troubled, the project has not been seen as a failure from the project management perspective. Instead, it is considered a successful and innovative project, a quite rare event from the project success angle, from which lessons of integration can be learned. The T5 project has been considered a transformational program, that established new ways of working in projects and that sought new approaches to solve present and future project challenges.

As this example illustrates, BAA managed to carry out a large project – including an extensive amount of horizontal and vertical integration of components, people and processes successfully as well as meeting the time and budget targets. The different project actors’ integration capabilities were challenged many times during this project as a major

⁷ Adopted from Davies et al. (2009).

⁸ Relating to e.g. staff facilities including parking areas not yet being ready, problems with signs, a number of passenger and staff lifts either not being fully commissioned or unserviceable for use, some of the baggage handling staff could not operate their new equipment or were unable to log on to the computer system, “jetties” transferring passengers on and off planes failed to perform as specified, causing delays etc. (Brady and Davies, 2010 p. 153-154).

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part of the sub-systems were manufactured off site by a large number of sub-suppliers (differentiated) and brought together for testing on the site (integrated). However, this project also dealt with issues that are typical for any large project, such as insufficient investment in the design phase and a call for better preparation and more effective joint working in the commissioning phase and in early operations.

The coordination of the supplier network, the logistics, coping with customer requirements and environmental regulations, and integration of the new infrastructure into existing operations are only a few examples of the many integration related issues the project had to overcome in order to meet the time, cost and quality targets of the project. One challenge, for example, was that during the project BAA decided on a new approach to deal with risk and responsibility. This was a cost-plus contract called the T5 agreement in which the customer pays the constructor the actual costs plus a profit margin, while BAA removed the risk from the supply chain and assumed full responsibility for the risk. Thus encouraging the project teams, within the different tiers, to collaborate and innovate, instead of seeking payments or legal disputes about the scope of the changes and other events. Moreover, an approach to project innovation in the production system have been identified: by recombining routine and repetitive processes, organizations can achieve more efficient project processes. The Chief Executive of BAA Sir John Egan⁹, played a significant role in the improvements in the project's productivity. He instructed BAA to adopt successful operational techniques (such as lean production and JIT) used in mass production industries and on other airport projects, into the T5 project for standardizing BAA's project deliveries. One of the important contributions that Egan made to the approach of building T5 was the recognition that every project is not unique and therefore predictable and replicable approaches to project design and delivery were needed. From this followed that for improving project performance standardized and repeatable tasks, milestones and stage-gates were developed and codified in the 'T5 Handbook'.

What are the lessons for integration from T5? Integration in a project relates to the fundamental notion that a project is an open system, in constant interaction with its environment, which should fulfill user requirements when finalized. From this case example,

⁹ *Former Chief Executive for Jaguar Cars (1980-90).*

one particular question relevant to integration research comes to light. This question is whether the encountered difficulties within different areas, e.g. problems with the baggage handling, indicate that in the T5 project the process of integrating was focused on too much, and that the actual focus of integration should have been on the providing of solutions, i.e. a functioning and fully operating terminal? In this thesis the focus is on integration mechanisms for ensuring a functioning solution.

1.3 RESEARCH PROBLEM AND OBJECTIVES

The aim of this thesis is to extend the knowledge concerning integration in project business by exploring the integration challenges that industrial project-based companies meet when they are providing integrated solutions to their customers. Based on this, a proposal is made as to how integration in project business can be achieved by making use of integration mechanisms. As described in the previous paragraphs, a growing trend in project business is the fact that customers have high expectations as regards the customized solutions they invest in and their functioning and performance levels, and thereby on the integration capabilities of their suppliers (see e.g. Davies and Hobday, 2005; Prencipe, 2003).

Therefore it is of crucial importance for most suppliers that there is knowledge about how to ensure that the solution that the customer has invested in – a product consisting of several components, a combination of several products into a large system or a system of systems, or a so-called integrated solution – can be integrated into the customer's operations environment and business model. As pointed out in paper III the qualities that exist in the customer's operations environment could be better met if the integration of customer specific requirements were already initiated by the supplier during the initial project activities. Moreover, the requirements need to be acknowledged by all the sub-suppliers in their scopes of supply throughout the project network, as pointed out in papers I and II. These notions relate to the traditional project set-up where many different project parties control the project to different degrees during different phases and functions.

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Based on studies of large-scale engineering projects, Berggren et al. (2001) have identified three problems in particular relating to integration (the problem of coordination, the problem of the absent customer, and the problem of organizational learning) as a result of fragmentation of the project environment both on the customer and supplier sides due to cost reductions. Third parties, such as management and technical consultants, are becoming central actors in these projects as, in the terms of Berggren et al. (2001 p. 39), “contractors outsource activities at the same time as clients trim their own organizations and reduce engineering staffs”. An example in the power industry is the independent power producers’ projects, from the customer side typically managed by consultants, who often unfortunately lack engineering and project management skills. On a project level, this fragmentation has consequences for project execution. According to Berggren et al. (2001) ‘the problem of coordination’ relates to a market-based approach to coordination, caused by involvement of third parties, involving heavy contracts and plans which lead to bureaucratization of communication and increased control costs. ‘The problem of the absent customer’ relates to end-customers and/or operators delegating responsibilities to third parties, thus suppliers lose opportunities to adapt the solution to real customer needs and unforeseen technical problems. ‘The problem of organizational learning’ relates to the suppliers outsourcing to third parties and the learning cycle becoming fragmented and crucial feedback loops being weakened, which again has implications for transferring lessons learned between projects. For the suppliers these three problems have major impact on integration, addressing the project life-cycle, communication, teamwork, feedback and the processes for organizational learning and knowledge creation that are vital for a successful project.

As pointed out in papers I, II and III, further examples of integrating knowledge bases during a project for any supplier and sub-supplier concerns knowledge about the quality and interaction of the different components within the scope of their own supply. In addition, knowledge about how the various components in different scope set-ups contribute to the total cost of the solution, i.e. the cost structure of the project is important. Despite the fact that suppliers seem to know that they should collaborate with the customer and work through the widespread and lateral networks ‘downstream’ towards the customer, they seem to perceive the integration of

technology and engineering related elements with the elements related to the customer's experience and knowledge as something difficult to accomplish (as pointed out in paper IV). Furthermore, it is not clear in existing research how the integration should be managed. Limitations that exist relate to for example (see e.g. Tell, 2011; Wikström et al., 2010; Martinsuo and Ahola, 2010; Artto and Kujala, 2008; Barki and Pinsonneault, 2005; Davies and Hobday, 2005; Hobday et al., 2005; Prencipe and Tell, 2001):

- The relationship between engineering and strategy in projects being vague and how to integrate them is not being clearly defined.
- The lack of empirical observations about integration mechanisms and how to manage integration in the project business.
- The lack of work on providing insights into integration mechanisms at different levels in a project context in order to provide functioning solutions.
- The lack of stress on the dependencies and interfaces between the project phases and functions during the life-cycle of industrial projects.
- Operations are not considered a part of the life-cycle in project business research.
- An insufficient amount of work providing insight into the integration of the customer into the project.

The descriptions above exemplify respectively some integration challenges in the literature, and the perceptions of project professionals in the studies¹⁰ conducted for this thesis.

One considerable issue seems to be that suppliers lack mechanisms for carrying out integration in a structured way for achieving high levels of integration (see e.g. Hobday et al., 2005; Barki and Pinsonneault, 2005). In other words, the fundamental part of how to integrate technology and engineering related elements is not clearly defined (e.g. Cook and Ferris, 2007; INCOSE, 2004; McCord and Eppinger, 1993). Nor is the stressing of technical performance and functioning made clear, along with elements related to customer oriented business performance that calls for a constant dialogue and exchange of information with the customer in the supply chain during

¹⁰ Papers I-IV, see also table 5.

business transactions (e.g. Payne et al., 2009; 2008; Vargo and Lusch, 2004). Bodies of literature where these elements are emphasized and interlinked in order to meet project targets are limited, although literature has presented the difficulties and integration challenges that suppliers face when they attempt to adjust their activities to bear the increased scope of their supply on the markets (Windahl, 2007; Hobday et al., 2005; Brax, 2005).

Over the years, several scholars have discussed that it is of importance to be able to carry out different mechanisms of coordination that are relevant in carrying out managerial and strategic efforts for fulfilling customer needs (see e.g. Barki and Pinsonneault, 2005; Grant, 1996a; Martinez and Jarillo, 1989). Drawing on the challenges identified for carrying out integration in real industrial project settings, as indicated by project professionals (Papers I-IV), together with the relatively limited literature touching on integration in project business, the objective of this thesis is to study how project-based companies manage the task of integration while ensuring functioning solutions for their customers. This will be explored by two fields of analysis:

1. The first field of analysis is integration mechanisms for value creation in industrial project networks (Papers I-III). One of the critical parts missing from the existing research agenda concerning project management seems to be how the suppliers carry out integration in the value chains during the different phases of industrial projects when providing various types of solutions to their customers. As Tell (2011) suggests, the knowledge concerning mechanisms for knowledge integration in relation to the organizational design of activities needs more focus. Moreover, the implications of integration in industrial projects are not clearly stated in project management literature, nor among the professionals.
2. The second field of analysis is how the integration process in project business is managed in the value chain (Paper IV). As industrial projects involve both division and bonding together of different technologies and systems and the cooperation between many companies (see e.g. Davies et al, 2009; Davies, 2004; Berggren et al., 2001; McCord and Eppinger, 1993), suppliers need to pay careful attention to the dependencies and interfaces between the different elements in the project networks. This includes both inter- and intra-organizational activities. In fact, these dependencies and interfaces between the different technologies, systems, and actors can be described

in terms of autonomous units which are mutually dependent on each others' performance, when providing solutions that are developed through multi-level networks.

More precisely, the two fields of analysis and specific research questions (RQs) that have been stated in papers I-IV, with an aim to extending the knowledge regarding integration in industrial projects are:

Field of analysis 1: Integration mechanisms for value creation in industrial project networks (Papers I-III)

- RQ1: How should systems providing feedback control be understood and implemented into the undertakings of industrial project organizations? (Paper I)
- RQ2: What are the character and implications for integration in delivery projects under new circumstances? (Paper II)
- RQ3: Do companies that acquire capabilities of integrating services with products in order to provide "solutions" for their customers, increase their competitiveness? If so, which are the critical capabilities they must develop? (Paper III)

Field of analysis 2: Management of the integration process in project business (Paper IV)

- RQ4: What are the characteristics and implications of the mechanisms in knowledge integration in industrial projects? (Paper IV)

These two fields of analysis have been developed to explore integration in project business (Papers I-IV). The industries and industry segments that have been studied are the shipbuilding industry (the segment of cruise ships) and the power generation industry (the segments of propulsion and machinery and power plants). The scopes of their supply consists of systems, systems and engineering, turnkey projects (EPC¹¹) and integrated solutions. Based on an inductive research approach, combining empirical observations and theoretical perspectives, integration has been addressed by how the suppliers organize their product and process structures, at different

¹¹ EPC = Engineering Procurement and Construction.

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levels in the project network during project life-cycles, when they are providing solutions to their customers on a project basis.

The present research has been part of the collaborative research enabled by the PBI Research Institute. PBI's methodological approach¹² can be described basically as an inductive approach. The research has been carried out in teams of several researchers and this applies not only to data collection, but also during analysis and reporting. PBI can be described as a tool or platform for real-time empirical research, providing means for data collection and analysis as well as theory and knowledge generation and testing by combining academic and consultancy perspectives on management research. The eight companies that are part of the design study and the case company in the commissioning and operations studies have partly guided this research. This guidance is considered a valuable characteristic, as it links the theoretical perspectives to relevant managerial situations in actual industrial contexts.

1.4 STRUCTURE OF THE THESIS

The thesis consists of two parts:

- I. Extended summary
- II. Papers

The extended summary (PART I) that includes five chapters: 1) introduction; 2) literature review; 3) research design and methodology; 4) results and discussion; 5) conclusions provides an overview of the thesis. The objective of the extended summary is to deepen the understanding of the conducted research by bringing together the definitions and concepts, approaches, and research results presented in papers I-IV. The aim of PART II is to present the one edited book chapter and the three journal articles, in the extended summary referred to as papers, which are included in their complete versions.

12 This paragraph follows Perminova (2011), Hellström (2005) and Wikström (2000).

2

CHAPTER 2 LITERATURE REVIEW

This chapter reviews perspectives in the literature relevant to this research. In the first section, the focus is on the concept of integration and on integration in organization studies and in projects, in particular. The second and third sections describe systems integration and integrated solutions. In the fourth section, the focus is on project business concentrating on projects and project-based companies, project-based business, evolving value chains, and modularity. The fifth section is a summary of the chapter. The aim of the literature review is to provide the theoretical background to the research by addressing different perspectives of integration and linkages to project business in terms of project-based suppliers and their business strategies.

2.1 INTEGRATION AS A CONCEPT

In its broadest sense, integration¹³ means to put something together. Two dictionaries, Webster's revised unabridged dictionary (1913) and The American heritage (2003) propose the following definition for the ordinary meaning of integration:

"Integration is the act or process of making something whole and entire."

Merriam-Webster (1984) defines integration as:

"[Integration] implies that the things (as parts, elements, factors, or details) combined are brought into such intimate connection with each other that a perfect whole results, and usually at the same time is suggested a complete fusion of coalescence of particulars with loss therefore of their separate identities."

The importance of considering the ordinary definitions of integration provided by dictionaries is that they give a basic, elementary meaning for the phenomenon. Integration is a widely used word in everyday life, and it is often referred to when discussing how e.g.

¹³ The word integration derives from the Latin word *integrates*.

various businesses, people, cultures, music or technologies should function together. Integration often also appears in e.g. mathematics, electronics, and programming. However, in different fields and within different contexts the process of integrating, *per se*, is often vaguely defined and exact definitions are hard to find. Therefore, integration can be considered a relatively broad activity to perform, consisting of many dimensions to take into account, while it at the same time is considered to be a straight-forward activity putting something together, which results in integration. Analogous words to integration found in dictionaries are for example to unite, combine, unify, consolidate, concentrate, coordinate, organize, and systematize. The terms integration and coordination are used interchangeably in this thesis.

2.1.1 Integration in organization studies

By adopting the rational open systems perspective to organizations (Scott, 2003) in project-based companies, this thesis views the supplier organization as embedded in a wider environment, whereas interaction with the environment is essential for the organization's functioning and survival. According to Galbraith (1977; 1973) the environment is characterized in terms of the amount of complexity and uncertainty it poses for the organization. Cf. Williams' (2005) description of structural complexity, which relates to scholars of systems design and information processing (e.g. Lawrence and Lorsch, 1967/1986; Burns and Stalker, 1961/2001; Dill, 1958). The environmental impact on organizations can therefore be considered a classical issue in organizational theory (Engwall, 2003). For instance Lawrence and Lorsch (1967/1986) propose that coalignment of an organization with its environment occurs on at least two levels as "the structural features of each organizational subunit should be suited to the specific environment to which it relates", and while "the differentiation and mode of integration characterizing the larger organization should be suited to the overall complexity in the environment in which the organization must operate" (Scott, 2003 p. 97).

Lawrence and Lorsch (1967/1986 p. 11) provide the following definition of integration in organizations, relating to the environment:

“The quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demands of the environment.”

In another work, Lawrence and Lorsch (1967a p. 4) define integration in slightly different words:

“The process of achieving unity of effort among the various subsystems in the accomplishment of the organization’s task.”

Lawrence and Lorsch indicate that integration cannot be achieved by a mechanical and entirely rational process (cf. managerial hierarchy) only. Interpersonal skills and their relationships are also necessary to acknowledge as they are closely connected to how effective the collaboration is (Ouchi, 1979).

Relating to scholars such as Lawrence and Lorsch (1967/1986; 1967b) and Ouchi (1979), among others, Martinez and Jarillo (1989) suggest that mechanisms of coordination¹⁴ in multinational companies can be grouped into three research streams. The two former streams (dating back to 1920-1950 and 1950-1980) focus on the more formal mechanisms for coordination whereas the latter stream (from 1980 onwards) takes a more informal approach. As Martinez and Jarillo (1989 p. 508) point out “an evolution from unidimensional to multidimensional perspectives on coordination can be observed”. This can at least partly be considered as a consequence of a deeper and more complex view of the company and organizational theory during the last decades. Eventually, Martinez and Jarillo (1989) divide the mechanisms for coordination in organizations into two groups following Barnard (1968): structural and formal mechanisms (Table 1) and other mechanisms, which are considered as less formal and more elusive (Table 2).

¹⁴ According to Martinez and Jarillo (1989 p. 490) a mechanism of coordination is “any administrative tool for achieving integration among different units within an organization”. The terms “mechanisms of coordination” and “mechanisms of integration” are used as synonyms by the scholars.

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Table 1. Structural and formal mechanisms of coordination in an organization¹⁵

<i>Mechanism</i>	<i>Example description</i>	<i>Example references</i>
Departmentalization or grouping of organizational units	Labor division, grouping of activities	Simon (1976)
Centralization or decentralization	Decision-making through the hierarchy of formal authority	Galbraith and Kazanjian (1986), Simon (1976), Galbraith (1973), Child (1972), Pugh et al. (1968), Lawrence and Lorsch (1967b)
Formalization and standardization	Establishment of policies, rules and manuals through standard practices and routines	Galbraith and Kazanjian (1986), Simon (1976), Galbraith (1973), Pugh et al. (1968), Lawrence and Lorsch (1967b), Thompson (1967), March and Simon (1958)
Planning	E.g. strategic planning, budgeting, scheduling intended to guide activities and actions of independent units	Galbraith and Kazanjian (1986), Galbraith (1973), Thompson (1967), March and Simon (1958)
Output and behavioral control	Evaluation of reports and data submitted by the organizational units	Mintzberg (1983b;1979), Ouchi (1977), Ouchi and Maguire (1975), Child (1973; 1972), Blau and Scott (1962)

Table 2. Less formal mechanisms of coordination in an organization¹⁶

<i>Mechanism</i>	<i>Example description</i>	<i>Example references</i>
Lateral or cross-departmental relations	Direct contact among managers of different departments that share a problem	Galbraith and Kazanjian (1986), Galbraith (1973), Lawrence and Lorsch (1967b)
Informal communication	Informal and personal contacts among managers across different units of the company	Kotter (1982), Simon (1976)
Socialization	Development of an organizational culture through a process of socialization of individuals by communicating to them the objectives and values of the company, the way of doing things, decision-making style etc.	Mintzberg (1983b), Pfeffer (1982), Galbraith and Edström (1976), Simon (1976), Selznick (1957/1984)

Accordingly, by drawing on Glouberman and Mintzberg (2001), Mintzberg (1979) and Thompson (1967/2008), Martinez and Jarillo (1989) point out that task complexity and task interdependence are two main factors on which each of the mechanisms' suitability for achieving organizational integration depends.

¹⁵ Based on Martinez and Jarillo (1989).

¹⁶ Based on Martinez and Jarillo (1989).

Related to interdependence, Thompson (1967/2008 p. 54), referring to Simon (1957), argue that “structure is a fundamental vehicle by which organizations achieve bounded rationality”. Understanding what structure is first requires understanding the interdependent elements that should be coordinated into structure in a complex organization. Hence, interdependence can, according to Thompson (1967/2008), be divided into three types (pooled, sequential and reciprocal), including different degrees of contingency.

The first in order, with respect to the lowest degree of contingency is referred to as ‘pooled interdependence’ (each part renders a discrete contribution to the whole and each is supported by the whole). The second in order, with a more advanced degree of contingency, is referred to as ‘sequential interdependence’ (direct interdependence can be found between the parts, in addition to the pooled aspect). The most advanced degree of contingency can be found in ‘reciprocal interdependence’ (the outputs of each part become input for the others), which is the third in order. All organizations have pooled interdependence, while more complicated organizations have sequential in addition to pooled interdependence. The most complex organizations have interdependencies of all three types. In the order above, the three types of interdependence are more difficult (and costly) to coordinate (Thompson 1967/2008). Coordination can, according to Thompson (1967/2008 p. 56) be divided into three types in order to achieve structure relating to the three types of interdependence. Routines and rules are appropriate for pooled interdependence (the set of rules should be internally consistent, which requires that the situations to which they apply should be relatively stable, repetitive, and limited). Plans are appropriate for sequential interdependence (do not require a high degree of stability and routines). Mutual adjustment and feedback are appropriate for reciprocal interdependence (transmission of information during the process of action, suitable in varying and unpredictable situations). All three coordination types constitute high levels of communication and decision-making in order to achieve structure in the organization.

Taking a view of the behavior of complex organizations as entities embedded in larger systems of action, consisting of interdependence that should be coordinated into structures, Thompson (1967/2008) considers two domains of integration that need to take place, vertical (p. 40) and horizontal (p. 94) integration:

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“Vertical integration refers to the combination of one organization of successive stages of production where each stage of production uses as its inputs the product of the preceding stage and produces inputs for the following stage.”

“Horizontal integration refers to that two or more divisions are sequentially interdependent, and the earlier division ‘sells’ its product to the later division that ‘buys’ its input from within the organization.”

Thompson (1967/2008 p. 45) denotes that vertically integrated organizations may contain a greater capacity than others at some production stages, as integration has proceeded “through acquisition of merger of other organizations”. However, the primary reason for balancing problems lies in the technology and task environment, and in the interdependence between elements. According to Thompson (1967/2008), the divisions involved in horizontal integration are expected to behave as if they were independent with respect to each other. Typically, organizations in project-based companies contain both vertical and horizontal integration processes (Pinto et al., 1993).

Dividing the mechanisms into structural/more formal vs. informal (Martinez and Jarillo, 1989), is in line with Ouchi’s (1979) division of organizational control mechanisms into three modes of control in order to move towards cooperative action of individuals holding partially divergent objectives. The three devices are: markets (control problem dealt with by precisely measuring and rewarding individual contributions); clans (rely upon a relatively complete socialization process, which effectively eliminates goal incongruence between individuals); bureaucracies (rely upon a mixture of close evaluation with a socialized acceptance of common objectives). These devices entail different aspects of measurement and socialization, which can be considered a daily issue to deal with in industrial organizations. As Ouchi (1979 p. 846) notes, “the problem of organization design is to discover that balance of socialization and measurement which most efficiently permits a particular organization to achieve cooperation among its members”. Relating to organizational rationalities, in so-called loosely coupled¹⁷ organizations (Weick, 1976; Orton and Weick, 1990) clans are considered to be the more appropriate control device as they evaluate the performance based on values, motivation, and norms. Market and bureaucratic devices are more

¹⁷ In contrast to tightly linked organizations (Weick, 1976).

suitable for contemporary, so-called tightly coupled organizations in which effective measurement is required with reasonable precision. These three different types of mechanisms for coordination (see also tables 1 and 2), which in today's literature are often considered the traditional approaches to coordination in organizations, are also closely related to coordination in industrial project networks which are often described as complex, temporary and specialized supplier organizations.

Two other scholars, Grandori and Soda (1995), suggest ten basic coordination mechanisms for sustaining and regulating inter-firm cooperation. These are identified based on a review of literature on inter-firm network studies and comprise of: communication, decision and negotiation; social coordination and control; integration and linking-pin roles and units; common staff; hierarchy and authority relations; planning and control systems; incentive systems; selection systems; information systems; public support and infrastructure. The issue of trust that was mentioned in the discussion on integrated solutions provision (see 1.2.1), is also mentioned by Grandori and Soda (1995 p. 198), as it is "one of the most frequently mentioned concepts in connection with inter-firm cooperative relations". However, according to Grandori and Soda (1995) trust is not considered to be a mechanism, instead it is considered to be a "characteristic of the emerging relationship". Moreover, it is assumed that the coordination (cf. Berggren et al., 2001) in any complex organization, such as the supplier organization, require a big effort and underlying motivation for being carried out properly.

Barki and Pinsonneault (2005 p. 166) argue that organizational integration, defined as:

"[...] the extent to which distinct and interdependent organizational components constitute a unified whole,"

represents the structural and relational characteristic of a given organization or between organizations. Organizational integration is further specified into two different types by Barki and Pinsonneault (2005) considering the process chain of the organization as an overarching concept: internal integration (within one organization or company) and external integration (between at least two independent organizations or companies). In Pagell's (2004 p. 460) words internal integration "examines integration across various parts

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of a single organization”. Barki and Pinsonneault (2005 p. 171) present a number of mechanisms for facilitating the achievement of organizational integration (standardizing work, standardizing output, standardizing skills and knowledge, standardizing norms, direct supervision, planning, mutual adjustment) according to the different organizational integration types (Table 3). See also Pagell (2004) regarding the two typical levels of analysis (internal and external) to study integration in organizations.

In this sub-section the focus has been on integration in organization studies. In particular, the practices and means for achieving integration within and between organizations, are in a central position. For instance Barki and Pinsonneault (2005) refer to these causal practices as ‘mechanisms for facilitating the achievement of organizational integration’. Grandori and Soda (1995) consider them to be ‘coordination mechanisms for sustaining and regulating inter-firm cooperation’, and Martinez and Jarillo (1989) see them as ‘mechanisms of coordination or integration’. Ouchi (1979) calls them ‘organizational control mechanisms in order to move towards cooperative action of individuals holding partially divergent objectives’, and Thompson (1967/2008) refers to them as ‘mechanisms to achieve concerted action’. Lawrence and Lorsch (1967/1986) discuss them in terms of ‘means (mechanisms) of achieving integration’. But, what is a mechanism?

Mechanisms¹⁸ are often used by scholars when explaining organizational change. Examples of such mechanisms are for instance ‘mechanisms that drive organizations to disharmony and to the construction of a new harmony’ (Lamberg and Pajunen, 2005), ‘mechanisms that improve innovation capabilities’ (Chapman and Hyland, 2004), ‘mechanisms of trust and networked reputation as drivers of competitiveness’ (Glückler and Armbrüster, 2003), ‘blocking mechanisms that prevent change’ (Chikudate, 1999), ‘mechanisms that enable or facilitate cross-functional collaboration, inter-functional communication and process overlap’ (Paashius and Boer, 1997), and ‘learning mechanisms’ (Levinthal and March, 1993). However, the nature and explicit consideration of what these organizational mechanisms are, turns out to be scarce in literature.

18 The Merriam-Webster Dictionary (1984) provides the following definition of a mechanism: “A process, technique, or system for achieving a result.”

Table 3. Organizational integration based on Barki and Pinsonneault (2005)

<i>Organizational integration types</i>	<i>Definition</i>	<i>Mechanisms of organizational integration</i>	<i>Potential benefits of organizational integration</i>
Internal	Integration within one organization/company		
Operational	Integration of successive stages within the primary process chain (workflow) of a firm	Planning Direct supervision Standardization of output Standardization of work Mutual adjustment	Greater manufacturing productivity Greater company competitiveness Strategic advantages Lower production and inventory cost Reduce errors Improved coordination
Functional	Integration of administrative or support activities of the process chain of a company	Standardization of norms Standardization of skills and knowledge	Products more attuned to market Greater interfunctional synergy Greater new product success Higher innovation rate
External	Integration of at least two organizations/companies		
Operational (forward)	Integration of successive process chain stages into distribution and retail	Planning Direct supervision Standardization of output Standardization of work Mutual adjustment	Economies of scale/scope Higher sales Higher switching costs Faster introduction of new products Faster delivery of products
Operational (backward)	Integration of successive process chain stages into supply	Planning Direct supervision Standardization of output Standardization of work Mutual adjustment	Economies of scale/scope Reduced shipment discrepancies Faster introduction of new products Faster payment Reduced credit
Operational (lateral)	Integration of successive process chain stages into components or parts	Planning Direct supervision Standardization of output Standardization of work Mutual adjustment	Economies of scale/scope Greater manufacturing productivity
Functional	Integration across companies of administrative or support activities	Standardization of norms Standardization of skills and knowledge	Lower administrative overhead costs Higher decision quality Downsizing

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As Pajunen (2008 p. 1449) notes in an attempt to elucidate the nature of organizational mechanisms, for offering an explanatory foundation for processual organization research “in most cases mechanisms, *per se*, are not defined at all or the definitions have remained vague and even contradictory”. Pajunen (2008 p. 1451) further argues, by referring to Glennan (2002)¹⁹, Machamer et al. (2002)²⁰, and in particular to Bechtel and Abrahamsen (2005)²¹, that mechanisms in the context of organization research are composed of four main and interrelated characteristics: 1) mechanisms consist of component parts and their activities/interactions; 2) mechanisms produce something; 3) the productive activity depends essentially on the hierarchical structure of the mechanisms; 4) mechanism explanations are representations or models of mechanisms that, if accurate, describe relevant characteristics of the mechanisms operating in organizational processes. This approach to mechanistic explanation in the context of organization research is taken to integration mechanisms in this present research.

2.1.2 Integration in projects

One of the definitions of integration, which directly relates to project management is from the standards of the Project Management Institute (PMI). The PMI's Project Management Body of Knowledge (2004 p. 77) considers project integration management as one of the nine knowledge areas of project management:

“The processes and activities needed to identify, define, combine, unify, and coordinate the various processes and project management activities.”

According to the PMI, project integration consists on the most general

19 According to Glennan (2002, p. 344) “A mechanism for behavior is a complex system that produces that behavior by the interaction of a number of parts, where the interactions between parts can be characterized by direct, invariant, change-relating generalizations.”

20 According to Machamer et al. (2000, p. 3) “Mechanisms are entities and activities organized such that they are productive of regular changes from start or set up to finish or termination conditions.”

21 According to Bechtel and Abrahamsen (2005 p. 423) “A mechanism is a structure performing a function in virtue of its component parts, component operations, and their organization. The orchestrated functioning of the mechanism is responsible for one or more phenomena.”

level of project plan development, project execution, and integrated change control. Moreover, according to the PMI, integration in a project management context includes characteristics of unification, consolidation, articulation, and other integrative actions for making choices, anticipating possibilities and for coordinating work, i.e. actions that are crucial for project completion.

Another project-related description of integration is provided by the International Project Management Association (IPMA) (2006 p. 40):

“Integration is crucial for project management success; it involves combining project requirements, activities and results to achieve the objectives and a successful outcome. The higher the complexity and the more varied the expectations of the interested parties, the more a sophisticated approach to integration is needed. Project management oversees the activities required to put together the detailed project management plan.”

The two definitions of integration presented by the PMI and IPMA are primarily for professionals and should therefore not be considered a source for scientific knowledge creation. Rather, they should be seen as current platforms for a diverse thinking among professionals about integration, as both of these definitions (or descriptions) fail to indicate the mechanisms through which integration can be achieved in projects. Nor is it stated in the above definitions the purpose for which integration needs to be carried out. A common view amongst professionals regarding the mechanisms for achieving integration is supposed to be that it most probably enhances the development of a structured approach towards carrying out integration for the suppliers providing solutions. However, today these mechanisms are poorly defined.

Together, the conceptualizations of integration in organization studies (2.1.1) and integration in projects (2.1.2), and in particular the definition provided by Lawrence and Lorsch (1967/1986), give the starting point for studying integration in the present research. This concept of integration is referred to in paper II as:

“Bringing or joining together a number of distinct things so that they move, operate and function as a harmonious²², optimal unit.”

In the above definition the word harmonious refers to how the different parts of a functioning solution should interact in relation to each other, and with the surrounding environment.

2.2 SYSTEMS INTEGRATION

Relating to how projects are used as a method for organizing networks of industrial activity across company boundaries (cf. internal vs. external integration) and by focusing on the delivery of various high-technology systems and solutions Davies and Hobday (2005 p. 88) define systems integration as:

“The core technical and strategic capabilities which enable a project business to combine all the various production inputs, including components, subsystems, software, skills and knowledge, to produce a product, system, construct, network or service.”

The above definition is referred to when relating to systems integration in this thesis. Along with this view, Hobday et al. (2005 p. 1138) argue that “systems integration is a capability at the heart of the strategic management of the modern high-technology corporation”, denoting that systems integration should not be seen as an activity including merely technical tasks (Prencipe, 2003). Systems integration should rather be understood as an activity including the principal technical, strategic, and organizational capabilities involved in the main stages of the production of different systems. This includes the range of activities that enable the solution providing companies “to bundle

²² *The word harmony is derived from the Greek word, meaning “a fastening or join”. Harmony is used in a general sense to refer to a state of “peaceful order”, and harmonisation refers to “the process by which different states adopt the same laws” (Encyclopædia, 2005). Integration, consonance, congruity, and concord are all analogous words to harmony and they all “designate the result attained or the effect produced when different things come together without clashing or disagreement” (Merriam-Webster, 1984). Harmony is also defined as “the unity, order, and absence of friction produced by the perfect articulation and interrelation of distinct parts in a complex whole”. According to The American Heritage (2003) harmony is the “agreement in feeling and opinion”, “a pleasing combination of elements in a whole” and “compatibility in opinion and action”. Harmony can also be described as “congruity of parts with one another and with the whole” (WordNet, 2005). A harmonic structure is then “an articulation by simple apposition of comparatively smooth surfaces or edges”.*

together their traditional products and software with services designed to provide customers with long-term solutions to their problems” (Hobday et al., 2005 p. 1136). Prencipe (2003) contends that systems integration is the coordination mechanism in network organizations and the integrator, who is in a central role, is required to possess a wide variety of knowledge bases (Paoli, 2003) such as:

- To put together the parts
- To manage interfaces
- To organize the architecture
- To invent the ‘missing’ links (e.g. to integrate)

Echoing Prencipe (2003) and Hobday et al. (2005), the resource-based view of the project-based company (Chandler, 1990; Richardson, 1972; Penrose, 1959) is adopted in the present research. A resource-based view considers each company to have its own distinctive history and capabilities that create a boundary around its freedom to maneuver²³. Hobday et al. (2005 p. 1110) defines systems integration (in its broadest sense) as:

“The capabilities which enable firms, government agencies, regulators, and a range of other actors to define and combine together all the necessary inputs for a system and agree on a path of future systems development.”

Assuming a company capability view, systems integration is concerned with the way in which companies and other agents bring together high-technology components, subsystems, software, skills, knowledge, engineers, managers and technicians to produce solutions in competition with other suppliers (Hobday et al., 2005). From this follows that the more complex, high-technology, and high-cost the product, system or integrated solution is, the more significant the systems integration becomes to the productive activity of the supplier.

As is depicted in figure 2 solutions offerings imply a move downstream in the direction of the final customer or consumer in the value stream of integrated solutions (Davies, 2004). In the value stream the outputs of one value-adding stage (each of which is closer to the final consumer) are the inputs of the next and thus value accumulates at each stage resulting in the overall value stream (Davies and Hobday, 2005 p. 222).

²³ In addition to the rational open systems perspective to organizations (see 2.1.1).

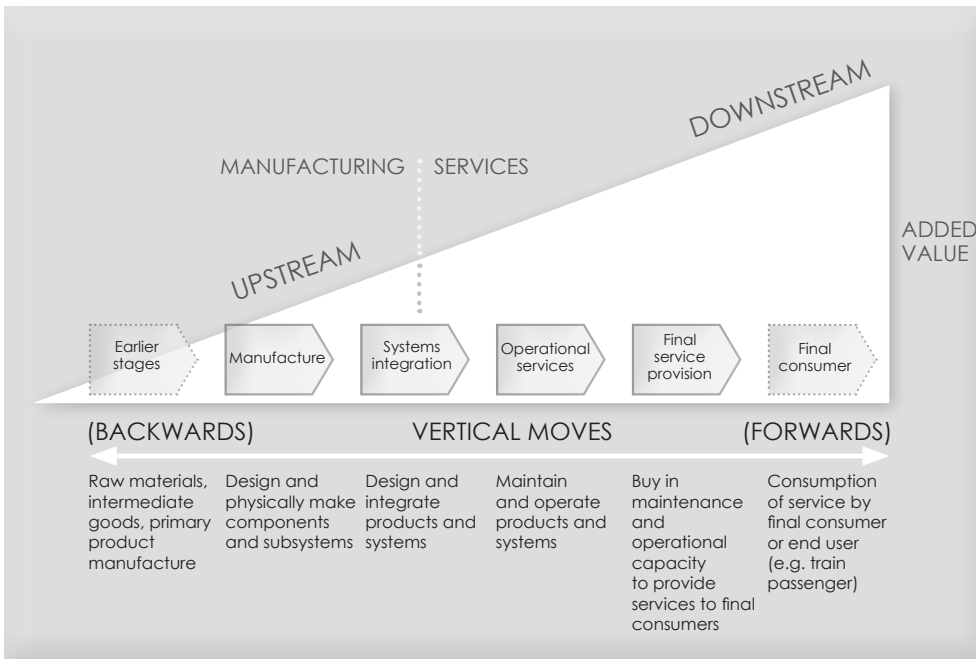


Figure 2. Moving base in the value stream.²⁴

Davies and Hobday (2005) imply that dealing with technological knowledge and organizational boundaries become equally important in industrial projects as the suppliers are responsible for ensuring that the value created by the project through integration and operational services provision will fulfil the customer’s expectations. Thus “solutions projects usually include the responsibility for the provider to manage, resource, support and improve the delivery of the solution through the life of the product or system in use” (Brady et al., 2005 p. 364). The ability to offer operational services, business consultancy services and financial services to customers, are additional capabilities that a solution provider will need, for competing successfully in the solutions business. As Andersson and Berggren (2011) contend, in technology based firms exchanging, exploring and implementing information and ideas constitute the activities of knowledge integration for developing solutions.

Taking a systems perspective on project organizations, the International Council of Systems Engineering (INCOSE) (2004 p. 10) defines a system as:

“An integrated set of elements that accomplish a defined objective”.

²⁴ Adopted from Davies (2004).

Accomplishing the defined objective, is thereby the aim of the integration efforts. Moreover, INCOSE (p. 181) considers the systems integration function to include “the integration and assembly of the system with emphasis on risk management and continuing verification of all external and internal interfaces (physical, functional and logical)”. Systems engineering is an overarching discipline having more of an engineering focus than a management discipline, using merely quantitative approaches. These ideas of systems engineering can be applied to systems integration in industrial project business, which typically constitute a high number of engineering processes.

2.3 THE INTEGRATED SOLUTIONS LIFE-CYCLE

The integrated solutions life-cycle refers to the four phases of essential activities that suppliers must carry out together with customers in order to deliver a solution (Figure 3). The essential activities – strategic engagement, value proposition, systems integration and operational services – are not usually identified as traditional project life-cycle models, as they are rather seen as either pre-bid or post-project activities (Davies and Hobday, 2005 p. 244):

- Strategic engagement: the high-level business discussions which are carried out with the customer to work out the customer’s needs or priorities.
- Value proposition: the detailed proposal or offer which is developed by the supplier to add value for the supplier and the customer.
- Systems integration: when the contract has been agreed and the supplier, through a project team and its partner organizations, is designing, building, integrating and verifying and testing the system before handing it over to the customer.
- Operational services: when the system is operated, maintained and supported, often by the supplier’s functional line organization, over a period of time specified in the contract.

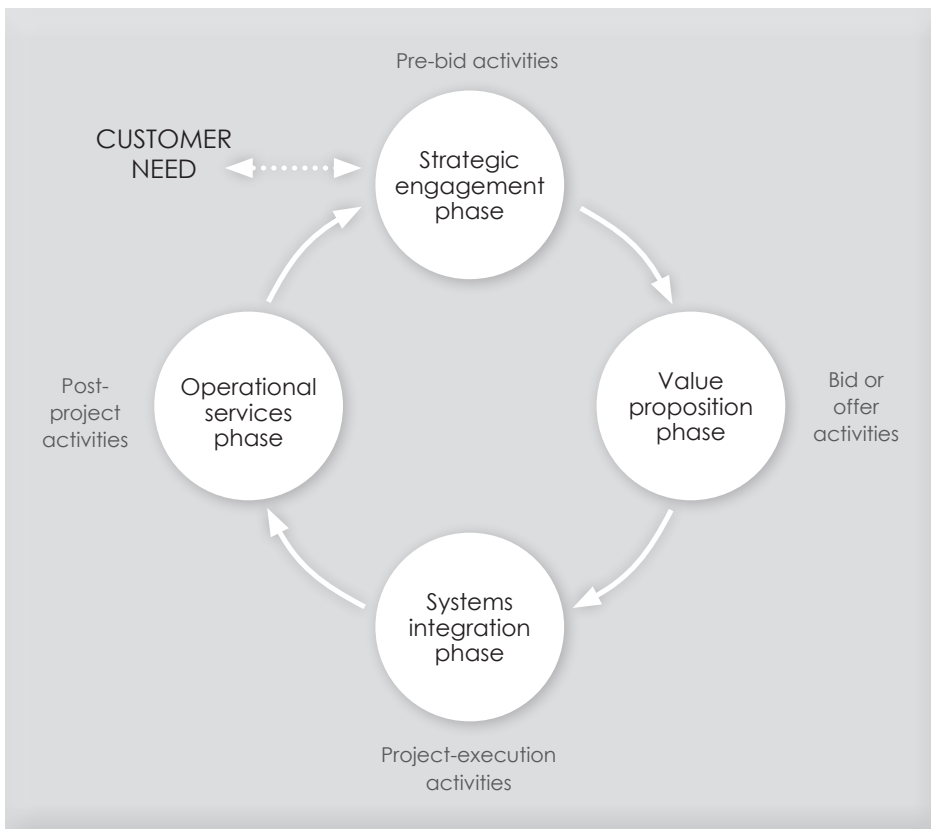


Figure 3. *The integrated solutions life-cycle.*²⁵

The integrated solutions life-cycle requires capabilities and expertise in commercial management, technical design, and project management (Davies and Hobday, 2005). Davies and Hobday (2005 p. 62) propose a framework of project capabilities, which are defined as “the appropriate knowledge, experience and skills necessary to perform, pre-bid, bid, project and post-project activities” that are needed in companies to compete in the global markets. The framework builds on Chandler’s framework of strategic and functional capabilities and adds project capability to it (Davies and Hobday, 2005; Brady and Davies, 2004; Davies and Brady, 2000). Bredin (2008) extends this project capability framework of three dimensions with a fourth dimension: people capability. People capability refers to the people management systems that consist of experiences, individual skills,

²⁵ Adopted from Davies and Hobday (2005).

role structures, processes, activities and routines throughout the organization. According to Bredin (2008) a more holistic approach to human resource management in project organizations can be reached when managing the relationship between people and their organizational context.

Following from the fact that when solution providers take over the responsibility for operational performance, they can receive critical information about “in-service problems” and thereby improve the design and functioning of future offerings (Brady et al., 2005 p. 364). For the same reason solution providers should develop strategic relationships with leading customers. This form of interaction where the supplier emphasizes the customer and the customer’s experiences and knowledge in order to enable innovation is considered in the literature (see e.g. Payne et al., 2008; Blazevic and Lievens, 2008) as an approach in which the customer becomes a co-creator of value. Prahalad and Ramaswamy (2000) argue that customers should be viewed as a source of business network competence that a supplier aims to connect with and integrate into its value co-creation. In other words, value is considered to be embedded in the co-creation process between the supplier and customer (Payne et al. 2009; Vargo and Lusch, 2004; Prahalad and Ramaswamy, 2000; Grönroos, 2000). When the knowledge is created together with the customer, innovation processes can be oriented and intensified towards mutual benefits, which in turn shortens the project life-cycles and maximizes the value of the solution that is provided (cf. Berggren et al., 2001).

Moreover, systems integration has fundamental implications for the capabilities of the supplier (Hobday et al., 2005). In order to provide integrated solutions it is therefore essential that suppliers “build a core capability in systems integration” (Davies and Hobday, 2005 p. 234). As a result of integrating the customer more into the project, a central dimension of systems integration is the capability of creating and managing an extensive amount of knowledge at different levels in the project network. This means that different sources of information and knowledge and different levels of information and knowledge – e.g. tacit, codified, individual and group (Brusoni and Prencipe, 2001b; Cook and Brown, 1999) – must be brought together successfully and should be integrated into the product and process structures systematically in order to reach the network levels concerned. Knowledge integration needs to occur both on

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an individual and collective level, but according to Tell (2011) the activities conducted for achieving knowledge integration both on intra- and inter-organizational levels are lacking. Tell (2011) further argues that basically it is a question of who it is that is conducting the knowledge integration in the organization.

As pointed out previously, suppliers providing solutions for their customers are forced to organize their internal and external activities in a restructured way (Davies et al., 2007; 2006; Davies, 2004). As Davies et al. (2007) suggest, many companies are adopting new organizational structures as they change their integration focus by combining systems selling with systems integration and thereby creating the know-how that is required in the organization²⁶. This implies backwards integration towards physical components. It is challenging for the solution providers, as they need to move into areas in the value stream, which traditionally have been handled by their customers.

In a study within the capital goods sector, Windahl (2007) demonstrates that many companies experience several ambiguities and challenges in the development and commercialization of integrated solutions. Such difficulties are related to, for instance, maintaining long-term customer relationships, ensuring and maintaining cost savings, differing customer demands and business cycles, environmental demands and regulations, and changing market structures. According to Windahl (2007), more competitive solutions offerings can be developed by integrating product/service innovation, by creating and managing independent business units with strong connections and dependencies on established organizational structures, and by managing increased dependency on customers and partners.

Windahl's (2007) conclusions are in line with findings reported by Brax (2005) on challenges in providing services, for a company

26 In order to analyze strategies and organizations that provide, or are attempting to move into the provision of integrated solutions Davies et al. (2007 p. 192) have identified two contrasting types of organizations, drawing on marketing literature: vertically-integrated systems sellers that produces all the product and service components in a system and systems integrators that coordinates integration of components supplied by external firms. These ideas originate in the 1960s or even earlier (see e.g. Hannaford, 1976; Mattson, 1973) and today's emerging organizational forms where an increased amount of integrated solutions are provided, elements of both systems selling and systems integration are combined.

that is a manufacturer of industrial equipment involving complex technology. The challenges relate to the fact that transaction-oriented business philosophy does not support service offerings, in which services are merely added on top of the original goods-dominant offering. These difficulties can be divided into six areas. Marketing is the first, which relates to that the old transactional-focused incentive systems do not support service business. Second, the production difficulty relates to integrative information systems and information management practices. Third, difficulties in delivery relate to the management of increased information across all company levels. Fourth, the product-design challenge relates to being able to support the customer's business goals and practice, i.e. having knowledge about the customer's business context and operational conditions. The fifth difficulty is related to communication, in which the supplier needs to express care instead of opportunism in order to motivate the customer in the business relationship. Sixth, the relationship challenge is related to that instead of concentrating purely on the quality of technology, the customer focuses on its business as a whole.

To determine the activities that are needed in order to provide value for customers and other stakeholders through solutions offerings that include services, the suppliers and their project networks apply business models that cross intra- and inter-organizational boundaries of companies and projects (Wikström et al., 2010). Wikström et al. (2010 p. 839) further state that "business models may be inter-organizational and may foster partnerships, although in some cases their primary purpose is to enhance rivalry between competing firms or projects". As argued by Wikström et al. (2010) a majority of suppliers engage in tailor-made solutions and extend their offerings beyond traditional project scopes by integrating maintenance, spare parts and services, management contracts and even partial ownership in multi-actor enterprises running the operations of a complex solution.

When the suppliers are aiming for a service-dominant logic, being customer-centric is insufficient. Instead the supplier must be adaptive to a customer's individual and contemporary needs when providing integrated solutions. Unique solutions can be achieved only by developing customized competitive value propositions (Lusch et al., 2007; Lusch and Vargo, 2006; Vargo and Lusch, 2004; Johansson and Olhager, 2004; Grönroos, 2000). In other words, in a supplier's

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transition from product- to service-based offerings the services need to be integrated into the existing value proposition (Oliva and Kallenberg, 2003). According to Wikström et al. (2009) the three main phases in a company's degree of maturity are the goods-dominant, customer-centric and business-dominant approaches.

By building on previous research (Vargo and Lusch, 2004; Galbraith, 2002a; Hobday, 1998) and by analysing the impact of the complexity of core project content together with the company's degree of maturity in including services as factors that enhance service provision, Wikström et al. (2009) have identified four different types of business logics for suppliers to include services into their business models. The four types of business logics for a project-based company exposing a typology of priorities on how and which services could be included, are:

- Product driven business logic (low complexity/low maturity)
- Innovation and technology driven business logic (high complexity/low maturity)
- Business driven business logic (high complexity/high maturity)
- Service driven business logic (low complexity/high maturity)

According to Wikström et al. (2009) the most relevant core project complexity drivers for these four business logics were: unit cost/ financial scale of project; variety of distinct knowledge bases; extent of embedded software in the product; degree of technological novelty; variety of skill and engineering outputs and finally, the degree of customization of final system. Regarding the company's maturity, the most relevant drivers were: the transforming of organizational concepts; company culture; approach to personnel, priority setting bases, main offering and sales bias. The business logics and maturity of companies discussed above, relate to the evolving value chains that the suppliers of integrated solutions are part of.

2.4 PROJECT BUSINESS

2.4.1 Projects and project-based companies

Projects are often seen as a core, strategic business activity that companies in different types of industries use for handling internal and external activities, product and process innovation, promoting organizational renewal, and for exploring new technology and market opportunities, among other things (Davies and Hobday, 2005). Treating the projects as core, strategic business activities (Söderlund, 2004) indicates how the project concept has evolved during the past few decades to become a strategic context where “dependent or independent multiple projects contribute to the fulfillment of strategic objectives” in business systems (Artto and Wikström, 2005 p. 344). This view has evolved from notions from the past. For instance, Gilbreath (1988 p. 6) suggests that “projects seek to create a limited impact through temporary and expedient means”. Gilbreath (1988) argues that projects, in contrast to operations, presuppose no fixed tools, techniques, or capability and that projects expire when their result is achieved, whereas operations may outlive their results. This perspective, which can be considered the traditional way of viewing the project activities as something different from the operations activities, is to adopt a rather one-sided view of projects. This view abandons the project outcome (the functioning solution) as an integrated part of the project. Therefore, in order to provide a functioning solution, taking a life-cycle perspective on the project which includes the project activities and the operations activities is important. In the life-cycle perspective, both the so-called pre-bid and post-project activities (cf. Davies and Hobday, 2005) are considered as essential activities of the project, and the value chain (see 2.4.3).

The temporary nature of project organizations is one of the elements that enable project organizations to adapt more rapidly to rapidly changing conditions and to furnish innovative solutions and approaches. It is also thanks to the temporary feature of the organization, that the procedures of a project organization remain ‘new’ at the same time as they become more standardized because of re-combination of recourses for repetitive processes in future projects.

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Taking the perspective of the project organization as a temporary organization, Turner and Müller (2003 p. 7) define a project as:

“A temporary organization to which resources are assigned to undertake a unique, novel and transient endeavor managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change.”

Cova et al. (2002 p. 3) then again takes a project marketing approach when defining a project as:

“A complex transaction covering a package of products, services and work, specifically designed to create capital assets that produce benefits for a buyer over an extended period of time.”

Following the PMI's guidelines (2004), a project constitutes and can be managed by five project processes: initiation; planning; execution; monitoring and controlling; closing. These processes relate to the nine project management knowledge areas that need to be acknowledged during a project: integration management²⁷; scope management; time management; cost management; quality management; human resource management; communications management; risk management and procurement management. These knowledge areas generally overlap, and it is the responsibility of the project organization to integrate them into each other. The PMI (2004 p. 5) provides the following definition of a project:

“A temporary endeavor undertaken to create a unique product, service, or result.”

According to the PMI “temporary” refers to that every project has a definite beginning and a definite end while “unique” refers to that the product, service or result is different from other products, services or results.

Besides the five management processes and nine knowledge areas listed above, supporting disciplines such as financial management and accounting, sales and marketing, manufacturing, logistics and supply chains, contracts and commercial law, planning (strategic, tactical and operational), health and safety practices, information and communication technology and personnel administration provides essential activities for carrying out projects. These activities can be seen as supporting project disciplines that must constantly

²⁷ For this study the integration management knowledge area (see 2.1.1.2) which emphasizes planning and change control is particularly relevant.

be acknowledged during a project's life-cycle, which is described by the PMI (2004 p. 19) as "the phases that connect the beginning of a project to its end". The life-cycle can also be considered as the specific process that one must go through to achieve the desired project objective (Morris, 1988), which in this thesis is referred to as the functioning solution.

Moreover, projects can be seen as systems in that they consist of many interrelated and interconnected parts or elements, which must function together as a 'whole' (Stuckenbruck, 1988). Stuckenbruck (1988 p. 59) further argues that "many elements of the project may have little direct relationship to the system being worked on, but they may be critical to ultimate project success". This diversity is applicable to the complex, high-capital and engineering intensive industrial projects, which are studied in the present study, where a high number of different actors and parameters interact in numerous ways.

Eventually, project-based companies differ from functionality-based companies concerning at least three issues regarding organization-wide learning (Whitley, 2006; Prencipe and Tell, 2001). First, the organizational mechanism is deficient in the means to transfer knowledge from one project to another. Second, a project is unique, and third, it is temporary by nature. Associating with the standardized procedures which were previously mentioned and by moving quickly through the learning cycle, replication strategies can be created (Davies and Brady, 2000). Davies and Brady (2000 p. 952) associate economies of repetition with "the reductions in costs and improvements in project effectiveness gained by moving from the first-of-its-kind bid or project to the execution of many similar types of bids or projects within cost, schedule and the required specifications". Moreover, as increased project frequency is emphasized, the amount of uncertainty and complexity has a tendency to increase and therefore integration varies as to its character during different project functions due to the different requirements stipulated by the internal and external processes, and in relation to the environment and task to which the project is provided.

The most distinguished difference in production processes in projects and mass markets is the nature of demand for large-scale capital goods

and their size and complexity²⁸ (Hobday, 1998). Typically, in projects demand is very low in comparison to so-called mass markets and the development often takes place during project execution since that is basically the only opportunity to test the particular configuration in real world settings as these goods are typically designed, engineered and manufactured to order (Hellström, 2005). Furthermore, the life-cycles of these customized large-scale goods may often be counted in decades.

2.4.2 Project-based business

For a definition of project business, the definition proposed by Artto and Wikström (2005 p. 351) is adopted:

“Project business is the part of business that relates directly or indirectly to projects, with the purpose to achieve objectives of a firm or several firms.”

By definition these suppliers perform their core operations based on a project-based logic, which implies that projects are their fundamental source of revenue. As previously discussed, over the years, industrial project business has become increasingly service and customer driven (Wikström et al., 2010; 2009; Davies et al., 2007; Lusch et al., 2007; Lusch and Vargo, 2006; Brady et al., 2005; Oliva and Kallenberg, 2003; Vargo and Lusch, 2004; Grönroos, 2000; Pinto and Kharbanda, 1995; Frame, 1994). The new business models of the suppliers outline strategies as to how to deliver innovative customer-tailored solutions (Davies et al., 2007; Flowers, 2007; Brady et al., 2005; Davies, 2004) by combining products, systems and services (Artto et al., 2008; Davies et al., 2007) into functioning solutions for the customers.

Artto and Kujala (2008) and Artto (2008) argue that there exist four major areas into which research on project business can be classified. According to the project business framework the four areas²⁹ are: 1) research on the management of a project (a single project and its environment); 2) research on the management of a project-based firm (a firm and its multiple projects as a whole); 3) research on the

²⁸ According to Hobday (1998) the term complex is used to reflect the number of customized components, the breadth of knowledge, skills required and the degree of new knowledge involved in production as well as other critical product dimensions.

²⁹ The framework includes also interfaces between these areas.

management of a project network (a project as an enterprise through managing multiple firms participating in the project) and 4) research on the management of a business network (a network of actors and their relationships in an open and competitive business marketplace). In the present research the focus is on the three latter areas – the project-based firm, the project network and the business network – while the single project is considered to be the origin of departure.

When dealing with engineering intensive organizations, such as the suppliers of industrial solutions, it becomes obvious that the performance and development processes of these organizations during a project differ in accordance to the settings and business model of the particular supplier. This relates to the research on evolving governance modes and the process leading to vertical integration, on the level of the value chain structure, reported by Cacciatori and Jacobides (2005). A supplier's product/service portfolio, performance activity, operations strategy, focus of market segment etc. are concepts that promote the performance of the organization. Lakemond and Berggren (2006) argue that in new product development projects both intra-project integration and inter-project organizational integration are needed, referring to the fact that a project should be integrated with its organizational context as an organizational integration focus (resource planning, decision structure and management approach). This notion is relevant for project business.

Departing from the findings of Berggren et al. (2001) discussed in section 1.3 the three central problems in large engineering projects are related to coordination, customer involvement, and organizational learning. As argued in the objectives of this thesis, these three problems are also central to solution projects. In the following paragraphs coordination, customer involvement and organizational learning are linked to evolving value chains (see 2.4.3) and modularity (see 2.4.4) in project business.

2.4.3 Evolving value chains

To provide solutions for customers, suppliers must work through lateral networks – networks that simultaneously face different forms of structural complexity (cf. Williams, 2005) and different types of interdependencies among interacting units (Brusoni, 2005; Danese et al., 2004; Galbraith, 2002b; Brusoni et al., 2001;

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Carlisle and Dean, 1999; Jones et al., 1997; Jarillo, 1988; Thompson 1967/2008). This is a result of the vertical and horizontal integration (cf. 2.1.1) that takes place during an industrial solution project that includes the handling of the technical innovations, sales, design, manufacturing, commissioning, warranty, operations and evaluation functions. Another consideration is that as these customized projects constitute combinations of innovative technologies, systems, and services that aim to provide unique solutions and value to customers, the understanding of each and every specific customer's business environment becomes important for the supplier to integrate into the value chain.

Considering integration in a value chain, and in relation to innovations, and research and development functions (R&D), Iansiti (1998; 1995) argues that technology integration, which is an organizational process, can provide enormous leverage for improvement. Technology integration is defined by Iansiti (1998 p. 21) as "the set of investigation, evaluation and refinement activities aimed at creating a match between technological options and application context" which is driven by knowledge³⁰ merging theories, production systems and user environments. This is important for the integration of the technologies, systems, and services in the solution projects.

Furthermore, when considering different knowledge bases in the projects, in concurrent-engineering (Swink, 1998; McCord and Eppinger, 1993) where several design, manufacturing, and other activities occur simultaneously and overlap in order to develop a solution, the integration process becomes especially demanding. Following Swink (1998 p. 105), "persons from different organizational functions must be willing to collaborate, share information, and resolve conflicts quickly and effectively" in other words to perform concurrently, which is connected to activities of cross-functional integration (see also Swink et al., 1996). The aspects of cross-functional integration and concurrency are further reflected in the definition of concurrent engineering provided by McGrath (1992 p. 91):

"Concurrent engineering means developing the product and all its associated processes, that is, manufacturing, service, and distribution, at the same time."

³⁰ According to Iansiti (1998 p. 21) "the elements of an effective process for technology integration thus fall into three types of mechanisms: mechanisms for knowledge generation; knowledge retention and knowledge application".

As Koufteros et al. (2005; 2002; 2001) conclude, concurrent engineering (i.e. cross-functional integration) enables companies to perform better in product quality.

In terms of outcomes of knowledge integration, Tell (2011 p. 33) distinguishes three groupings as means towards different ends, based on how knowledge integration is conceived: efficiency; effectiveness and innovation/novelty. Drawing on these arguments, it follows that an organization's capacity to integrate knowledge appears most likely, to be an essence of its organizational capability to manage flexible integration across multiple knowledge bases (see also Johansson et al., 2011). For organizational learning (cf. Berggren et al., 2001) to take place, communication and understanding become central issues among the actors in the project organizations in relation to information sharing and knowledge creation. Cranefield and Yoong (2005) highlight that the extent to which an organization is open to communication and its readiness and ability to recognize, absorb and apply the value of new knowledge, remarkably affect the success of knowledge transfer in the organization, which in turn enhances integration in the value chain. The knowledge transfer resembles Iansiti's (1998) technology integration, which induces decision-making and problem solving based on how well an organization is able to generate, capture and apply knowledge.

This implies that information sharing between actors and different departments in an organization or network is important during the early phases in the development process of industrial projects, before too many parameters are decided and while changes are relatively low cost and easy to handle. In other words, integration can be considered as the merging of different disciplines or organizations with different goals, needs, and cultures into a cohesive and mutually supporting unit (Baiden et al., 2006; Austin et al., 2002; Jaafari and Manivong, 1999).

Supply chain scholars (e.g. Handfield and Nichols, 2002; Frohlich and Westbrook, 2001) emphasize relationship management including the flow of information, products, services, knowledge, and coordination of the forward physical flow of deliveries from sub-suppliers and suppliers to the customer. In addition, they highlight, the backward coordination of information, and data from the customer to the supplier and sub-suppliers. In fact, integration

is recognized by several scholars as a fundamental principle of supply chain management (Romano, 2003). In order to advance the integration of knowledge in project business integration in supply chains is a highly relevant dimension to consider, as it provides approaches for cross-functional organizations to share information across interfaces in the value chains.

2.4.4 Modularity

Among other things, the evolving value chains implies that the networks that the suppliers operate in need to develop standardized structures for both products and processes – modules (Brusoni, 2005; Langlois, 2002). Modularity³¹ facilitates the development of ‘standardized components’ that can be combined and recombined at much lower costs than solutions comprised of entirely customized components. This is due to the fact that the modularized structures become unstable and thereby flexible when the boundaries between the modules are well-known and can be easily integrated with each other (Hellström and Wikström, 2005; Sanchez and Mahoney, 1996). By employing modular product and process structures, combined with organizational networks, companies increase their ability to be more flexible and to manoeuvre the de-composition and the flow of knowledge and activities more effectively, utilizing these so-called unstable structures (Brusoni et al., 2007; Brusoni, 2005; Hellström and Wikström, 2005; Foote et al., 2001, Davies and Brady, 2000; Arora et al., 1997). In practice, this means increasing the variability of what is offered, and the manner in which it is offered. This increases the challenges in project management, especially as the industrial projects constitute widespread supplier networks.

These networks often entail system structures with considerable interdependencies between the elements. For instance product or task interdependence plays a central part in organizing and organizational design in general (Galbraith, 1973; Thompson, 1967/2008). Such interdepartmental dependencies and coordination mechanisms are a result of how the task at hand is partitioned into sub-tasks, and show

31 Modularity provides a means of managing the entire construction and delivery process of a product: the method of managing the delivery set-up outlined by modularization is to assign full freedom and responsibility for the sub-scopes to respective suppliers (and organizational units) (Hellström, 2005 p. 156). In other words, modularity can be seen as a strategy for both decomposition and integration.

how well the knowledge is integrated at the different levels of the system in the value chain.

2.5 SYNTHESIS

This section synthesizes and further refines and evaluates the theoretical perspectives that arise from the literature review as well as the fields of analysis that are the subject of the empirical observations introduced in chapter 1. The key perspectives are integration, systems integration, the integrated solutions life-cycle, and project business.

The first perspective is *integration*. In particular the vertical and horizontal integration that provides integrated solutions as well as the coordination within and between departments, organizations and companies (e.g. Barki and Pinsonneault, 2005; Martinez and Jarillo, 1989; Lawrence and Lorsch, 1967/1986; Thompson, 1967/2008).

The second perspective is the *systems integration* i.e. the activity which includes the technical, strategic and organizational capabilities that are involved in the main stages of the production of different systems (e.g. Davies and Hobday, 2005; Prencipe, 2003). Building on the definitions provided by Lawrence and Lorsch (1967/1986; 1967a), integration is considered the essential process for accomplishing an industrial project, whereas the accomplishment of the industrial project is considered as the result of integration.

The *integrated solutions life-cycle* is the third perspective. In order to be able to provide solutions with greater scope, including more engineering hours, technologies, and a wider project network, a change is needed in the mindset of the suppliers. As a consequence of this change they would be able to take the required responsibility and carry out these new approaches (e.g. Davies and Hobday, 2005; Hobday et al., 2005; Brady and Davies, 2004). For the supplier it is important to be able to integrate products, systems and services (e.g. Vargo and Lusch, 2004; Grönroos, 2001). The supplier also needs to have the capabilities to integrate the cross-functional organizations and departments in the project network, the knowledge and information between and within these organizations and departments, together with knowledge and information from the customer into the project (e.g. Tell, 2011; Brusoni and Prencipe,

2001b). Moreover this integration needs to take place during the entire life-cycle of the project and at different levels of the project network, so as to ensure the functioning solution that the customer expects. This transition in the business logic can be seen in the business models that are emerging (e.g. Wikström et al., 2009). The challenging commercialization of solutions (Windahl, 2007), moreover, requires a business dominant approach which necessitates a highly complex and mature project supplier.

Project business (Artto and Wikström, 2005) is the fourth perspective. When project-based suppliers provide solutions for their customers, it means that they are increasing their supply ranges by taking over some of the activities in the value chains that have traditionally been handled by the customers. By taking, on the one hand, the process perspective on integration it is argued that integration is the development of linkages within and between organizations in project-based companies and is also a cross-functional interaction (following scholars as e.g. Koufteros et al., 2005; Adler, 1995 and Oliff et al., 1989) in order to intersect points in the product and process structures. Integration is also considered a fundamental activity for knowledge creation and processing, and information sharing (e.g. Swink et al., 2007; Koufteros et al. 2002; 2001), resembling the evolving value chains. Modularity (e.g. Brusoni, 2005; Hellström and Wikström, 2005; Langlois, 2002) is closely linked to the evolving value chains, and is also related to the development of standardized product and process structures in order to provide more flexible solutions with higher variability.

The unit of analysis, which constitutes the three project functions (design, commissioning and operations) in industrial solution projects that are delivered by a supplier (a project-based company) and its sub-suppliers is studied utilizing the four theoretical perspectives that are summarized and synthesized above. The theoretical perspectives build on the following two models:

- The 'value stream of capital goods' (Figure 2) by Davies (2004). I.e. the four main value stream stages³² in a typical capital goods industry.
- The 'integrated solutions life-cycle' (Figure 3) by Davies and

³² According to Davies (2004) the four stages are manufacture, systems integration, operational services, service provision.

Hobday (2005). I.e. the four phases of central activities that suppliers must carry out together with the customer in order to deliver a solution³³.

Drawing on these four perspectives, in order to address the objectives of this thesis (section 1.3) integration in project business is studied by approaching integration mechanisms for value creation in industrial project networks through the following three research questions presented in papers I-III: RQ1 (Paper I) 'How should systems providing feedback control be understood and implemented into the undertakings of industrial project organizations?'; RQ2 (Paper II) 'What are the character and implications for integration in delivery projects under new circumstances?'; and RQ3 (Paper III) 'Do companies that acquire capabilities of integrating services with products in order to provide "solutions" for their customers, increase their competitiveness? If so, which are the critical capabilities they must develop?'. The management of the integration process in project business is studied through research question RQ4 (Paper IV) 'What are the characteristics and implications of the mechanisms in knowledge integration in industrial projects?'.

33 According to Davies and Hobday (2005) the essential activities are strategic engagement, value proposition, systems integration, operational service.

3

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

The aim of this chapter is to present the research design and methodology which have resulted in the papers and the thesis. First, the research approach, the studies and the studied industries are presented. Then the research process is described. This is followed by a description of the methods of data collection that has been employed, and a review of the data analysis. The chapter ends by reflecting on the research quality.

3.1 RESEARCH APPROACH

The starting point for the present research is the need to increase knowledge about integration in project business. In order to uncover areas for research and theory development and to identify which the key issues related to integration in project business are, qualitative research methods have been applied. While a pragmatic-critical realism conception (Johnson and Duberley, 2000) has been adopted, this thesis sets out to find answers to research questions based on empirical and rational reasoning. The implications of positioning this research within pragmatism and critical realism as epistemologically subjective and ontologically objective (Johnson and Duberley, 2000 p. 180) is that social and natural realities are considered to exist independently from human knowledge. Thus, by focusing on the processes of knowledge development and transformative action, problems can be comprehended in new ways, which bring new perspectives to complete a research problem. As a result of this perspective, which combines empirical and rational reasoning, thirteen integration mechanisms (Table 9) and a typology for integration (Figure 7) are proposed. The result of this inductive approach is aimed at supplementing existing theories, and bringing potential value to managers in industry.

The research is collaborative by nature. Collaborative research (see 3.1.1) refers to research that is conducted together and in close

cooperation with the industrial project organizations that are studied, employing empirical, explorative and abductive processes. Empirical research refers to the interdisciplinary data sources employed, whilst explorative research refers to the combination and implementation of several practices which have been applied. Dubois and Gadde (2002) describe the abductive approach as a process where several methods are used simultaneously and systematically combined in order to enhance the theoretical development. This research evolves according to what is discovered through literature studies, fieldwork, analysis and interpretation, in which the conducted empirical studies build on input from different industries and industry segments.

The empirical studies constitute three project functions: 1) design, 2) commissioning and 3) operations. Each of these project functions represent different attributes of integration. The industrial projects that are reflected in the studies are delivered to the customer by a project-based company, the supplier. The supplier either acts as an expert during some of the project functions or is considered to be the key actor throughout the project value chain (playing a major role during all project functions).

The fact that the interests of the studies have been formed to meet certain purposes in actual industrial situations and supplier needs, has brought important insights to the studies. These include for instance, the possibility to adopt valuable experiences and arising needs from the professionals working in the interdisciplinary industrial projects at the present time. The research process is depicted in figure 4.

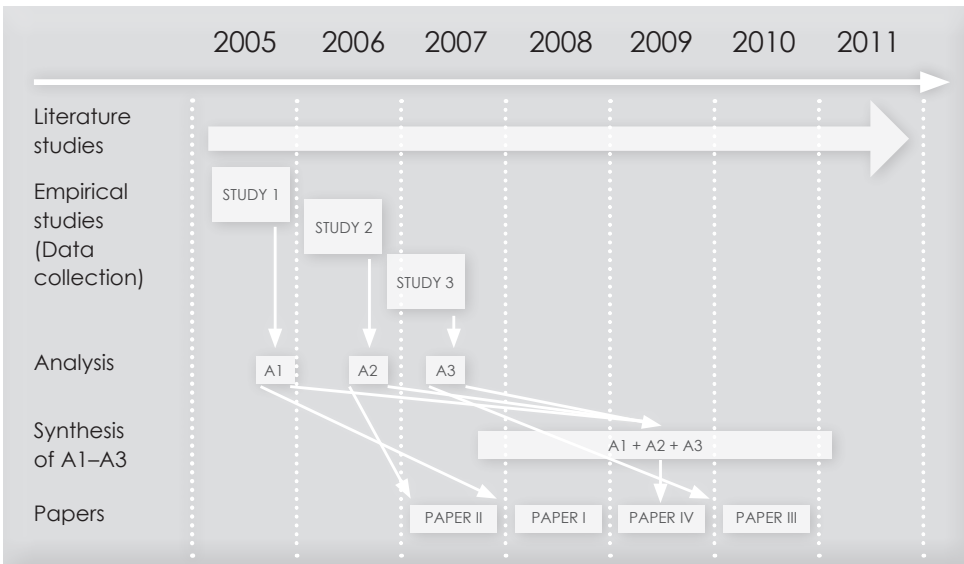


Figure 4. The research process.

The research questions presented in section 1.3 build on each other, according to the fact that papers that are written based on studies and analysis conducted in later steps of the research process build on findings from papers written based on studies and analysis conducted earlier in the research process, as is illustrated in figure 4. The findings of the different studies (Papers I-III) have then been synthesized (synthesis of A1-A3) in paper IV. These findings are developed further in this extended summary. The extended summary should be seen as a synthesis and further development of what the four papers (I-IV) achieve together by addressing different research questions and different studies, and how they collectively contribute to extending knowledge about integration in project business. The critical project functions in the studies have resulted in the proposed integration mechanisms that contribute to the overall value creation processes where entire project value chains have been integrated.

In summary, the way each of the thirteen integration mechanisms (Table 9) was developed, is the following:

1. Meetings, observations, workshops (initial design study) and interviews (commissioning and operations case studies), supplemented with documentation and other materials in order to collect data (see 3.2 and 3.3).
2. Writing summaries of the collected data in order to reflect on and to consider relevant topics and categories connected to the studies and interview questionnaires, as the first part of the data analysis (see 3.4).
3. Discussions, meetings and workshops with fellow researchers and industry representatives in order to further analyze and categorize the collected data, as the second part of the data analysis (see 3.4).
4. The integration mechanism was developed as a result of the data collection and data analysis conducted in 1-3 above.

3.1.1 Collaborative research

In order to increase the understanding of managing integration in the business of industrial projects, a collaborative research approach is taken. Collaborative research refers to the effort by two or more parties working together – in which 1) at least one is a member of an organization or system under study and 2) at least one is an external researcher, [...] with the intent of both improving performance on

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the system and adding to the broader body of knowledge in the field of management (Pasmore et al. 2008 p. 20). This form of knowledge creation is by Schein (2001; 1995; 1993; 1987) referred to as 'clinical research' and it is also known as 'process consultation'. 'Engaged scholarship' is another term for collaborative research, discussed by Van de Ven and Johnson (2006). This term used by Van de Ven and Johnson (2006) is based on the strategy of exploiting differences in the forms of knowledge that scholars and practioners can contribute to a problem of interest. Hodkinson et al. (2001) and Pettigrew (2001) further claim that research needs to achieve the dual objectives of applied use and advancing fundamental understanding, which addresses the meaning of management research. The dual objective is further addressed in the question of differences of knowledge-creating systems in academia and management consulting and the tensions that need to be overcome in the collaboration between academics and practioners (Werr and Greiner, 2008).

The present research, which has been carried out in three steps, is twofold. First, the initial study of the design function (step one) in cruise ships projects was carried out as part of a development program on shipbuilding in Finland, due to the changing paradigms in the shipbuilding industry. In this study, which was conducted in 2005, professionals from eight companies participated in workshops, held meetings, and discussed different aspects of the design phase in cruise ships projects whose supplier network they had been part of or at that time were still part of (Paper I).

Second, two case studies were conducted at Company X. The study of the commissioning function was carried out in 2006 (step two, paper II) and the study of the operations function was carried out in latter part of 2006 and the early part of 2007 (step three, paper III). Company X, the case company in the two case studies, is a supplier of power solutions for the marine and energy markets. The company has about 17500 employees in 160 locations in 70 countries worldwide. The headquarters of the company are in Europe. Company X was established in the 1880's and since then the company has transformed its functions through a wide range of traditional industrial manufacturing areas to become the company it is today. In the case studies, carried out within the ship machinery and power plants projects executed by Company X, experiences from several projects over many years were discussed and reflected upon together with the professionals that had participated in the projects.

The projects discussed, and reflected in the initial design study and in the commissioning and operations case studies consist of different scopes provided to customers operating their businesses in different geographical areas under different conditions and for different end-customers. In some of the projects, the customer was known by the supplier from earlier projects and in some cases the scope that was provided was similar to a scope that had been provided earlier to another customer. In line with the propositions of Gustafsson et al. (2008 p. 99), it is thus argued that “no industrial project is the same and yet they all share certain characteristics”. The five categories of project characteristics (see appendix 1 for classification of projects and a comparison of the studies) suggested by Gustafsson et al. (2008) are: project size and length; life-cycle complexity; customer; sub-suppliers; other stakeholders. Following this reasoning, it is apparent that the capabilities needed for providing successful projects differ to some extent between the projects considered in the three studies. Basically, the experiences from the projects that are considered in the studies face different degrees of uncertainty and complexity, in relation to the five categories listed above. Drawing on the fact that the projects and their scopes are different by nature, it is important to note that the complexity and uncertainty of a project varies at different stages during the project’s life-cycle. This means that as the contents of these projects, and the contexts they are carried out in are diverse, the integration mechanisms needed for different functions during the life-cycles of these projects also vary.

In the studies, the markets for the projects under consideration were the following:

- The shipbuilding industry:
 - The segment of cruise ships
- The power generation industry:
 - The segments of propulsion and machinery concepts for cruise ships and merchant vessels
 - The segment of oil power plants for the decentralized power generation

Table 4 summarizes these two industries³⁴ and compares some of the characteristics which specify the state of the context and content.

³⁴ For a broader review of product and process descriptions for these industries, please see Hellström (2005) and other industry related documentation.

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These characteristics include the industry segment, the delivery range, the scope of supply, the customer, the end user, the project location and the distinct features and in which of the studies and papers the industry segments constitute the context.

Table 4. Characteristics of the shipbuilding and power generation industries

<i>Characteristic</i>	<i>The shipbuilding industry</i>	<i>The power generation industry</i>	
Segment	Cruise ships	Propulsion and machinery concepts for cruise ships and merchant vessels	Power plants for decentralized power generation
Delivery range	Cruise ships and ferries	Equipment Integrated solutions	Equipment Equipment and engineering EPC
Scope of supply	Cruise ships and ferries for passengers, cars and cargo (design and engineering of a cruise vessel, life-cycle services)	Low- and medium-speed engines Propulsors/propulsion packages Automation and generating sets Engine auxiliary systems Environmental technologies	Turnkey power plants (typical plant sizes 1-300 MW) Engine units (typical unit size 1-17 MW) Extensions to existing power plants/equipment
Customer	Ship owners	Ship owners Ship yards	Utilities and independent power producers Energy firms Industry
End user	Passengers Operators	Cruise and ferry Merchant Offshore Naval Special vessel	Oil and gas industry Mining Cement manufacturing Textile industry Food processing Pulp and paper mills Municipalities
Project location (building site)	Yard	Yard	The developing world Remote areas, islands
Distinct features	Typical size: 225 000 gross tonnage and over 300 meters, occupancy over 3500 passengers 'Floating cities' incl. amenities such as cabins, restaurants, bars, gambling space, pools, shops, sports facilities (ice skating & rock-wall climbing), theatres etc.	High-capital investments with life-cycles of decades	Fuels: diesel oils and heavy fuel oils, crude oils, liquid biofuels, biomass
Employed in the following study	The initial design study	The commissioning case study The operations case study	The commissioning case study The operations case study
Papers	I, IV	II-IV	II-IV

The benefit of the close cooperation between industry representatives and academics is that both scientific and professional needs are taken into account. This interaction ensures that the knowledge that is generated is relevant and novel and has at least to some parts been tested and evaluated in applied settings during development. This also enhances the conceptualization of the results. The collaboration between academics and professionals has a limitation in that the research may be directed too much by the current agenda of interest of the industry in question. This is, however, avoided through striving continuously to present the results at academic conferences and by publishing in academic journals, where the results are usually peer reviewed by more than one expert. This research approach, which is employed by PBI, has enabled an approach where the results can simultaneously be tested for practical relevance or validated and falsified (Popper, 1935), with regard to the theoretical contribution.

Moreover, in this thesis the objective is to extend knowledge about integration in project business by exploring industrial projects. The qualitative data for this exploration has been collected by employing different methods such as interviews, discussions, observations, meetings and workshops. Denzin and Lincoln (2000 p. 3) describe the approach of a qualitative researcher as “study(ing) things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them”. Qualitative researchers are also described as deploying a wide range of interconnected methods, hoping to obtain a better understanding of the subject matter at hand. Table 5 provides a methodological summary of the studies: industrial context; unit of analysis; description and characteristics of the unit of analysis; studied actors; data collection methods; empirical sample; methods of data analysis and in which of the papers the study is employed.

Table 5. *Methodological summary*

<i>Methodological aspect</i>	<i>The initial design study</i>	<i>The commissioning case study</i>	<i>The operations case study</i>
Industrial context	Cruise ships	Propulsion and machinery concepts for cruise ships and merchant vessels Oil power plants for the decentralized power generation	Propulsion and machinery concepts for cruise ships and merchant vessels Oil power plants for the decentralized power generation
Unit of analysis	The design function	The commissioning function	The operations function
Description and characteristics of the unit of analysis	An initial project phase, in which critical project components (products, systems, processes and resources) are evaluated and planned Several actors from different industrial disciplines Often several and conflicting areas of interest among the participating units → different delivery scopes and different goals	A project phase in which the different parts of the project are brought together and should work as a whole The coordination and integration efforts of different actors can be seen as the functional result Many different sub-systems and technical components Conflicting requirements and standards	Typically the end phase, in which the project has been handed over to the customer, who runs and operates it This phase often lasts for several decades The customer either operates the investment or outsources operations activities Customer and situation specific
Actors which have been studied	The supplier Sub-suppliers	The supplier The sub-suppliers The customer	The supplier The customer
Data collection methods	Workshops, supplemented with process descriptions received from the participating companies, telephone interviews	Case study Semi-structured face to face interviews supplemented with process descriptions and documentation received from the participating companies	Case study Semi-structured face to face interviews supplemented with marketing documents
Empirical sample	Twenty experienced professionals (e.g. technical managers, coordinators, engineers, and designers) from eight different companies within the marine industry	Fifty-two experienced professionals (e.g. project managers, commissioning managers, personnel from sales, support, site and operations and maintenance departments)	Twenty-three customers, account managers
Methods of data analysis	Content analysis, categorization of main concepts, discussions with fellow researchers and practitioners, within-and-across case analysis	Content analysis of transcribed interviews, categorization of main concepts, discussions with fellow researchers and practitioners, within-and-across case analysis	Content analysis of transcribed interviews, categorization of main concepts, discussions with fellow researchers and practitioners, within-and-across case analysis
Data employed in papers	I, IV	II, IV	III, IV

3.1.2 Case studies

In order to study integration, collaborative research including case studies and process analysis, guide the data collection. A case is understood as the empirical unit that constitutes the context for the study (Ragin and Becker, 1992), which in this thesis is the case company, Company X. The two units of analysis are the functions of the commissioning and operations phases in projects delivered by the case company.

According to Eisenhardt (1989 p. 548) “theory developed from case study research is likely to have important strengths like novelty, testability, and empirical validity, which arise from the intimate linkage with empirical evidence”. Pettigrew (2001) further states that for process analysis events and chronologies are crucial and that the aim of the analysis is to produce a case study, not a case history. Moreover, according to Pettigrew (2001) the quality of a process analysis lies in the linkage of processes to outcomes, as well as linkages of the analyses of the outcomes to the process under investigation. When conducting process research temporal interconnectedness, searching for holistic rather than linear explanations of processes, and a need to link process analysis to the location of outcomes, are the embedded characteristics of the consistent guiding assumptions.

According to Yin (1981) no fixed recipes exist for case study research, and the situation of a researcher is compared to the work of a detective: a researcher has to evaluate a multitude of choices during a research process following the case study approach in order to produce conclusions relevant to the research community. In other words the researcher has to face the requirement of making the most relevant and wise choices, amongst multiple available alternatives which can be seen in different lights depending on the perspective from which the problem is observed.

According to Benbasat et al. (1987) three outstanding strengths of the case study approach can be identified: the phenomenon can be studied in its natural setting and thereby theories can be generated from practice; the case method helps to understand the nature and complexity of the process taking place; the case method tends to make itself early, exploratory investigations by which valuable insights can be gained. Remenyi et al. (1998) point out that empirical evidence must never be collected in a theoretical vacuum. Thus it is important

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that the researcher sees the collection of empirical evidence in relation to the underlying concepts and paradigms which will shape and determine the evidence that is collected.

As Eisenhardt (1989) points out, the selection of cases and the concept of a population are important aspects in case studies, especially in building theory from case studies. In the situation where a researcher is near the closure of the research, it is important to stop adding cases if theoretical saturation has been reached. It is also important to stop iterating between theory and data when saturation is reached. That is, when any incremental improvement to the theory is minimal.

The studies of the commissioning and operations functions at Company X form the basis of this research, where the two fields of analysis are the commissioning and operations functions (see table 5). Although the case studies in this research focus primarily on two project functions, these two functions together represent highly critical functions during the life-cycle of an industrial project. The commissioning and operations functions were selected because these two functions are strongly interlinked to the overall life-cycle by the fact that all the project phases and functions have joint interfaces in terms of taking into consideration customer needs, collective recourses and shared information channels. These represent some of the several joint interfaces.

3.2 THE RESEARCH PROCESS

The research process can be divided into three steps, each consisting of one study resulting in one paper, which has then shaped the direction of the study in the next step and the following papers. The fourth paper synthesizes the concepts built up along with the initial design study, and the commissioning and operations case studies.

3.2.1 Step one: the initial design study (Paper I)

The initial design study explored integration in the beginning of a project, focusing on the functions during the design phase. The data

was gathered as one part of a development program³⁵ on shipbuilding conducted in Finland. The study that was initiated by the changing paradigms in the marine cluster, more specifically within the shipbuilding industry and segment of cruise ships, offered an opportunity to discuss the current problems with expert professionals within marine project networks, i.e. the challenge of coordinating design activities and resources in the rapidly transforming projects. In this study, a company consortium consisting of professionals from eight companies set out to explore new business concepts for the designing and provision of modularized systems for cruise ships. One of the eight companies was a supplier of maritime air conditioning systems; one a manufacturer of prefabricated modular cabins; two were naval architecture and engineering firms; one was a supplier of ship interiors; one a supplier of passenger and cargo lifting equipment; one a supplier of power solutions for marine markets, and one a shipyard. The overall objective of the program was to assist the companies to increase their competitiveness in international markets by:

- outlining how the tasks and responsibilities during development of modular machinery and equipment should be distributed;
- outlining how the interfaces during the development should be handled;
- outlining how the milestones and phases should be organized;
- suggesting a new way to maintain the design function in the marine cluster,

and at the same time acknowledging the specific needs of all the companies contributing to the study.

Discussions, workshops, and follow-up meetings were held together with representatives of these eight companies. In the beginning of the project, four project teams each consisting of five to six professionals (technical managers, coordinators, engineers and designers) from the participating companies were established and these teams corresponded to the production units of a ship. The ship as a whole; the engine room; the shaft areas; the cabins and the public areas (see appendix 2 for the four teams). Multiple researchers participated

³⁵ In 2003 The Association of Finnish Marine Industries and TEKES (The Finnish National Technology Agency) launched a national program for the Finnish marine industry, MERIKÉ. The overall objective of the program was to assist Finnish industries in maintaining their competitiveness in international markets.

in the four sub-projects and validated the outcomes from the discussions with the company representatives during the sub-project specific workshops that were held. In addition to the memorandums written after each of the discussions and workshops, the data was supplemented with technical drawings and documentation, process charts and other relevant documentation acquired from the participating companies. The data collected in this study is employed in paper I, which discusses how systems providing feedback control should be understood and implemented during the initial activities of industrial projects.

3.2.2 Step two: the commissioning case study (Paper II)

In this case study, integration during the commissioning function was studied, in order to evaluate the phase in an industrial project where all the interdependent parts of the solution should be properly coordinated and the functioning of the solution should be ensured, before transferred to warranty and operations. Commissioning is a critical phase during a project, which often contributes to how the customer's view of the supplier's project capabilities is formed, as a result of how well the solution functions. It is considered a critical project function that can be seen to start already during the sales phase.

The study was initiated by discussions at middle managerial level in the power plants segment at Company X, regarding the current state of the commissioning function in the power plant projects. Numerical customer feedback collected from several projects over a number of years showed that Company X was graded low concerning the commissioning in power plant projects, and therefore the commissioning function, its routines and procedures, needed to be evaluated and developed (see appendix 3 for a description about the numerical customer feedback). The study was carried out in three steps: 1) evaluation of commissioning routines at Company X; 2) benchmarking with nine companies; 3) synthesis of steps one and two.

The first step of the study aimed at an overall view of the routines and procedures of the commissioning function at Company X. The focus was on interviewing professionals working with various project activities (see appendix 4 for list of interviews). This research

design aimed at achieving a comprehensive and realistic view of the current way of working at Company X as regards commissioning. The interviews covered the traditional project phases (sales, design, manufacturing and factory tests, installation, handing over, warranty, operations) in terms of how the activities carried out influenced the commissioning. In particular, the interviews covered the following topics: roles and responsibilities; documentation; customer involvement; current problems and the ideal process or 'best practices' for commissioning (see appendix 4 for the interview agenda). In addition to the conducted interviews, relevant documentation such as commissioning process charts was also accessed.

In order to gain a comparative and wider understanding of commissioning routines and procedures in industrial projects, nine companies representing the marine, power and pulp and paper industries were studied for benchmarking purposes in step two of the study (see appendix 4 for the benchmarking interviews). As in step one, during step two the interviews also covered the traditional project phases (see above) in terms of how they influence or are influenced by the commissioning function.

In step three, the findings from the interviews conducted at Company X were compared to the findings from the interviews conducted for benchmarking purposes. The aim was to study if similar procedures, problems, or challenges related to commissioning, that were identified in Company X, could be identified at other companies delivering similar projects. The collected data is employed in paper II, which discusses what the character and implications are for integration in delivery projects under new circumstances.

3.2.3 Step three: the operations case study (Paper III)

In this case study, the operations function in industrial projects was studied in order to analyze if a customer's overall purchasing behaviour is related to the customer's strategies or to how the supplier is seen. A second aim was to identify ways in which the supplier should respond and improve the situation in order to enhance positioning in the market and to develop market opportunities. In addition improving profitability by focusing on customers and being able to provide solutions for the specific needs of customers was considered.

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The operations study was initiated by a segmentation study in which numerical customer feedback from customers of Company X were compared with sales figures in order to identify customer characteristics (see appendix 3 for a description about the numerical customer feedback). These characteristics were used to discover whether and how any patterns in the different purchasing behaviours of customers could be explained (Gustafsson and Arhippainen, 2006). The manner in which Company X was, at that time, grouping their customer base into groups that share similar characteristics, was according to demographics, industry, or other typical external factors. This transpired not to correspond to their customers' needs. The outcome of this segmentation study was a pattern showing that the customers can be divided into four main categories, i.e. four different customer segments in terms of their purchasing behaviour and how they view the supplier: 1) Company X is a reliable supplier of service and components; 2) Company X is a reliable supplier of components; 3) Company X is one of many component suppliers or 4) Company X is a supplier one can outsource to.

Based on the findings above, concerning the division of customers into four segments (1-4), questions regarding customer behaviour and the performance of Company X were raised. To discover what influences a particular customer's view of Company X, interviews with 23 customers were conducted (see appendix 5 for list of interviews), each customer representing one of the four segments. Previous to these interviews, separate interviews with the account manager for each of these customers, were conducted. The reason for first conducting interviews with the account managers was to determine the sales and claims history (see appendix 5 for interview agenda nr. 1 for the account managers). Then interviews with the 23 customers were conducted in order to ascertain patterns in the terms by which the customers described Company X, the market situation in general, their current business strategy and the reasons for their purchasing strategy (see appendix 5 for interview agenda nr. 2 for the customers). The purpose of these two sets of interviews was to identify potential differences between how the customer and account manager described the relationship and the offerings. The data collected in this study is employed in paper III, which discusses whether companies that acquire the capabilities of integrating services with products, in order to provide solutions for their customers, increase their competitiveness. The further question was what the critical capabilities they needed to develop were.

3.3 METHODS OF DATA COLLECTION

The nature of the study guides the methods used during a research process. In this section the methods which have been employed for data gathering are presented: the interviews, the meetings, observations and workshops, and the documentation and other materials.

3.3.1 Interviews

In this sub-section, the reason for interviews being chosen as the main source for information in the studies is described. First, interviews are considered a well-established method by many scholars. For instance, Yin (1994) describes them as 'essential sources of case study information', Robson (2002) considers them as 'powerful tools' and Stake (1995) refers to them as 'the main road to multiple realities'. Robson (2002) further points out that an interview is an adaptable way of discovering things. These views also emphasize how important it is to recognize the many different ways of interpreting the answers obtained in an interview, which affect and contribute to the different conclusions made later during the research process.

Second, as the aim of the conducted interviews was to evaluate and develop processes, a form of semi-structured, open-ended, in-depth interviewing was chosen. 'Semi-structured' and 'open-ended' refers to interviews based on predetermined questions, the utilization of which is affected by their appropriateness to the depth of response that is sought (Robson, 2002). Typically, the researcher uses so-called check-lists or agendas displaying the topics of interest. As the interview proceeds, the topics are discussed with the respondent in such an order that preferably suits the discussion. The interviews conducted for this research resemble the semi-structured and open-ended interviews, as they were characterized by conversation based on an interview agenda. The character of the conversation made it possible for the interviewer, during the discussion, to focus on what was found to be most important at that time, in relation to the interview agenda. This form of conducting interviews also gives the respondent the possibility to bring into the discussion important items that the interviewer might not have considered, but that might also be relevant and of high value to the topic under discussion.

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Third, because the interview agenda is not too rigid, flexibility can be brought into the interviews. Hence it is possible to choose and discuss respondent specific items, such as, for instance, the respondent's earlier experiences, specific work tasks, memories regarding the matter of interest and so forth. Thereby some critical but unexpected data can be accessed. Possible misunderstandings are relatively easily solved during these types of interviews where the matter of interest can be discussed in more detail if needed, and thus misleading conclusions are often prevented. In other words, the in-depth interview process allows the researcher to 'dig deep' into issues which transpire to be respondent specific, and thus these interviews may result in unexpected but valuable and unique information. This approach offers the researcher the possibility to experience more than was expected, by revising and discussing the topic in a unique relationship with the respondent's experiences.

In order to achieve a comprehensive and realistic view of the present routines, procedures, and processes when working in projects, professionals with strong qualifications and experience regarding the particular functions under study (design, commissioning, or operations) were invited to be part of the interviews at the proposal of the managers in key positions in the studies. The potential respondents were approached either by e-mail or phone in order to agree on a suitable time and place for conducting the interview. Each interview lasted for one to two hours, and they were recorded and later transcribed to ensure accuracy and for analysis purposes. In addition to the initial identification of respondents for the interviews, the managers in key positions in the studies played an important role throughout the studies as several times they provided critical and up-dated information, that was considered important for each of the studies (see 3.3.2).

The conducted interviews were mostly face-to-face interviews (Table 6). A few telephone and written interviews were also conducted. The reason for primarily conducting face-to-face interviews is that this approach offers flexibility and a possibility to identify and interpret responses expressed by body language and visual cues in addition to the direct, verbal communication. Unfortunately, this is something that the telephone and written interviews lack.

Table 6. Overview of the interviews

<i>TYPE OF INTERVIEWS</i>			
	<i>Face-to-face</i>	<i>Telephone</i>	<i>Written questionnaire</i>
Number of interviews	73	9	2
Distribution of interviews between studies	Commissioning: 50 Operations: 23	Design: 9	Commissioning: 2

Despite the fact that the interviews are considered a positive, flexible, adaptable, and interpretative way to discover information, there are also weaknesses identified which cause limitations on the method. Such limitations originate, for instance, from language barriers (when languages other than the mother tongue are used) and confidentiality issues. The level of interpretation that the researcher makes during the interview and analysis, is a further limiting issue. Such limitations are acknowledged here.

The author conducted all telephone interviews in the design study. The majority of face-to-face interviews and two written interviews in the commissioning study were also conducted by the author. In the operations study, the author conducted 12 of the 23 face-to-face interviews. In all three studies, the author was involved in the analysis process of the interviews, which involved discussion and elaborating on the findings together with fellow researchers, as well as outlining the further steps for the research.

3.3.2 Meetings, observations and workshops

Each of the studies started with an initial meeting and then one or two follow-up meetings. During the meetings managers who came to be in the key positions of the studies, and researchers participated in guiding the focus of the research into a direction of increased relevance for both the industry and academia by sharing critical knowledge, information and ideas. The purpose of the meetings was to evaluate different ways of approaching the particular matter of interest. During the meetings, the author observed and participated in the discussions and listened to shared experiences,

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stories, problems, and related issues that were put forward regarding a particular interest in each of the studies. After the meetings, the observations were recorded in minutes by the author, which were then sent out to all meeting participants for comments and further refinement.

While the studies progressed, a constant dialog was held with the managers in key positions of the studies, which made it possible to keep different parties up to date on how the studies were evolving and issues regarding, for example scheduling, travel arrangements, and other themes that could be of interest to the managers. During these discussions, possible changes could also be discussed and preliminary results presented.

In each of the studies there was a final step where a workshop was arranged, which typically lasted for one day. The workshops involved the key professionals from the participating companies, managers in key roles in the studies, and researchers. The participants of the workshop discussed and evaluated the results and recommendations of the study. The aim of the workshops was also to further refine and validate the results, and to develop action plans for how to convert the recommendations into practice within the project companies and networks.

3.3.3 Documentation and other materials

In addition to the interviews, meetings, observations and workshops, also other materials was used to increase knowledge concerning the functions and processes under study, such as, numerical customer feedback, materials such as reports and documentation, minutes of meetings, process descriptions, process charts and web-pages. The documentation and other materials were either company specific or strongly related either to the studied project functions or studies conducted earlier in relation to the subject of a particular study. They were used for preparing discussions and for formulating questions for the interviews, for contrasting the interviews and discussions, and for reference purposes.

3.4 DATA ANALYSIS

The data analysis is characterized by an iterative process, involving a regular moving back and forth between literature, empirical observations, interview data, documentation and other materials, and the various ways of categorizing and describing. This follows Miles' and Huberman's (1984) approach, which is an overlapping approach to data analysis including data reduction, data display, drawing conclusions, and verification.

For the data analysis the following iterative methods were applied:

1. Categorization of the main concepts of the documented data through content analysis.
2. Regular discussions and workshops with fellow researchers and professionals from industry in order to evaluate results and report the results of the research.
3. Within-and-across case analysis to compare the studies and their outcomes to outline similarities and differences between them. Based on this analysis some future research directions are proposed.

The structuring of the collected data can be considered the initial step of the data analysis. This was done by writing short summaries of the meetings the author attended (which were later transformed into the minutes of the meetings), and of the conducted interviews immediately after the data had been collected. In the summaries, certain points of interest of a particular study were considered, and documented for further analysis. Writing these summaries was an excellent opportunity for the author to reflect the quite recently conducted interview or meeting. The aim of the summaries was to support the next step of the analysis by writing down the most relevant topics and categories discussed with the interview respondents or professionals in key positions of the studies. Most of the recorded interviews were transcribed, which helped in the further analysis when the contents of the interviews were additionally described in order to analyze the categories and contextual factors in more detail.

The minutes of meetings, the summaries of interviews and the interview transcripts together with additional documentation

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formed the basis of the reports that were prepared based on each study, involving triangulation (Yin, 1994). These reports can also be considered 'case descriptions'. In these detailed reports, patterns were searched for by performing within-case analysis (Yin, 1994). These descriptive reports including the results and recommendations were then presented to the professionals in key positions of the studies and other company representatives during the one-day workshop arranged as the final step in each of the studies. During these workshops the results and recommendations were discussed in detail and the participants had the possibility to question the statements by the researchers. The aims of arranging the workshops were to present and elaborate the findings, to further refine and validate the findings and statements.

In parallel with the studies, regular discussions and meetings were held with fellow researchers, and there were also meetings arranged with the industry representatives in order to maintain a constant dialog and to report and evaluate initial findings during the time the studies were in progress and ongoing.

As has been described earlier, the writing of the papers was a highly iterative process moving between research questions, literature studies, collected data and the data analysis, including many discussions with fellow researchers and the co-author(s) in order to compare and contrast the research findings. Each of the papers was rewritten several times, before it was considered to be in a form that it could be submitted for review to a journal or the book editors. The writing process also included several earlier versions of the papers, which were presented at conferences where research colleagues had an opportunity to comment on the relevance of the paper for the academic community. On many occasions some of the statements in the papers were questioned, resulting in constructive feedback. Based on the feedback some sections in the papers were then re-written.

The schedule for writing the papers was such that a paper was written based on the findings of a study as it was completed. This meant that a new study had usually already started by that time. Although the focus of a paper was on the already completed study, some ideas from the next study also are present in the papers. This is because the author's understanding of integration during a project's life-cycle increased together with the evolvement of the following study and insights into a particular project function.

3.5 RESEARCH QUALITY

For the research to present a logical set of statements, it is necessary to ensure the quality of the research. The quality can be examined, for instance, by evaluating the methods used or the result, which will show how well the methods have been applied in the research design and how applicable the result is. A more common way to establish the research quality is to address the validity and reliability of empirical social research (Yin, 1994). As the initial design study and the commissioning and operations case studies are of empirical nature, addressing validity and reliability is most applicable here.

3.5.1 Validity

Validity can be divided into construct, internal and external validity (Yin, 1994). Construct validity refers to establishing correct measures for the study (critical for data collection). Internal validity (for explanatory and causal studies only) is concerned with establishing a causal relationship where certain conditions lead to other conditions (critical for data analysis). Finally, external validity deals with the question of whether the findings can be generalized beyond the study in question (critical for the entire research design).

In order to assure the construct validity, multiple data sources and data and methodological triangulation (Denzin, 1978) have been applied. To justify the external validity of the thesis, the context of projects that have been studied have been limited to concern only those large-scale industrial solutions projects that are provided to customers acting in dynamic, complex and situation specific environments.

3.5.2 Reliability

The objective of the reliability, which is critical for the overall data collection is to evaluate how well the study can be repeated (Yin, 1994). This means that another researcher should be able to arrive at the same conclusions when repeating the same study, by following the documented procedures in the completed study. According to Yin (1994), reliability can be achieved by creating protocols of the case studies and by developing case study data bases, i.e. by documenting the methodology thoroughly.

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The reliability has been assured by systematic reporting and documentation of the research steps. Most of the face-to-face interviews have been recorded and transcribed and the meetings and workshops have been documented. The findings of the analyzed data have been discussed and verified together with industry representatives and the results were reported back to them during joint meetings and workshops. It should be noted that as this thesis draws on a collaborative research approach, some characteristics typical to collaborative research, which limits the repeatability are acknowledged, such as the fact that the relationship between the people and the events is situational and context specific.

3.6 SUMMARY OF RESEARCH DESIGN AND METHODOLOGY

In this chapter the research design and applied methodology is presented. First, the research approach and the research process are described and then the methods of data collection and data analysis are presented, followed by a reflection on the research quality. Table 7 summarizes the papers.

Table 7. The papers

Study	Research question(s)	Data sources and data collection	Data analysis	Main contribution
<p>Paper I: Feedback control as a means for integration in industrial projects: industrial design and the human dimension <i>Linimaa, J. (2008). In Minina, V., Wikström, K., Gustafsson, M. and Kosheleva, S. (eds.) New Challenges to Managing Organisations in Project Business, St. Petersburg State University Graduate School of Management, St. Petersburg, pp. 186-205.</i></p>	<p>The initial design study</p> <p>How should systems providing feedback control be understood and implemented into the undertakings of industrial project organizations?</p>	<p>Twenty experienced professionals (e.g. technical managers, coordinators, engineers and designers) from eight different companies within the marine industry</p> <p>Workshops, supplemented with process descriptions received from the participating companies, telephone interviews</p>	<p>Content analysis</p> <p>Categorization of main concepts</p> <p>Discussions with fellow researchers and industry representatives</p>	<p>Definition and description of four integration mechanisms</p> <p>Four categories representing critical elements to focus on for an integrative approach in the beginning of an industrial project</p>
<p>Paper II: Integration as a project management concept: a study of the commissioning process in industrial deliveries <i>Kirsiä, J., Hellström, M. and Wikström, K. (2007). International Journal of Project Management, Vol. 25, No. 7, pp. 714-721.</i></p>	<p>The commissioning case study</p> <p>What are the character and implications for integration in delivery projects under new circumstances?</p>	<p>Fifty-two experienced professionals (e.g. project managers, commissioning managers, personnel from sales, support, site and operations and maintenance departments)</p> <p>Semi-structured face to face and written interviews supplemented with process descriptions and documentation</p>	<p>Content analysis</p> <p>Categorization of main concepts</p> <p>Discussions with fellow researchers and industry representatives</p> <p>Within-and-across case analysis</p>	<p>Definition and description of three integration mechanisms</p> <p>A framework pinpointing the technical and social dimensions of integration, emphasizing the importance of looking at the whole project life-cycle and its actors for carrying out integration</p>
<p>Paper III: Integrating the customer as part of systems integration <i>Linimaa, J. and Gustafsson, M. (2010). International Journal of Managing Projects in Business, Vol. 3, No. 2, pp. 197-215.</i></p>	<p>The operations case study</p> <p>Do companies that acquire capabilities of integrating services with products in order to provide “solutions” for their customers, increase their competitiveness? If so, which are the critical capabilities they must develop?</p>	<p>Twenty-three customers, account managers</p> <p>Semi-structured face to face interviews with customers, supplemented with relevant documentation</p>	<p>Content analysis</p> <p>Categorization of main concepts</p> <p>Discussions with fellow researchers and industry representatives</p> <p>Within-and-across case analysis</p>	<p>Definition and description of six integration mechanisms</p> <p>A description of how to manage the technical and social dimensions of integration by considering customer integration and service capabilities as part of systems integration</p>
<p>Paper IV: Integration in project business: mechanisms for knowledge integration <i>Linimaa, J. and Wikström, K. (2009). International Journal of Knowledge Management Studies, Vol. 3, No. 3/4, pp. 331-350.</i></p>	<p>The design, commissioning and operations studies</p> <p>What are the characteristics and implications of the mechanisms in knowledge integration in industrial projects?</p>	<p>See papers I-III above</p>	<p>Content analysis</p> <p>Across-case analysis</p>	<p>Description and categorization of the thirteen integration mechanisms according to the impact they have on the management of knowledge and information in industrial projects</p>

4

CHAPTER 4 RESULTS AND DISCUSSION

This chapter presents and discusses the research results. The findings from papers I–IV are elaborated on, and the findings are synthesized and further developed in order to make the contribution of this thesis exceed those results presented in the papers. The chapter will evolve from addressing the research problem to the findings in the papers, ending in a synthesis and further discussion.

4.1 ADDRESSING THE RESEARCH PROBLEM

Based on the literature review and a description of the research design and methodology, chapters 2 and 3 have created a basis for presenting the findings of the two fields of analysis that were formulated in chapter 1, and which have been addressed in the papers. The two fields of analysis are: 1) integration mechanisms for value creation in industrial project networks (Papers I–III) and 2) management of the integration process in project business (Paper IV).

The research questions addressed in papers I–III (see table 7) resulted in thirteen integration mechanisms. In section 4.2 these mechanisms will be elaborated. The mechanisms have been developed further, as presented in paper IV, which focuses on the second field of analysis concerning the process of managing integration for providing solutions in project business. The discussion on what the components and outcomes of the mechanisms for integration in industrial projects are follows the reasoning in section 4.2, while section 4.3 suggests a typology of four categories that should be addressed in project management for carrying out integration in the business of industrial projects. The typology is a synthesis of the findings presented in papers I–III and IV. In other words, the objective of sections 4.2 and 4.3 is to extend the knowledge regarding integration in project business, for which the papers have set the initial direction. This objective has been met by exploring integration mechanisms in industrial projects, and by suggesting a typology for how to manage integration in project business where solutions with different scopes are offered.

4.2 INTEGRATION MECHANISMS

Providing high-capital, engineering and knowledge intensive complex industrial solutions as projects requires repositioning and new approaches to strategic decision-making for the supplier's organization. Customers that invest in these solutions run their businesses and operate their investments in different environments where different country-specific, economical, political, sociological, and managerial principles, among a myriad of principles, should be acknowledged by the supplier that provides the solution. The repositioning in the value chain and altering strategic decision-making is primarily related to fulfilling customer needs. The needs can be fulfilled by providing the optimal value propositions to the customers in the form of solutions for their business needs. The repositioning is also related to increasing the market shares by innovative use of technologies and new products in order to combine products and services into new functioning solutions for ensuring even better performance of the investments. Therefore, one emerging supplier capability is to have the right mechanisms for integrating accurate and relevant knowledge and information from the project network (including different sub-suppliers) and the customer during a project's life-cycle. With respect to this, integration becomes especially critical regarding the mechanisms used to manage this integration across multiple knowledge bases in the project network, at different levels and in different organizational setups.

Altogether thirteen integration mechanisms that are related to different levels in industrial project networks have been identified through the studies of the design, commissioning and operations functions that have been conducted in the shipbuilding and power generation industries. By analyzing the data collected in the studies (using qualitative research methods) and in combination with the inductive approach of going back to theoretical perspectives in literature several times during the analysis, the integration mechanisms emerged. In the design study four mechanisms emerged (Paper I). Three mechanisms emerged in the commissioning study (Paper II) and in the operations study six mechanisms emerged (Paper III). These mechanisms constitute activities that enable integration to take place in industrial projects, and for integration to evolve and achieve innovative approaches during the life-cycle. In table 8 the thirteen integration mechanisms are summarized. In addition in which of the studies they were identified is presented, as well as in which of the papers each mechanism is first introduced.

Table 8. Thirteen integration mechanisms

<i>Study</i>	<i>Integration mechanisms</i>	<i>Introduced in paper</i>
Design	(1) Systems design (2) Technical evaluation (3) Technology management (4) Supplier management	Paper I
Commissioning	(5) Planning and coordinating activities (6) Interface management (7) Strategic decision-making	Paper II
Operations	(8) Interest in customer's need and business (9) Prompt response and solving of customer needs (10) Knowledge of technical development (11) Ability to listen to the customer and to reflect (12) Taking responsibility for the delivered installation after handing over (13) Logistics competence	Paper III

The thirteen mechanisms presented in table 8 display characteristics that are needed for achieving integration in order to ensure the most efficient and functioning solutions offerings. These mechanisms have a direct impact on the performance of the supplier, and consequently on the functioning and performance of the solution that the customer invests in.

The mechanisms can be argued to represent various tools, competencies, capabilities, and/or management areas. Drawing on the discussion about mechanisms in organization studies (see 2.1.1), the mechanisms in table 8 are referred to as integration mechanisms. In these mechanisms, the component parts of a certain mechanism and the interaction of these components produce the activity of the mechanism and its outcome (Pajunen, 2008 p. 1462), as will be described in sub-sections 4.2.1-4.2.4, see also table 9. The following sub-sections provide an overview of the thirteen integration mechanisms and discuss them in relation to the life-cycle of industrial projects, and evolving value chains in project business.

It is not claimed that all the mechanisms that are central in order to integrate in industrial projects have been identified. Other

integration mechanisms are most probably also present. The thirteen mechanisms which have been identified, were the most relevant and most mentioned integration mechanisms in the empirical data.

4.2.1 Integration mechanisms in the design study (Paper I)

In industrial projects the design function is often referred to as an initial project function (Table 5). One essential issue during the design function concerns how to prepare the sub-suppliers in the project network to meet the new requirements of shorter project life-cycles, including systems thinking and concurrently working cross-functional project teams; as these teams might not be familiar with working with each other previously. Cooperating with several actors is often an issue for sub-suppliers. The basic question that arises, and which is a fundamental condition, seems to be how the sub-suppliers of different systems and scopes are able to understand each other promptly regarding technical and contractual matters (concerning e.g. definitions, concepts, procedures and goals). This again has considerable consequences for the systems sourcing (e.g. Gadde and Jellbo, 2002; Trent and Monczka, 1998) as the systems that should be designed and build are often composed of many different products and sub-systems (that are delivered by several sub-suppliers) to form complex systems (mechanism: systems design). Therefore, complex systems often entail a large number of interfaces among the different sub-systems and sub-suppliers, which have to be taken into account and managed.

Networking, coordination, planning and decision-making activities regarding acquisitions, procurement and technical procedures should therefore take place in the initial project phases (mechanism: technology management). This is where an iteration of alternative concepts and ideas, before arriving at the most optimal idea, is more cost effective than later in the project. For instance, if different designs of a component are tested at a conceptual level before proceeding to manufacturing and installation (cf. common and shared computer-aided design systems, CAD), it will most probably have less costly consequences for the project than if a diverse set of designs not are tested until e.g. manufacturing. This means that technical and contractual definitions and specifications from different actors and sub-suppliers need to be evaluated early in the design, for the project

network to be able to make the most efficient decisions regarding the overall design of a system before it becomes costly (mechanism: technical evaluation). Obviously, these definitions and specifications need to be based on knowledge and information from the customer, revealing the customer needs and requirements that the solution should attain.

Because of the many interfaces that need to be dealt with in the beginning of a project, the design phase could be the starting point for a dependency-based view of managing technical and contractual procedures associated with the sub-suppliers and their scopes, in dispersed work settings. Therefore, addressing how to involve sub-suppliers more comprehensively into the project network becomes another crucial issue of integration (mechanism: supplier management). In the design phase, the sub-suppliers would be able to foresee more systematically the amount of work for which they are responsible, if they constantly receive current and up-dated data. This applies, for example, to incorporated data regarding the different sub-suppliers' scopes of supply, dependencies, interfaces between the scopes of supply (e.g. CAD applications), as well as the functionality parameters of each sub-supplier's scopes which affect and interact with the other sub-suppliers' scopes of supply. Moreover, if all of the sub-suppliers were aware of the various standardized procedures and the upcoming dependencies and interfaces between themselves and the other sub-suppliers in the network and their systems from the initial project phases, the process of each sub-supplier could be better organized to fit the purposes of other sub-suppliers and the main integrating supplier. This awareness would include, for example, distributing information to the sub-suppliers about the sales process of the solution, and on what basis the price is set for the different components or a complete system in the solution. This coordination of engineering, strategy, and systems design could then help to take the design of complex engineering intensive solutions in a direction where the requirements of customer needs and future projects are better met.

The mechanisms related to the design function constitute critical activities upstream in the value stream of capital goods (Davies, 2004). The systems design, technical evaluation and technology management are seen as formal mechanisms (Martinez and Jarillo, 1989) or market/bureaucracy devices (Ouchi, 1979), of the integration activities of a solution provider. Based to Ouchi

(1979) the components of supplier management reveal a less formal mechanism (or clan device), related foremost to information regarding engineering activities, interfaces and responsibilities between the parties. Moreover, systems design, technical evaluation and technology management can be seen as internal-operational (Barki and Pinsonneault, 2005) integration types, as they pertain to the primary activities of the supplier. Supplier management is more of an external-operational type mechanism, integrating several sub-suppliers in the project network, which is then directed backwards in the value stream.

These four mechanisms relate to the literature on capabilities for organizing internal and external project activities in a restructured way (Davies et al., 2007; 2006; Artto and Wikström, 2005; Davies, 2004) and to product-design challenges in service business (Brax, 2005). Moreover, these mechanisms reveal that the design function is a critical part to integrate into the value proposition phase of integrated solutions, for combining the most appropriate skills and recourses in the project network for being able to provide a high performing solution, for which a highly mature (Wikström et al., 2009) supplier is needed.

4.2.2 Integration mechanisms in the commissioning study (Paper II)

In industrial projects, the commissioning function is traditionally considered as the point in the project where all the parts should come together and work as a whole, i.e. be verified as a functioning solution, which meets the customer's quality targets (Table 5). However, commissioning often constitutes the end phase from the point of the view of the supplier and therefore the commissioning function is often described as 'the problem solving process of the project', rather than the start up of the solution or the handing over to the customer. The commissioning process is often further considered to be too time consuming as the activities are usually not well planned and unexpected changes (related to e.g. technical conformity issues) are often found in the different sub-systems (components, equipment and systems) that are delivered by different sub-suppliers and that should function together during commissioning. Unexpected changes are considered to be a result of documentation not being updated properly and an arrest in the information distribution channels

in the project network during earlier project functions, i.e. during installation, manufacturing, design and sales (mechanism: interface management). Commissioning activities therefore do not seem to meet the desired level regarding time, cost and quality. This can be considered a consequence of the fact that the whole commissioning process, and primarily its outcome, seems to be unclear and poorly defined among the project actors. A demand for clear performance guidelines, more strictly documented definitions and performance procedures would help to make the commissioning process more clear (mechanism: planning and coordinating activities). As one commissioning manager stated:

“If you ask X engineers to define commissioning, you will get X different answers”.

In relation to earlier discussion, the principal issue seems to be that commissioning should not be considered the final project function in which the solution is monitored according to specifications before handing over to the customer. Instead it should be seen as a preparation process for handing over the solution to the customer. This means that the customer needs to be more involved during the commissioning activities in order to learn about the investment's operations and performance before the handing over takes place and the customer needs to operate the solution. Basically, this means that the sub-suppliers, on different levels in the project network, and the supplier need to develop capabilities in order to deliver functioning solutions, and not merely the technical equipment or system to the customers (mechanism: strategic decision-making).

The mechanisms associated with the commissioning function, point to the importance of collaboration (Alderman, 2005; Weick, 1995) between the actors in the project network. The planning and coordinating activities which are of the internal-operational type (Barki and Pinsonneault, 2005) are considered to be formal (Martinez and Jarillo, 1989) and a market/bureaucracy device (Ouchi, 1979), whereas interface management and strategic decision-making are considered to be less formal (clan devices) and of internal-operational type.

By systematically following up and providing information, interfaces become easier to handle. Strategic decision-making through clearly defined target levels enhance the ability to meet the differing

customer demands and business cycles. This also related to the notion of involving the customer in the project at different stages during the project, so that the customer creates value together with the supplier (Ramaswamy, 2000).

4.2.3 Integration mechanisms in the operations study (Paper III)

In industrial projects the operations function typically lasts for decades (Table 5). Because of this the customer is not necessarily aware of the latest development regarding the technologies and systems applied in the solution in which the customer has invested. Nor does the customer have the same technology expertise or supplier base from which to source parts and knowledge for operating and maintain the solution. This indicates a need for the supplier to act proactively. A proactive approach here means that the supplier should have a continuous communication process with the customer and knowledge about each customer's specific business requirements and how these requirements relate to the functioning and operations of the solution (mechanism: interest in customer's need and business). One relevant issue for the supplier to reflect on is: 'What level of impact does it have for the customer's business if the solution does not function and operate as it should?'. For instance, future breakdowns would probably present a much smaller risk if the supplier, who is the expert on the offered technology, has the necessary organizational focus and commitment and communicates with and informs the customer on a regular basis. Additional examples of issues that the supplier should focus on when aiming at delivering a high performing solution are identifying maintenance and upgrading needs, foreseeing the customer's future business requirements, and the need for parts, engineers, and research and development (mechanism: taking responsibility for the delivered installation after handing over). These processes include supplier capabilities to ensure a harmonious and functioning solution, which can be attained if the supplier has key-knowledge about individual customers and their business needs. These needs include the ability to listen to customers (mechanism: ability to listen to the customer and to reflect), and respond to the customers quickly (mechanism: prompt response and solving of customer needs). This can be achieved when the supplier acknowledges the affect the solution has on the customer's business. When the supplier has the capabilities to approach customers with service and spare-parts on time, this most likely has a favorable

impact on future activities together with the customer. This will result in, and most likely be perceived by the customer as a highly valuable integrated service (mechanism: logistics competence). If a proactive approach is not practiced, the alternative for the customer is to invest in the necessary technological knowledge and to build experience regarding the operations of the solution over a long period of time, which is something that the customer does not often have the time or finances to achieve.

These so-called integrated services, which aim at ensuring that the solution is adapted to the customer's operations environment, increase the value of the supplier's offering. Integrated services, including a proactive approach, can therefore be considered key elements in an industrial solutions offering. However, engineering competence is not less important. Without expert technical knowledge, regarding the high-quality components and processes, the dimension of additional customer focus and support would be meaningless (mechanism: knowledge of technical development). Therefore, what is needed in a solutions offering is a dimension that ensures that the delivered technology functions according to the requirements in the operations environment of the customer.

The six mechanisms identified in the operations study are seen as less formal mechanisms (Martinez and Jarillo, 1989) or clan devices (Ouchi, 1979). Prompt response and solving of customer needs, knowledge of technical development, taking responsibility for the delivered installation after handing over and logistics competence are seen as external-operational-forward integration types (Barki and Pinsonneault, 2005). They are also seen as having downstream direction in the value stream towards the customer. Interest in customer's need and business, and the ability to listen to the customer and to reflect on their needs are seen as external-operational-backward integration types, in a downstream direction.

These six mechanisms are related to the literature on service providing, and to supplying the best process for the benefit (Wikström et al., 2009; Windahl, 2007; Vargo and Lusch, 2004; Oliva and Kallenberg, 2003) of the business driven business logic, which is the business logic many solution providers aim for.

Table 9 provides an overview of the thirteen integration mechanisms presented: components; outcomes; attributes and examples of related mechanisms and literature in organization studies (cf. 2.1.1).

Table 9. Components and outcomes of the integration mechanisms

Integration mechanism	Component(s)/Short description of the integration mechanism	Outcome/Potential implication(s) for industrial projects	Type of organizational integration ³⁶	Formality of mechanism ³⁷	Mode(s) of control ³⁸	Related mechanism(s) ³⁹	Related literature ⁴⁰
(1) Systems design	Systems design and engineering activities need to start before detailed design issues are stressed	Systems thinking help to clarify the technical and organizational dependencies	Internal-operational	Formal	Market Bureaucracy	Planning	Galbraith and Kazanjian (1986), Galbraith (1973), Thompson (1967), March and Simon (1958)
(2) Technical evaluation	As the scopes of delivery change, also the mindsets of technical (design) processes need to change accordingly e.g. which design processes constitute core design processes and which are sub-processes need to be re-evaluated Classification of different processes, interfaces and responsibilities need to be clear	By standardizing the technical procedures, the load of specific resources and actors, in relation to time and cost can be optimized	Internal-operational	Formal	Market Bureaucracy	Formalization and standardization	Galbraith and Kazanjian (1986), Simon (1976), Galbraith (1973), Pugh et al. (1968), Lawrence and Lorsch (1967b), Thompson (1967), March and Simon (1958)
(3) Technology management	Coordination, planning and decision-making activities regarding acquisition of resources, material and technical procedures should take place preferably during early design activities The technical specifications need to be evaluated at the same time as the design activities start The manufacturing procedures need to be re-thought in order to meet the new requirements	Principles for designing and manufacturing modularized entities are the starting point for a dependency-based view of managing technical procedures in dispersed work settings	Internal-operational	Formal	Market Bureaucracy	Formalization and standardization	Galbraith and Kazanjian (1986), Simon (1976), Galbraith (1973), Pugh et al. (1968), Lawrence and Lorsch (1967b), Thompson (1967), March and Simon (1958)
(4) Supplier management	Supplier engagement by intensifying information to sub-suppliers in the network regarding general arrangements, scopes of supply, dependencies, interfaces and functionality parameters affecting every sub-supplier's work Information to sub-suppliers about standardized procedures regarding e.g. the sales process and pricing already during project start-up	Clarifying the current and upcoming dependencies between different sub-suppliers and their systems early enough would make it easier for each sub-supplier to organize their own processes to suit the processes of the others	External-operational-backward	Less formal	Clan	Lateral or cross-departmental relations	Galbraith and Kazanjian (1986), Galbraith (1973), Lawrence and Lorsch (1967b)

36 Based on Barki and Pinsonneault (2004).

37 Based on Martinez and Jarillo (1989).

38 Based on Ouchi (1979).

39 Based on Martinez and Jarillo (1989).

40 Based on Martinez and Jarillo (1989).

(5)	<p>Planning and coordinating activities</p> <p>Credible plans for delivery process handling through continuous and open communication which is followed-up continuously</p> <p>The documentation need to be well structured, configurable and accessible to all that need it</p> <p>Changes (drawings, specifications, errors etc.) need to be well documented and easily accessible</p> <p>Responsibilities and roles need to be clear from the start of the project</p>	<p>When handling the documentation and change processes on a systematical and open basis the coordination of information in the project network is optimized</p>	Internal-operational	Formal	Market Bureaucracy	<p>Planning Output and behavioral control</p>	<p>Galbraith and Kazanjian (1986), Mintzberg (1983b; 1979), Ouchi (1977), Ouchi and Maguire (1975), Child (1973; 1972), Galbraith (1973), Thompson (1967), Blau and Scott (1962), March and Simon (1958)</p>
(6)	<p>Interface management</p> <p>Systematically follow up from where and about what information is received, and how it concerns oneself and others in the delivery chain</p> <p>Systematically provide information to those organizational functions in the delivery chain that are interfering</p>	<p>Proper communication and internal cooperation between the units in the project network makes the handling of technical, functional and organizational interfaces smoother</p>	Internal-operational	Less formal	Clan	Socialization	<p>Mintzberg (1983b), Pfeffer (1982), Galbraith and Edström (1976), Simon (1976), Selznick (1957/1984)</p>
(7)	<p>Strategic decision-making</p> <p>Define what the core function of the solution is</p> <p>Define a target level of performance for the solution in the beginning of the project for defining, the scope of supply</p> <p>Share a common opinion regarding the strategic choice among all parties in the project</p>	<p>When there is a common strategic choice and understanding between all organizational functions in the project network about the scope, solution providing becomes more efficient</p>	Internal-operational	Less formal	Clan	<p>Socialization</p> <p>Lateral or cross-departmental relations</p>	<p>Galbraith and Kazanjian (1986), Mintzberg (1983b), Pfeffer (1982), Galbraith and Edström (1976), Simon (1976), Galbraith (1973), Lawrence and Lorsch (1967b), Selznick (1957/1984)</p>
(8)	<p>Interest in customer's need and business</p> <p>Collect information about every customer's business requirements and operations environment</p>	<p>When improvements on the solution are done as soon as possible, the risk of downtime decreases and the operations is more efficient for the customer and the customer's business</p>	External-operational-backward	Less formal	Clan	Mutual adjustment and feedback	Thompson (1967/2008)

(9)	Prompt response and solving of customer needs	Give response to and addresses customer inquiries and problems thoroughly Be available to the customer 24/7 365 days per year If needed, be able to send qualified service personnel to the customer's location	Responding immediately, and thoroughly gives the customer an opportunity to concentrate on its business while the solution is taken care of by experts, which in turn increases customer satisfaction	External-operational-forward	Less formal	Clan	Informal communication Lateral or cross-departmental communication	Kortter (1982), Simon (1976)
(10)	Knowledge of technical development	Increase the knowledge base regarding updates on technology and generation processes Inform the customer proactively about updates and new technical solutions	When suppliers provide updates and improvements proactively, the customer can focus on its own core business activities	External-operational-forward	Less formal	Clan	Lateral or cross-departmental relations	Galbraith and Kazanjian (1986), Galbraith (1973), Lawrence and Lorsch (1967b)
(11)	Ability to listen to the customer and to reflect	Take time to listen to what customer says Take time to consider and evaluate the information received from customer	Future problems and breakdowns will be less problematic because of good communication	External-operational-backward	Less formal	Clan	Mutual adjustment and feedback	Thompson (1967/2008)
(12)	Taking responsibility for the delivered installation after handing over	Be committed to solving the problems the customer may have on the solution Supply the customer with the training and assistance which is needed for optimal operations Show interest in how the solution operates	If problems and breakdowns are worked on and solved on time then the customer does not need to argue with the supplier about claims and cost	External-operational-forward	Less formal	Clan	Lateral or cross-departmental relations	Galbraith and Kazanjian (1986), Galbraith (1973), Lawrence and Lorsch (1967b)
(13)	Logistics competence	Maintain knowledge about logistics on land, sea and air guarantees spare-parts and service availability	Customer can expect the supplier to provide spare-parts and service on time and has no need to invest in costly logistics	External-operational-forward	Less formal	Clan	Lateral or cross-departmental communication	Galbraith and Kazanjian (1986), Galbraith (1973), Lawrence and Lorsch (1967b)

4.2.4 Towards integration in industrial projects

As was indicated by the discussion in sub-sections 4.2.1-4.2.3, the mechanisms presented in table 9 are critical to differing extents during different phases of a project's life-cycle. All of the mechanisms affect the overall performance of the project with regard to the fact that they all, to some extent, are related to how the supplier and sub-suppliers in the project carry out their tasks, and to how the project evolves as a high-quality solution for the customer. Eventually each of the mechanisms also contribute extensively to how much value the customer sees in the solution in terms of how well the investment meets the quality targets and desired performance level during operations.

Drawing together the thirteen integration mechanisms described in the previous paragraphs it has further emerged that in each of the integration mechanisms there is constantly a technical and a social dimension present (cf. division of mechanisms into formal and less formal by Martinez and Jarillo (1989) as well as market, bureaucracy, and clan devices by Ouchi (1979)). This finding draws on the perception that while a mechanism consists of tangible elements that are often related to technical and contract associated issues (cf. formal/market/bureaucracy), the mechanism, at the same time, also consists of intangible elements connected to morale reflection and strategic assets (cf. less formal/clan) in order to be carried out. From this it follows that the technical and social dimensions of a mechanism interact, affect and reinforce each other constantly and in parallel:

- The technical dimension refers to those technical and contractual elements in a project that interact with and influence the product and process structures within the project, and accordingly its outcome and relation to the customer in terms of formal and contractual engineering activities.
- The social dimension refers to those elements that do not consist of contractual activities, but should rather be seen as closely related to how they are taken into account and performed. Therefore the informal, social dimension has a most valuable impact on the product and process structures in the project in terms of how well the overall project organization functions.

CHAPTER 4

As argued above, the technical and social dimensions of a mechanism should not be seen as separate or isolated from each other: the integration process should be considered as a process constantly in progress where the two dimensions are interacting and overlapping. In each of the mechanisms either the technical or social dimension is emphasized as being stronger than the other one, depending on the nature of the components of the mechanism. Figure 5 illustrates this distribution in which the dimension that is more emphasized in a mechanism is marked with '+', in contrast to the '-' which illustrates the dimension that is less emphasized.

Emphasis on technical dimension	Emphasis on social dimension	
+	-	1. Systems design
+	-	2. Technical evaluation
+	-	3. Technology management
-	+	4. Supplier management
+	-	5. Planning and coordinating activities
-	+	6. Interface management
-	+	7. Strategic decision-making
-	+	8. Interest in customer's need and business
-	+	9. Prompt response and solving of customer needs
-	+	10. Knowledge of technical development
-	+	11. Ability to listen to the customer and to reflect
-	+	12. Taking responsibility for the delivered installation after handing over
-	+	13. Logistics competence

Figure 5. Technical and social emphasis on integration mechanisms.

As is figuratively illustrated in figure 5, both the technical and social dimensions exist in each of the integration mechanisms. Thus

both dimensions must be acknowledged, understood and, most importantly, they must be accepted by the entire project network and its members at different levels within the network in order to be able to realize and achieve the integration that is needed in the project. The research result reveals that the most critical challenge arises when the suppliers strive to be more flexible and adaptive in their projects – from the point of view of both the technical and social dimensions – when providing better quality solutions by meeting customer demands on a more complex level.

As the present research shows, it is important for performance-oriented industrial suppliers and sub-suppliers to develop a structured process for integration in order to add value to the solution. For value creation in industrial projects the following four main components therefore need to be recognized and brought together at all times during the project life-cycle, and the value chain of the solution, correspondingly:

- The technical dimension of integration – integration of the technical and contractual (formal) elements in a project.
- The social dimension of integration – integration of the intangible (less formal) elements to see beyond the technical and contractual elements.
- Customer integration – integration of customer needs, experiences and knowledge.
- Project network integration – integration of knowledge and information regarding product and process structures at different levels in the project network.

Several authors in the stream of project business are reflected in the four components of integration above. These include Wikström et al. (2009) and Artto et al. (2008) as regards the evolving business logics of project-based companies, Lusch et al. (2007), Oliva and Kallenberg (2003), Galbraith (2002a) and Levitt (1983) as regards the customer centric and service-dominant business logic, Davies et al. (2006) and Davies and Hobday (2005) on the subject of the complex systems and integrated solutions provision (see also Windahl, 2007) and Principe et al. (2003) concerning the business of systems integration.

In the components of integration in industrial projects presented above it is considered that while the project evolves in the value

stream (Figure 2), the amount of social and technical emphasis on integration mechanisms vary (Figure 5) as they are needed to function simultaneously and interact concurrently. This is in line with what was discussed earlier, i.e. that the two dimensions should not be considered separate or isolated from each other. Instead, these two dimensions interact and function as drivers for the integration activities and therefore integration should be considered as constantly in progress.

In the components it is also considered that both the project network (supplier and sub-suppliers) and the customer affect the final project outcome by their interactions during the project's evolution in the life-cycle. The extent to which these actors affect the project varies during different phases in the project as the project value chain evolves. The importance of recognizing and having knowledge about different actors and their roles during the project is reflected in figure 6, where the roles of the project network (supplier and sub-suppliers) and the customer are figuratively illustrated⁴¹.

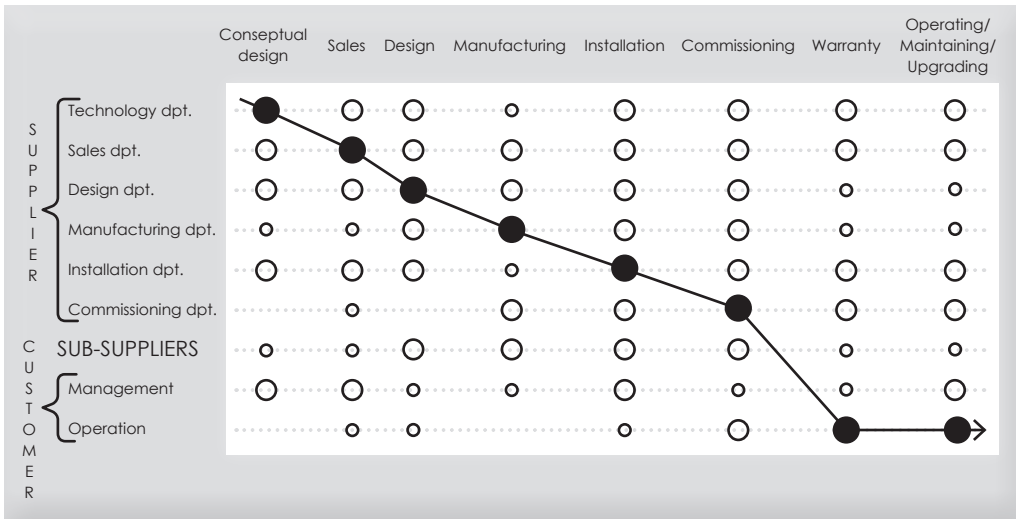


Figure 6. Figurative dependencies between different actors and departments in an industrial project.

41 Adopted from paper III.

In figure 6 the actor (or department) dominating the solution during a specific project phase is illustrated as a large black dot. The minor circles in the figure refer to those actors/departments that do not dominate the project during a particular phase. However, they are closely connected to it, and, are therefore, affected by as well as exerting affects on the activities carried out by the actor/department that has a dominant role during that particular project phase and on the other actors/departments. It can be seen that all actors and their departments respectively interact and are dependent on each other to some extent throughout the project, as the supplier, sub-suppliers, and the customer constantly carry out iterative information sharing processes along with the project's evolvement according to its life-cycle. The black arrow, which passes through all the dominating actors/departments (large black dots) and project phases, illustrates how the control of the project moves from one actor/department to the other as the project evolves.

It should be noted that for a supplier the need to carrying out integration is not concentrated to the phases where the supplier controls the project, i.e. until commissioning/handling-over. Integration takes place both before and after the traditional project execution functions (beginning with sales and ending in handing-over the project). When the customer operates the solution in an environment of high uncertainty where different situations⁴² can arise at any time, the supplier still faces the challenge of ensuring that the customer is able to achieve its business targets by the functioning solution provided by the supplier. Although it is the customer who is in control of the project (solution) during the warranty and operations functions, it is nevertheless in the interest of the supplier that the solution functions and performs on the desired level. The supplier, therefore, needs to be integrated into the activities of the customer as an influencing and value-adding party during warranty and operations (Paper III). This is similar to the customer and the sub-suppliers needing to be integrated in the earlier project functions when the supplier controls the project (Papers I and II). As is illustrated in figure 6, all the project actors, the project network and

⁴² *Examples of such situations and changes are: technological advances; fluctuations in the customer's main field of business; ad-hoc situations such as breakdowns; changes in the supply chain and changes in the logistical supply chain. The customer most probably knows that most of these events probably will take place at some point, and that they may influence significantly the profitability of their business. However, it is not possible to know when they will occur neither what these changes will look like.*

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the customer, affect the final project outcome (i.e. the functioning solution) by their knowledge, interactions and activities during the project life-cycle. However, the extent of each of the actors' affect will vary with regard to the different phases and their functions in the project.

In sub-section 1.2.2, the T5 project was reviewed (based on Davies et al., 2009) in order to illustrate and motivate the need for integration in projects by pointing out some of the attributes of integration in a large infrastructure project. In fact, many relevant issues relating to the findings of this thesis about integration in project business by making use of integration mechanisms for value creation in industrial project networks were present also in the T5 project. To start with, in the T5 project the processes were developed on a systems basis, then adjusted and integrated to fit the particular requirements of the project and its organization. The project organization also had to overcome the resistance they may have encountered from traditional project management when having to adopt, refine and extend existing combinations of their processes to approaches declared in the 'T5 Handbook' so that they could later be used and replicated in other projects. This notion acknowledges the relevance of creating capabilities for replication strategies (Ruuska and Brady, 2011) which is related to the economies of repetition. The systems approach and replication strategies are two central themes exemplifying integration challenges that are addressed in the T5 project, and are related to for example some of the modularity-based activities carried out during the life-cycles of industrial projects.

Furthermore, Davies et al. (2009) have developed the required processes of systems integration needed for improved project performance that was identified in the T5 project, into a systems integration model. The six processes that the model proposes, and which according to Davies et al. (2009 p. 120) should be "carefully planned and executed as a system" are as follows: 1) systems integration, to coordinate the design, engineering, integration and delivery of a fully functioning operational system; 2) project and program management, to support an integrated supply chain; 3) digital design technologies, to support design, construction, integration and maintenance activities; 4) off-site fabrication, pre-assembly and modular production, to improve productivity, predictability and health and safety; 5) just-in-time logistics, to coordinate the supply of materials and to increase speed and efficiency; 6) operational integration, to undertake systems tests, trials and preparation for hand-over to operations.

Considering these six processes of systems integration in the model echoing the T5 project, parallels can be drawn to the findings this thesis presents in terms of integration mechanisms (cf. table 9) that need to be executed in order to provide a functioning solution. In particular, the last of the six processes, operational integration, should be emphasized for the achievement of project success, as well as “the difficult transition from project to operational processes” (Davies et al. 2009 p. 120). Operational integration is extensively related to several problems that the T5 project encountered. As exemplified in the T5 case, developing capabilities for achieving integration in projects is relevant (cf. the six processes above).

4.3 A TYPOLOGY FOR INTEGRATION

The four components of integration proposed (see 4.2.4) are further categorized into a 2x2 typology, where four categories emerge for enhancing integration in industrial projects (Figure 7).

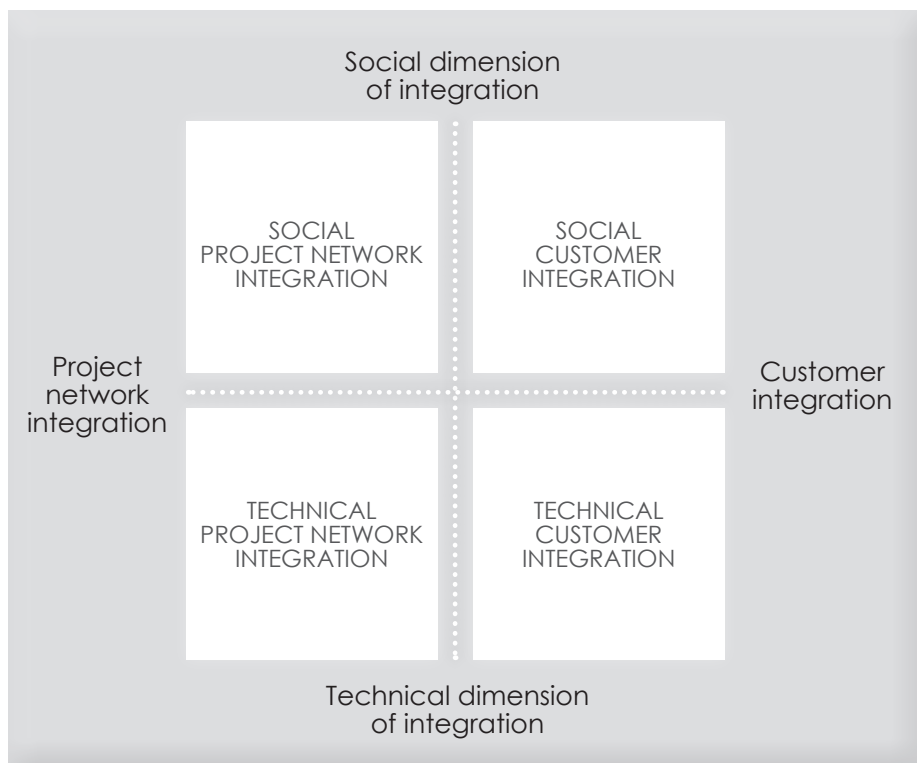


Figure 7. Typology for integration.

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The four categories in the typology above (social customer integration, social project network integration, technical project network integration and technical customer integration) are the categories that a supplier should emphasize and manage in order to achieve integration in an industrial project. The four categories constitute the following integration mechanisms:

- Social customer integration (4.3.1)
 - Interest in customer's needs and business requirements
 - Prompt response to and solving of customer needs
 - Knowledge of latest technical development
 - Ability to listen to the customer and to reflect
 - Taking responsibility for the delivered installation after handing over
 - Logistics competence
- Social project network integration (4.3.2)
 - Supplier management
 - Interface management
 - Strategic decision-making
- Technical project network integration (4.3.3)
 - Systems design
 - Technical evaluation
 - Technology management
 - Planning and coordinating activities
- Technical customer integration (4.3.4)
 - Finding those technical and contractual elements acknowledged by social customer integration

In relation to the discussion in sub-sections 4.2.1-4.2.3 (see also table 9), the mechanisms of technical and social project network integration are considered to be an internal type of integration (except for the mechanism 'supplier management') whereas the mechanisms of technical and social customer integration are considered to be of an external integration type. Moreover, as discussed in sub-section 4.2.4 the technical dimension is considered to be more formal, while the social dimension is considered less formal (cf. Martinez and Jarillo, 1989; Ouchi, 1979). It should be noted that the four categories of the typology are not mutually exclusive, although they are illustrated on different axes in the typology. In the following, the relationships between the four categories of the typology are described in more detail. The categories are also exemplified by the integration mechanisms they constitute.

4.3.1 Social customer integration

Integrating the customer into a project seems to be challenging for suppliers, who for a long time merely focused on executing the core product and process structures without the presence of customers in the processes. When changing the mindset towards a direction where the customer should be incorporated into the different stages of the project planning and execution phases, the situation can be seen as a considerable change in the supplier's logic of acting (Brady et al., 2005; Barki and Pinsonneault, 2005; Pinto and Kharbanda, 1995; Frame, 1994). The social customer integration is driven by the fact that when the supplier collaborates with the customer the supplier can create more innovative systems and solutions for their customers. The reason for this is because the customer needs are then better acknowledged and more specific and advanced customer-tailored solutions can be developed. This collaboration impels the customers to experience more value with the offering than would have been experienced without acknowledging them, i.e. the social customer integration.

The key element here for the supplier is to look beyond the traditional roles of project actors – the supplier and the customer roles – and to collaborate and co-create with the customer in a structured way from the beginning of the project onwards to the final handing-over, and the operations that may last for decades. This means that interaction and collaboration with the customer during the entire project life-cycle improves the performance of the project network and most probably it also improves the supplier's market situation, as the customer's requirements are better met and more customer value can be offered.

The present research results indicate that social customer integration can occur on the desired level only if and when the supplier understands the customer's operations and business environment for which the solution is intended. By doing this, the supplier can ensure that the solution can adapt and adjust to the predictable as well as unpredictable changing circumstances that may take place in the customer's business and operations environment at any time. This criterion can be achieved when the supplier acts in a proactive way and acknowledges the customer's knowledge in the innovation and engineering processes, and during operations. Proactive behavior can be accomplished by a few fundamental changes in the way the

supplier acts (Paper III), and including integration mechanisms such as: *showing interest in the customer's needs and business requirements; promptly responding to and solving customer needs; having knowledge concerning the latest technical development; having the ability to listen to the customer and to reflect on what has been said; taking responsibility for the delivered installation after handing it over and having logistics competence to guarantee availability of parts and service.*

4.3.2 Social project network integration

Social project network integration is related to the question concerning collaboration (Papers I and II) in the project network. This means that the relationships (dependencies and interfaces) between the functionalities and qualities of the project must be clear and understood by all parties. For the sub-suppliers, in addition to having the latest information about their own scope of supply, its functionality and quality parameters, this also includes having front end knowledge about the scopes that the other sub-suppliers are providing. Thus the social project network integration becomes a question about how well the actors in the project network are able to adapt their own scope of supply to changing circumstances that may also affect the intersecting points of their scope with the other sub-suppliers' scopes. A re-thinking of the value definitions, on a social level, is associated with the performance of the project network, according to scholars such as Davies et al. (2007), Davies and Hobday (2005), Hobday et al. (2005; 2000), Prencipe (2003) and Hobday (1998).

Based on the research results *supplier management* (Paper I), *interface management* and *strategic decision-making* (Paper II) are mechanisms that enable social project network integration. Supplier management is concerned with engaging the sub-suppliers in the project more effectively from the beginning of the project by offering them all the information that they need so as to consider themselves more committed to the project from the outset. This can be reached by providing the sub-suppliers with the data they need for designing and manufacturing their scopes, as the sub-suppliers then are able to organize their processes (and sub-processes) in a way that fits the processes of the other sub-suppliers in the supply chain and thus the overall functional dependencies in the project. Interface management is closely related to the management of sub-suppliers,

as it is concerned with systematically providing the required data and information to the interfering units and following up information channels in the project network. Strategic decision-making is to define the scope of supply and its performance level, and to share this common view amongst all the parties at the different levels in the project network.

4.3.3 Technical project network integration

The research findings contend that technical project network integration deals with those technical and contractual elements (sketches and specifications, resource allocation, budgets, schedules etc.) that are required in the project network, which are in line with systems and concurrent engineering approaches proposed by INCOSE (2004) and McCord and Eppinger (1993). Technical project network integration includes the activities that the project network should undertake in order to ensure the technical requirements necessary for the functioning project outcome (Papers I-II). *Systems design* is the mechanism that clarifies the technical and organizational dependencies in the project network. *Technical evaluation* and *technology management*, is the standardization of the processes, the management of the acquisitions of resources. Moreover, the standardized procedures become critical activities for carrying out collaborative procedures and processes at different levels in the project network. Finally, this all requires extensive *planning and coordinating activities* which refers to the continuous and open communication in the project network, including well structured documentation that is up-dated, easily accessible and configurable (see e.g. Dvir, 2005) according to the sub-suppliers' varying requirements at different stages in a project.

4.3.4 Technical customer integration

Technical customer integration refers to the technical and contractual elements (technologies, laws and policies, environmental regulations etc.) that are present in the customer's operations environment (Paper IV). These elements typically have a considerable impact on the customer's business as they set the criteria for the customer's operations and business. These elements are usually country specific,

which adds multiple dimensions to the elements in question that the supplier must take into account in global projects. It is important for the supplier to have the latest knowledge about these critical elements, in order to be able to provide customers with solutions that meet the technical requirements and operations criteria. It is argued that technical customer integration, which is closely related to social customer integration, is the capability of the supplier to take into account those regulations that exist in the customer's business and operations environment, and to adapt the solution to fit these regulations. This means that the supplier must have the latest information regarding technical and contractual elements, in addition to the technical know-how that is needed for innovating, designing, manufacturing, installing, and handing over the solution to the customer, that is, being able to integrate technically with the customer.

4.3.5 Summary

Building on the 13 integration mechanisms (Table 9) that are categorized into the four components described in sub-sections 4.3.1-4.3.4, the typology for integration (Figure 7) gives supports by explaining the dependencies and the vital activities for integration of the project network with the customer during industrial project life-cycles:

- First, there is the integration between the project network and the customer and then the integration of knowledge about the product and process structures within the project network at its different levels.
- Second, both the technical and social dimensions of integration mechanisms must be acknowledged, understood and most importantly, they must be accepted by the entire project network at different levels at all the time.

As is proposed, based on the presented research findings, a structured approach to integration as part of actual project management practices is crucial in order to achieve integration in project business.

5

CHAPTER 5 CONCLUSIONS

In this concluding chapter, the key findings will be summarized. First, the theoretical contribution is presented, followed by a discussion on managerial implications. Then the limitations of the thesis are reported. Finally, suggestions on directions for future research related to integration in project business are outlined.

5.1 THE KEY FINDINGS

The principal objective of this research is to study how industrial project-based companies organize their knowledge base when they provide various types of customized, high-capital and engineering intensive solutions to their customers. The two particular fields of analysis are integration mechanisms for value creation in industrial project networks, and the management of the integration process in project business. To answer the research questions in the papers (see also section 1.3), theoretical perspectives and empirical data have been analyzed in which a resource-based view of the project-based company has been adopted in addition to taking a rational open systems perspective with regard to organizations in these supplier companies. The results reveal that integration, defined⁴³ as *bringing or joining together a number of distinct things so that they move, operate and function as a harmonious, optimal unit*, plays an essential role in project business.

Achieving integration in industrial performance oriented projects consists of several levels of actions and concerns integration of both the project network and the customer, in order to ensure high-quality functioning solutions:

- It is concerned with integrating the supplier and sub-suppliers and the customer's business and operations environment during the project life-cycle.

⁴³ Paper II, see also sub-section 2.1.2.

- The mechanisms for value creation in industrial project networks that the thirteen integration mechanisms stand for (Table 9) belong to one of the four categories in the typology for integration (Figure 7): social customer integration; social project network integration; technical project network integration and technical customer integration.

Typically, the focus of the suppliers on the customer's business and operations environment, has not been emphasized sufficiently during the life-cycle of the project. Neither has the importance of acknowledging and managing the interfaces between the actors in the project network been emphasized adequately during the life-cycle. In fact, the levels and channels for knowledge and information sharing has suffered from the basic condition that during the project, the project network (supplier and sub-suppliers) has not been considered as an integrated unit which also includes the customer.

The proposed mechanisms for achieving integration in project business in order to provide solutions (Table 9), include project management activities that need to be developed and carried out in a proactive way. As discussed, this includes technical and engineering front-end knowledge generation, utilization, as well as strategic decision-making, and customer awareness during a project's life-cycle. This is in line with what earlier research has shown (Wikström et al., 2009; Payne et al., 2009; 2008; Blazevic and Lievens, 2008; Elofson and Robinson, 2007; Davies et al., 2007; Lusch et al., 2007; Lusch and Vargo, 2006; Brady et al., 2005; Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2004; Oliva and Kallenberg, 2003; Berggren et al., 2001; Grönroos, 2000; Pinto and Kharbanda, 1995; Frame, 1994) in the body of knowledge regarding projects and coordination in evolving project value chains.

The findings of the present research suggest that to achieve integration in project business, industrial solution providers must emphasize both the technical and social dimensions of the integration mechanisms at the same time. In order to emphasize the technical dimension of integration, technical and contractual elements that need to be integrated are required and to emphasize the social dimension of integration, project actors that must be integrated are needed. The emphasis of these two dimensions varies as the project evolves in the life-cycle and they complement each other. This means

that the prerequisites and needs for the two different dimensions vary as the project proceeds and value is generated in the project. The importance of addressing the two contexts of project network integration and customer integration together with the technical and social dimensions of integration in parallel is highlighted by the following scenarios. These scenarios are described by the project professionals in the design, commissioning, and operations studies:

- When the supplier has deep knowledge about the customer's business needs (and the customer's business model), the solution can be designed and built so that it fits the business environment and enhances the business opportunities for the customer. However, if the supplier is not updated on the political, economical environmental etc. regulations in the customer's operations environment, most probably there will occur some unforeseen problems for the customer when operating the solution. Once more, this will have a negative impact on the business for the customer in terms of the business not being able to run at the most favourable level.
- Even though the sub-suppliers are already suitably engaged in the project during project start-up and in early design, and well-defined responsibilities and information channels reaching across the system interfaces are employed, problems in process implementation most probably occur if the dependencies, functional parameters, and information technologies are not standardized procedures commonly used by all the sub-suppliers in the project network.
- Well-structured project documentation including systematically followed up changes to technical drawings, materials, engineering processes, technologies etc. do not guarantee efficient information flow in the project network, if the documents are not accessible across the interfaces and different project phases and functions, and to concerned parties (stakeholders), when they need them.
- Consider a situation where a supplier has world-leading technical knowledge about development and updates on technical equipment and solutions, but acts reactively and does not inform the customer on a regular basis. This leaves the customer with the responsibility for contacting the supplier and asking about recommendations and updates, which is most probably inconvenient for the customer in such critical situations where problems need to be solved 'before they happen'.

- Service and spare-parts availability cannot be guaranteed to the customer at a given time if the supplier does not have logistic competence and accurate knowledge about specifications for existing regulations concerning e.g. transportation in the customer's operations environment.

In the following sections, the key findings are discussed in more detail when elaborating on the theoretical contribution (section 5.2) and managerial implications (section 5.3).

5.2 THEORETICAL CONTRIBUTION

The present research contributes to the project business research field. The thesis contributes primarily to two streams of project research by means of conceptual application and empirical studies by:

- Addressing the call for more studies on the evolving value chains in project business as a result of the moving downstream in the value chain of the large scale capital products and systems (and combinations of them) with industrial services (Wikström et al., 2010; Prencipe et al., 2003). This thesis also brings new insights into mechanisms for inter- and intra-organizational value creation in industrial project networks (see 5.2.1).
- Addressing the calls for more empirical and interdisciplinary research on projects and their environment (Artto and Wikström, 2005; Söderlund, 2004; Berggren et al., 2001; Shenhar et al., 2001) in the field of industrial project business where the core project content is increasing (Davies and Hobday, 2005; Hobday et al., 2005; Davies and Brady, 2000). Therefore, this thesis brings new insights into the management of the integration process in project business (see 5.2.2).

In the following the two main streams of research that this thesis contributes to will be described and explained through the key perspectives of the literature that has been adopted.

5.2.1 Contribution to research on integration mechanisms for value creation in industrial project networks

The first contribution of this thesis is that it provides thirteen integration mechanisms for value creation in industrial project networks (Table 9). The mechanisms trace the traditional coordination principles in organization studies which have been addressed by various scholars, e.g. Martinez and Jarillo (1989), Lawrence and Lorsch (1967/1986) and Thompson (1967/2008). These mechanisms and principles of coordination, that are considered as traditional, have already been applied for decades by different organizations. As the above scholars have established, both more formal and less formal mechanisms are needed for coordination within (cf. internal integration) and between (cf. external integration) organizations. There is usually a need for formal structuring in an organization at some point, which then changes into a need for more elusive and less formal mechanisms as the formal structure within the organization is established.

More precisely, the contribution of mechanisms for value creation in industrial project networks is the finding that both mechanisms with technical and social emphasis are needed for coordination and integration during an industrial project's life-cycle. As presented in chapter 4, during the initial project phases and functions, mechanisms with an emphasis on the technical dimension (cf. more formal mechanisms) is dominant and vital when establishing common technical and contractual principles for carrying out processes for creating a solution (cf. systems design, technical evaluation, technology management, supplier management). While the project life-cycle evolves, the presence of mechanisms with dominance in the technical dimension decreases as the formal procedures and specifications become established, and value starts to be generated in the project (cf. planning and coordination activities, interface management, strategic decision-making). The social dimension (cf. less formal mechanisms) then becomes more dominant, in terms of e.g. preparing the customer for taking over and operating the solution. At this point, when the customer controls the solution, further market opportunities in terms of offerings for maintenance and upgrading agreements or new projects may also be developed (cf.

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interest in customer's need and business, prompt response and solving of the customer needs, knowledge of technical development, ability to listen to the customer and to reflect, taking responsibility for the delivered installation after handing over, logistics competence).

The need to take into account both the technical and social dimensions of integration mechanisms throughout the project, is in line with observations in traditional organization studies (e.g. Galbraith 2002a; b; Langlois and Robertson, 1995; Ouchi, 1979; Thompson, 1967; Lawrence and Lorsch, 1967/1986). They are also central in the more recent literature on project business and especially in industrial solutions business (Wikström et al., 2010) where approaches to integration including customer-focused supplier organizations, systems integration, concurrent engineering, and a more flexible approach to creating product and process structures are critical for value creation models (e.g. Wikström et al., 2009; Artto et al., 2008; Lusch et al., 2007; Davies et al., 2006; Davies and Hobday, 2005; Prencipe et al., 2003; Oliva and Kallenberg, 2003; Galbraith, 2002a; Levitt, 1983).

Moreover, the integration mechanisms are argued to relate to the activities in the integrated solutions life-cycle (Figure 3) developed by Davies and Hobday (2005). The findings regarding the thirteen mechanisms expands the knowledge concerning the kind of capabilities it is important for the actors (primarily the supplier acting as the main integrator) in a project to acquire in order for innovations to prosper, and for offering and selling solutions. This has been advocated by Artto et al. (2011) from a project management perspective and by Davies et al. (2007) from a marketing perspective, but has not been examined earlier, specifically in the shipbuilding and power generation industries. By adopting the proposed mechanisms in order to integrate thoroughly, and by applying them already during early stages in the project life-cycle, capabilities for value creation can be developed and achieved as the understanding of why it is necessary to integrate the relevant contextual parameters (related to cost, schedule, regulations etc.) with the end-use of the solution, increases.

5.2.2 Contribution to research on management of the integration process in project business

As a second contribution, the present research proposes new insights into the management of the integration process in project business. Projects have typically been perceived as successful from a business perspective when they meet the time, budget, and quality/performance goals (Kerzner, 2003; Cleland and King, 1988). Shenhar et al. (2001) contend some further distinct dimensions to address in the management for successful projects. These distinct dimensions include meeting project resource constraints (in terms of schedule and budget), meeting the functional requirements and performance measures (including technical specifications) in terms of customer's satisfaction and willingness to come back for future generations of the installation or another project, a project's direct impact on the supplier's business (results and market share) and the supplier's innovativeness and preparation of organizational and technological infrastructure for the future. This multidimensional approach to managing projects is extended in this thesis as the research results show that it is important to combine technology and engineering related elements with elements related to customer oriented business performance in industrial projects moving downstream (Davies, 2004), taking a systems integration approach for creating value.

Moreover, Artto and Wikström (2005) have pointed out the importance of a more in-depth understanding of the company's product and process structures for the logic of value creation in project business. The approach of information and task management for knowledge creation in multi-level project networks, which is proposed in this thesis, also contributes to the value generation logic by employing the thirteen integration mechanisms for managing the interfaces between actors, scopes and engineering. Furthermore, it contributes to the area of empirical studies of activities in projects and project organizations that Söderlund (2004) calls for. As the results show, integration in an industrial project is an evolving process. The process displays varying needs for the technical and social dimensions of integration mechanisms to be applied at different stages of the project, in order to carry out the integration mechanisms for achieving a balanced and coordinated way of working in the project network offering solutions.

The findings of the present research propose a life-cycle perspective for industrial projects where the customer's business and operations environment should be integrated during the project life-cycle. Finally, as Söderlund (2004) notes, in addition to the research calculated to understanding the projects better, the results of project management research can also be utilized for wider purposes, i.e. to increase the understanding of general management.

5.3 MANAGERIAL IMPLICATIONS

For ensuring customers with high-quality functioning solutions, achieving integration during the project life-cycle has become a critical capability for suppliers. In practice this means that to provide functioning solutions:

- The supplier must match the solution to the customer's business and operations environment not only with respect to engineering and contractual matters such as sales documentation, and product and process flows, but also with respect to qualities related to intangible assets, such as commitment and reflection during a project.
- Following this reasoning, project suppliers are encouraged to emphasize customer needs and knowledge as well as the interfaces between the different sub-suppliers in the project network and their scopes, in parallel, for ensuring quality and functioning solutions.
- By acknowledging this recommendation, integration will most probably have a positive impact on project management and project quality as e.g. the number of claims and change orders during the project will be less than without considering integration as an approach in solution projects.

By applying the typology for integration (Figure 7), i.e. concurrently recognizing both the technical and social dimensions of customer and project network integration during the project life-cycle together with the integration mechanisms (Table 9) that this thesis proposes, a critical element of project management is met as information and knowledge sharing becomes smoother.

Papers I and II provide managers with ideas on how to manage integration processes within the project network. Paper I identifies factors during the design phase where several sub-suppliers should work together based on relatively little information and few decisions made. Paper II contributes by presenting the critical factors in the commissioning phase of the project where different parts that have been designed, manufactured, and installed should work together and function as a coherent whole. It is also in this phase that the customer faces the functioning solution for the first time. Dependencies and interfaces between different sub-suppliers and their sub-suppliers, sub-suppliers and the supplier, and the supplier and customer are considered important for the project managers to realize in order to share knowledge and information within the project network.

Of managerial interest is the level to which integration processes are carried out through the mechanisms of systems design, clear classification of processes, interfaces and responsibilities, sub-supplier engagement through standardized sales and pricing procedures, technical specifications assessed on-time for integrated decision-making about acquisition of resources, and material and technical procedures. Continuous and open communication, well structured documentation that is configurable and accessible, change management and clear definitions about roles and responsibilities, providing and following-up project information relevant to different actors, and strategic decision-making regarding the targeted performance level of the solution at required times are the suggested linkages to approach in order to achieve integration within the project network. Basically, these linkages relate to scheduling, cost structures, resource allocation and strategy within the project network providing the capital and engineering intensive innovative solutions, which have direct impact on the performance of the supplier's business.

Paper III emphasizes the importance of acknowledging the customer's business in the project value chain. Further, it is argued that this does not mean that the scope of supply is extended when reflecting the customer's business and end-customers during the project. For managers this means that the interfaces towards the customer and sub-suppliers and their scopes of supply need to be recognized in terms of how they relate to their own business, so as to be able to acknowledge the customer's business accordingly. For example, managers need to evaluate how the scopes delivered by

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other (sub-)suppliers are interlinked with their own scope and which dependencies and influences need actions, in order to increase the efficiency of their own scope of supply. Moreover, this means that while different departments/actors are in charge of different scopes during different project phases, the department/actor not in charge at a specific moment must not be left outside of the project and the information exchange. Instead, each actor/department must be part of the project at all times, the degree of influence only varies with respect to different phases in the project.

Supplier capabilities emphasizing the two inseparable dimensions of project integration, the technical and social dimensions, strengthens the argumentation regarding the importance of managing actors, the context, the dependencies between them and interfaces among them that were stressed in papers I and II. The integration mechanisms, which are presented in paper III, imply that the supplier's need to be aware that achieving integration is related to showing interest in the customer's needs and business requirements, prompt response to and solving of customer needs, having knowledge concerning the latest technical development, having the ability to listen to the customer and to reflect on what has been said, taking responsibility for the delivered installation after handing it over, and having logistics competence to guarantee the availability of parts.

These findings highlight the managerial need to acknowledge and learn to understand the critical elements in a project and how they impact on the project. When taking into account all the various processes and product dimensions in a project the value generated by the supplier increases, as many unexpected operations-related events are addressed and responded to during the initial project activities. Integration in projects can then evolve in a more structured way, and thus integration would be achieved more efficiently from an industrial project business perspective.

Paper IV provides managers with a framework where it is proposed that the two dimensions of integration mechanisms (technical and social) need to be addressed jointly throughout the project life-cycle in order to facilitate integration in industrial project business. The assumption here is that every actor who is aware of the dual nature of mechanisms for integration can develop distinctive linkages between the different dimensions of mechanisms, and thus the dependencies

and interfaces with other actors across the project network and the customer and customer's operations environment can be better met during the project. In addition to the traditional principles of project management, where work is distributed across many sub-units, approaching integration as a management concept in industrial projects means to first decompose scopes for assigning freedom and responsibility to suppliers of these scopes, and then to integrate while managing the product/process structures and their intersecting points.

This thesis encourages project managers to take an integrative approach to business activities. This implies providing solutions in a more flexible and adaptive way from both a technical and social point of view when meeting customer demands by implementing the proposed integration mechanisms. As the findings highlight, this is a value adding component for customer driven industrial project-based suppliers and their supplier networks to develop structured processes in order to integrate knowledge and information from the customer into the projects.

5.4 LIMITATIONS

In this thesis about integration in project business, certain limitations exist. The means influencing the generalizability of the results presented will therefore be discussed with respect to the selection of theory and research design.

First, the theoretical perspectives were limited to literature on integration as a concept (integration in organization studies and integration in projects), systems integration, integrated solutions, and project business (project-based companies, project-based business, evolving value chains and modularity). This limitation of the literature follows from the fact that these particular perspectives were found to be the most relevant and intriguing perspectives for the research on integration in project business.

Second, related to the research design, the research focused on industrial projects being carried out in the shipbuilding and power generation industries which, as has been discussed previously,

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displayed several industry specific-characteristics, not applicable in other contexts (cf. table 4). Moreover, the numbers of project functions that have been studied are limited to three. Generally speaking, these functions represent the beginning, middle and end stages of a project life-cycle. However, as discussed in chapter 4, these three functions remarkably influence the whole value chain in a project through different critical means. The conclusions drawn are based on rich empirical data that the studies provided. This data was then evaluated and interpreted by the author together with fellow researchers and initial findings were proposed. The conclusions were then drawn based on an iterative process between collected data, theoretical reasoning, and objective validation of results. These findings were then presented to expert professionals in industry by means of roundtable discussions and workshops; they were also presented to research colleagues on international academic seminars and conferences. In the studies, most of the interviews were carried out in English, which was not the mother tongue of the interviewer and rarely that of the respondent.

Third, when linking the two items above, the understanding of critical variables was narrow in the beginning of the research process but as the research evolved, the theoretical understanding of integration increased. Similarly, with the research design, after more empirical research was carried out, the better the integration in project business was understood by the author and the descriptive approach progressed into more of an explanatory approach. Therefore, the terminology also evolved together with the studies conducted. In this extended summary, the terminology is narrowed down to specific key terms.

As shown above, there are limitations related to the content, context, and research design that are acknowledged. At the same time, it is also these specific limitations that make the findings of this thesis unique and applicable to industrial project business.

5.5 PROPOSALS FOR FUTURE RESEARCH

This thesis has provided insights into how to manage integration in project business by exploring integration in industrial project contexts. Consequently, the thesis has also identified a number

of interesting themes related to the context of industrial projects, and project business that need more research. To further develop the present research on mechanisms for integration and to better understand the role of integration in projects both in academia and in industry, more conceptual and empirical research would be clearly useful in this area. In this concluding section, the most central themes that this thesis has established as a basis will be discussed and a number of proposals for the direction of future research into integration are presented.

To grasp more fully the concept of integration in project business, the typology for the integration proposed (Figure 7) in order to achieve integration in projects would need to be developed. More specifically, research regarding the four categories which are proposed in the typology for integration is invited. The development of the categories of the typology is especially needed in order to enhance a deeper knowledge base for understanding and applying an integrative approach to project management.

First, future research could address, in more detail, which factors and mechanisms project suppliers apply in order to create an integrative atmosphere or infrastructure in a project setup in a given context, including different organizational entities, contents, contexts, scopes, budgets and schedules, mentioning only some of the elements that are critical to integrate and have an impact on integration and on how the project turns out. Closely linked to this, it would be relevant to study integration in solutions business in transition from industrial engineering services towards providing life-cycle solutions. For instance, Wikström et al. (2010; 2009) have initiated novel research on various business models in project business and their relation to different organizational entities. It would also be of interest to conduct further studies regarding enablers for integration, as well as findings about the obstacles for carrying out integration within the project network and between the different organizations that are involved in the project, and the critical relation between these in different contexts. Therefore, studies into the integrative role of different stakeholders in a project are called for. Another intriguing area of future research would be to identify disablers for integration in relation to different functions in a project and in the project network on different levels. This type of research would help to identify the circumstances that exist to prevent disabling functions

for integration in a project.

Second, as this thesis has also pointed out, projects that a supplier provides often have some similar characteristics, and thus they are most often not unique. Therefore, learning how to replicate project functions even better than can be accomplished in the present situation, would be an important capability for suppliers in order to acquire capabilities that can be implemented more than once in projects (Ruuska and Brady, 2011; Davies and Brady, 2000). Different projects require that a focus is placed on different facilitating functions and therefore, for collective learning to take place among project actors, individual learning has to be the base. Learning is about adapting existing information, knowledge and capabilities with evolving information, knowledge and capabilities, and the ability to combine them. It is also about transferring knowledge between different actors in the business network. Based on the present research it is suggested that strategies and processes for enhancing project integration capabilities, both on an individual level and approaches for collaborative learning in a project-based company needs to be further studied. Development of this area is needed to further promote the combining of the technical and social dimensions of integration in a project and in order to find a balance between them so as to execute projects by applying a project management concept in which successful integration is the key to successful projects.

Third, a longitudinal study where the focus could be on ascertaining further developed and alternative approaches to integration, different levels of where integration can be applied, and the capabilities relating to re-integration and dis-integration, is suggested. Cacciatori's and Jacobide's (2005) research into how the British building industry has evolved and shifted into vertical re-integration, and how this relates to the governance structures of inter-firm relationships represents one of the first efforts to show how an industry's vertical architecture affects the knowledge bases, capabilities, and trajectories shaping industry transformation.

Fourth, future research could also be related to a wider industrial context than that which has been studied here. Further industrial contexts can be explored by applying the typology proposed for integration as an analytical tool to further explore the integration

concept and the role of understanding and applying the thinking behind the four categories which are proposed. This could be carried out as a longitudinal study covering several industries and industry segments. In other words, a relevant issue is to study how the results presented based on the present research could be used as catalysts to develop and increase understanding regarding the potential implications integration mechanisms have for value generation in industrial business on a longer time interval.

Learning and knowledge creation is an evolving integrative process. Therefore, the findings of this thesis can lead to new potential directions and various possibilities being explored, studied and combined, which might not have been motivated without the present research into integration and industrial projects, in order to enhance knowledge about why integration is needed in project business and how such integration is achieved.

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APPENDIX 1

CLASSIFICATION OF PROJECTS

In table A1 below, the projects in the design, commissioning, and operations studies are compared according to the five categories of project characteristics, suggested by Gustafsson et al. (2008).

Table A1. Comparison of studies

<i>Characteristic</i>	<i>The design study</i>	<i>The commissioning study</i>	<i>The operations study</i>
1A. Project size	Large projects	Large projects	Large projects
1B. Length of operational period	Decades	Decades	Decades
2. Life-cycle complexity	Complex product Routine site: yard Routine conditions Repeat projects with some changes	Complex product Both routine and non-routine sites Both routine and non-routine conditions Some repeat projects	Complex product Both routine and non-routine sites Both routine and non-routine conditions Some repeat projects
3. Customer	Limited number of customers Mostly known from earlier projects	Several customers Customers with varying experiences	Several customers Customers with varying experiences
4. Sub-suppliers	High number Mostly known from before	High number Some are known from before Some are new	High number Some are known from before Some are new
5. Other stakeholders	Authorities, classification and regulations are mostly known	Authorities, classification and regulations are sometimes known but not in every project	Authorities, classification and regulations are sometimes known but not in every project

APPENDIX 2

THE DESIGN STUDY

The design study covered four sub-projects, each carried out by one of the project teams (T1-T4). Three joint workshops were held for the four teams (10.6, 13.5 and 6.4.2005).

T1 – the ship as a whole

T1 focused on 1) project management principles for ship systems and 2) 3D-modelling as a unifying tool for the suppliers providing the modularized systems to the ships. According to the team members the ship's systems can be divided into six main groups:

- General arrangements
- Deck outfitting
- Interior
- HVAC
- Machinery
- Electricity

In the ship projects, the hull constitutes the basic condition for how the ship is constructed. T1 discussed the fact that in future projects modularized systems would constitute the conditions for how the ship is constructed, while the hull would constitute only one system (among others) to be integrated during the construction. In the sub-project, telephone interviews regarding ideas and attitudes on 3D/multidimensional modelling were conducted with nine company representatives (technical managers and designers) selected by the T1 team members. See interview agenda below:

1. How/for what purpose would you use the 3D-model? In the sales phase?
2. Which are the areas that would benefit from using the modeling tool?
3. Would 3D-modelling make the sales phase easier?
4. How detailed should the 3D-model be?

5. Which benefits would there be in a 3D-model (compared to a 2D-model)?
6. The use of 3D-modelling regarding general arrangements: for what use and in which phase would you benefit from a 3D-model?
7. Which are the benefits/possibilities of using 3D-modelling for managing the information flow?
8. Which benefits would you hope to gain by using 3D-modelling?
9. Functional calculations connected to 3D-modelling?
10. Do you have experience in using 3D-modelling?

The thoughts and ideas from the interviews were categorised and raised for discussion on the subsequent team meeting. The ideas were further negotiated and evaluated by the participating companies.

Altogether five workshops were held (6.6, 25.5, 11.5, 27.4 and 13.4.2005) in T1.

T2 – the engine room

T2 focused on new practices for providing a propulsion system, where the different parts of the propulsion system should be provided as an integrated automation system instead of separate automation units. To test and evaluate the ideas that T2 had under development, a joint meeting with colleagues from the participating companies was held. The outcome of the joint meeting was that T2 received constructive feedback from their colleagues, and ideas on how to further develop the new work procedure of providing an integrated automation system. The ideas were further negotiated and evaluated by the participating companies.

Altogether six workshops were held (7.6, 30.5, 25.5, 10.5, 29.4 and 14.4.2005) in T2.

T3 – the shaft areas

T3 focused on the dependencies and interfaces in the design of shaft areas in one particular ship. The shaft areas can basically be divided into three groups:

- Elevators
- Machinery
- HVAC

The team focused on the design and procurement processes of the elevator- and HVAC-shaft areas, in particular emphasizing the standardization of conceptual, basic, and detail design processes, by taking into account the analyzes of the shaft areas that had previously been built by the ship-yard. A process description for the activities was made. The ideas were further negotiated and evaluated by the participating companies.

Altogether four workshops were held (9.6, 26.5, 9.5 and 25.4.2005) in T3.

T4 – the cabins and public areas

T4 focused on the design processes regarding the public and cabin areas. The team discussed different approaches for coordinating the basic and detail design procedures, and for shortening the overall duration of these procedures. One important issue that arose was that feedback must constantly be available between the different phases of design, as this would enhance the standardization of the design procedures.

T4 further discussed how the workload should be divided between the ship-yard (the systems integrator) and the suppliers of the different systems. The ideas were further negotiated and evaluated by the companies.

Altogether four workshops were held (7.6, 20.5, 3.5 and 14.4.2005) in T4.

APPENDIX 3

NUMERICAL CUSTOMER FEEDBACK

The numerical customer feedback consists of data which is retrieved from customer satisfaction monitoring in projects, which is based on a process that has been developed based on research on customer orientation and customer involvement in projects (Gustafsson, 2002; Wikström, 2000). The numerical customer feedback reports combine self-evaluation and customer opinion indexes. As the indexes are shown separately for each of the questions in the report, it is possible to trace back how the different customers' relationship with a company has developed over time.

The process Westerholm et al. (2009) describe for utilizing customer satisfaction as part of project control, builds on the method presented by Gustafsson (2002) for handling customer-supplier relationships based on a process of continuous self-examination and feedback, and the objectives of incorporating the customer and customer relationships as an important asset in project management (Wikström, 2000). The process includes the following five steps:

1. Supplier self-evaluation
2. Customer opinion (same questionnaire as used in the supplier self-evaluation)
3. Comparison and analysis (of the self-evaluation and the customer opinion)
4. Actions and communication
5. Follow-up

The questions or statements that are used for the supplier self-evaluation and for the customer opinion (see Westerholm et al., 2009 pp. 172-173) are answered through a numerical value, 1-10, where 1 indicates a low performance or disagreement, and 10 a high performance or agreement with the statement. Space for giving written feedback or comments is also included. The retrieved data (the

numerical (and written) feedback) is stored on a web database. The numerical values stated in the supplier self-evaluations and customer opinions are normalized in order to minimize the different scales (that the correspondents apply), and then the numerical values are calculated into indexes, presenting the performance of the supplier, as seen by the supplier (self-evaluation) and the customer. As Toivola (2007) points out, the supplier self-evaluation is not about looking in the mirror, i.e. the suppliers look at the situation from their own perspective and the customers from their perspective – instead, the supplier representatives evaluate their own activity from the customer point of view, since this defines the quality of the supplier's performance. The process is built on a web-based system for efficient handling of different setups of questionnaires and language versions.

The indexes calculated based on self-evaluations and customer opinions were gathered in reports. These reports show the current indexes, as well as changes in the index, i.e. the development for the past two to four annual quarters.

The key elements in the process are considered to be the timing of the assessment, the relevance of the contents of the monitoring, the involvement of the right people, the integration of day-to-day project practices, and applying follow-up (Westerholm et al., 2009). Therefore, these elements are constantly paid attention to during the five steps of the customer monitoring process⁴⁴.

In the operations case study, the customer opinions were compared with sales data, by utilizing Mathworks Matlab, and from this correlation analysis a matrix showing the correlation between customer opinions indexes and sales data resulted.

44 For more information regarding the process of continuous customer satisfaction monitoring in projects, see Westerholm et al. (2009), Toivola (2007) and PBI Research Institute.

APPENDIX 4

THE COMMISSIONING STUDY

Interviews

List of interviews at Company X (Table A4a):

Table A4a. Interviews at Company X

<i>No.</i>	<i>Divison/function of respondent</i>	<i>Date</i>
1.	Project management	8.3.2006
2.	Support function	8.3.2006
3.	Site	9.3.2006
4.	Site	9.3.2006
5.	Site	9.3.2006
6.	Support function	13.3.2006
7.	Commissioning	14.3.2006
8.	Commissioning	16.3.2006
9.	Support function	16.3.2006
10.	Project management	27.3.2006
11.	Project management	27.3.2006
12.	Project management	27.3.2006
13.	Project management	28.3.2006
14.	Project management	28.3.2006
15.	Design	28.3.2006
16.	Commissioning	3.4.2006
17.	Project management	3.4.2006
18.	Project management	3.4.2006
19.	Support function	3.4.2006
20.	Project management	4.4.2006
21.	Project management	4.4.2006
22.	Support function	12.4.2006
23.	Design	12.4.2006
24.	Sales	12.4.2006
25.	Commissioning	12.4.2006
26.	Support function	12.4.2006
27.	Support function	21.4.2006
28.	Sales	27.4.2006
29.	Support function	28.4.2006
30.	Project management	28.4.2006
31.	Commissioning	8.5.2006
32.	Commissioning	8.5.2006
33.	Commissioning	8.5.2006
34.	Commissioning	8.5.2006
35.	Commissioning	8.5.2006
36.	Support function	8.5.2006
37.	Operation and maintenance	9.5.2006

Interviews for benchmarking purposes (Table A4b):

Table A4b. Interviews for benchmarking purposes

<i>Industry</i>	<i>Number of interviews</i>	<i>Number of companies</i>
Marine	7	4
Power	2	2
Pulp and paper	4	3

Interview agenda

The following topic/process combinations were covered in the interviews (Table A4c):

Table A4c. Interview agenda

<i>Topics / Processes</i>	<i>Roles & responsibilities</i>	<i>Documentation</i>	<i>Customer (involvement)</i>	<i>Current problems</i>	<i>Ideal procedure</i>
Sales	x	x	x	x	x
Design	x	x	x	x	x
Procurement	x	x	x	x	x
Transportation	x	x	x	x	x
Installation	x	x	x	x	x
Pre-commissioning	x	x	x	x	x
Commissioning	x	x	x	x	x
Performance test	x	x	x	x	x
Warranty / O&M	x	x	x	x	x

Main questions in brief:

Describe the commissioning process to date:

Identify the main short-comings.

-Suggest a solution to them.

Describe the commissioning process in an ideal case:

How should this be specified in the contract?

What kind of information is needed from procurement/supply?

What kind of information is needed from the design team?

What kind of information is need from the installation staff (if there is a separate commissioning manager/engineer)?

When and who should plan procedure and involve the customer?

How is it possible to make a successful transfer from commissioning to operations?

APPENDIX 5

THE OPERATIONS STUDY

Interviews

The dates of the interviews with the customers and which industry segment each of the customer belongs to, is presented in table A5 below:

Table A5. List of customer interviews

<i>No.</i>	<i>Date</i>	<i>Industry segment</i>
1.	11.12.2006	Oil power plants for decentralized power generation
2.	11.12.2006	Propulsion and machinery concepts for cruise ships and merchant vessels
3.	12.12.2006	Propulsion and machinery concepts for cruise ships and merchant vessels
4.	13.12.2006	Oil power plants for decentralized power generation
5.	13.12.2006	Oil power plants for decentralized power generation
6.	14.12.2006	Propulsion and machinery concepts for cruise ships and merchant vessels
7.	15.12.2006	Oil power plants for decentralized power generation
8.	15.12.2006	Oil power plants for decentralized power generation
9.	18.12.2006	Propulsion and machinery concepts for cruise ships and merchant vessels
10.	19.12.2006	Propulsion and machinery concepts for cruise ships and merchant vessels
11.	19.12.2006	Oil power plants for decentralized power generation
12.	19.12.2006	Oil power plants for decentralized power generation
13.	2.1.2007	Oil power plants for decentralized power generation
14.	3.1.2007	Propulsion and machinery concepts for cruise ships and merchant vessels
15.	4.1.2007	Oil power plants for decentralized power generation
16.	6.1.2007	Propulsion and machinery concepts for cruise ships and merchant vessels
17.	8.1.2007	Oil power plants for decentralized power generation
18.	11.1.2007	Oil power plants for decentralized power generation
19.	15.1.2007	Oil power plants for decentralized power generation
20.	16.1.2007	Oil power plants for decentralized power generation
21.	17.1.2007	Oil power plants for decentralized power generation
22.	19.1.2007	Propulsion and machinery concepts for cruise ships and merchant vessels
23.	23.1.2007	Propulsion and machinery concepts for cruise ships and merchant vessels

Interview agenda nr. 1 (questions for account managers)

1. What kind of company is the customer?
2. Which products have been sold to the customer?
3. What is the customer's purchasing strategy?
4. Reasons for purchasing behavior?
5. Which are the reasons for differing purchase behaviors (the four segments)?
6. Events during the last five years that may have affected the relationship with the customer? What, how, and why?
7. What kind of claims have been made, and how many?
8. Which products have been promoted to the customer, why? What has the response been?
9. How could the customer's purchase behavior be changed, to buy more?

Interview agenda nr. 2 (questions for customers)

Questions for all four segments:

1. Describe your company's relationship with Company X. How has the relationship developed over time?
2. How do you consider Company X (as an equipment supplier, solution provider, partner, or as something else)? Why?
3. Present and discuss Company X's strategy with the customer – is the strategy a realistic one? Is Company X's current way of working in line with their strategy? If not, why not? What could be done to change it?
4. Which products/services has Company X offered to you?
5. Are you familiar with their offering (contracts, training, e-business etc.)?

6. Have the offered products been of interest? Why/why not?
7. How is the contact handled between the organizations? Is there something that could be improved in the communication?
8. What is your company's strategy for purchasing (spare parts, services etc.)? What is the reason for your strategy?
9. Spare parts handling of Company X? Easiness to order, availability & delivery process? How does the customer order? Is there anything to improve in that process?
10. How do you consider the services provided by Company X (availability, price, warranty, competence, etc.)?
11. What is your company's strategy for operating? What is the probability that your company will change strategy?
12. Which are your expectations regarding future cooperation with Company X? Which main things are there to improve in the cooperation?

Specific questions/topics for customers in segment 1:

1. Why do you not want to outsource the operations?
2. Show list of different alternatives.
3. What is your present way of managing the operations, maintenance, supervising and spare parts ordering?
4. What do you think about outsourcing some of the operations to Company X?
5. Show list of different alternatives.
6. Discuss the performance of Company X.
7. Discuss products/services that the customer does not purchase.

Specific questions/topics for customers in segment 2:

1. Why do you not want to purchase service, maintenance and supervision?
2. It may be that they purchase some, in that case, why do they not buy more?

3. Who does the maintenance, do they do it themselves or does someone else do it?
4. Is it possible that your company will purchase service from Company X in the future? Show list of different alternatives.
5. What do you think about outsourcing some of the operations to Company X?
6. Show list of different alternatives.
7. Discuss the performance of Company X.
8. Discuss products/services that the customer does not purchase.

Specific questions/topics for customers in segment 3:

1. Why do you not purchase more from Company X?
2. Do you have any other key suppliers?
3. Which are the central principles of your company for operating the installation?
4. Do you maintain the installation yourself? Do you think someone else could do it more profitably and efficiently?

Specific questions/topics for customers in segment 4:

1. Discuss the performance of Company X.



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