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Capturing Advance Demand Information from Project Delivery Networks for Demand Supply Planning

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Abstract

This work reports an explorative study on the front-end of demand planning in project business, conducted for an international mobile telecom equipment supplier. The main research question of the study is: How can advance demand information be captured from project delivery networks for demand supply planning? Advance demand information is defined as any information beyond orders.

The theory review addresses the research question by combining ideas from the fields of project management and supply chain management contributing to, among other things, a better understanding of project delivery networks and project-based demand.

The empirical study describes how advance demand information is captured from the project delivery network in the execution phase of two telecommunications infrastructure projects. The emphasis is on the local context, the sources and quality of advance demand information and access to it, and, the collaborative processes in place for capturing it.

The research method used in the study is inductive multiple-case study. The key data consists of 17 semi-structured interviews carried out in two projects in the United Kingdom and the United States. The main interview data was complemented with several pre-interviews, internal documentation, observation, workshops and various quantitative planning data. Both within and cross-case analyses were conducted.

The main results of the research are two rich case descriptions and several propositions, arising from the current state analysis, for development and further research. A systematic and visual framework for mapping demand collection was built in the research process.

In the two cases, it could be observed that the situations in the field can be highly diverse in terms of e.g. local institutional settings, the end product, project supply chain configuration, customer-supplier relationship, and the competitive situation, which implies a need for segmentation and customized value offerings. This study addresses this need by introducing a managerial framework for identifying appropriate demand-supply chain designs for varying demand visibility situations in projects.

Despite the differences in the cases, also patterns could be identified. For instance, it seems that the overarching hurdle or enabler for capturing any advance demand information is that of incentive alignment between partners.

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1 Introduction

This chapter introduces the research to the reader. It opens with background discussion, presents the case setting, and then proceeds to the research objectives and limitations. Then, the actual research process, and used methodology and material will be presented. The chapter closes with a description of the structure of report.

1.1 Background

The growth of technological complexity and the need to streamline manufacturing activities and asset structures have led to increased subcontracting in today's project business. As a result, longer delivery chains and interdependency between companies characterize project business nowadays[1]. This networked reality translates into increased coordination needs between the project stakeholders in order to align the material and work flows at the project site, and to optimize manufacturing, transport and warehousing operations across the whole project delivery chain.

In a project environment, project equipment manufacturers, such as the case company, are often confronted by hard-to-forecast lumpy demand. Such unpredictable demand, without one being able to derive the real requirements in advance, translates into carrying high levels of safety stock, inefficient capacity utilization and other waste throughout the project supply chain, which the end-customer eventually ends up paying for in service, quality and cost. The good news for project suppliers is that the sources of demand are often concentrated in a handful of key accounts, and thus the sales and projecting organizations of project suppliers are in a unique position to retrieve such demand information.[2]

In a situation where demand is a critical driver of business planning, it is of high practical importance to know the actual procedures of collecting demand so that the value of the input information for planning demand and supply can be evaluated; It is often unclear to the people utilizing the demand information to what extent the volumes represent the hopes and expectations of the sales people and to what extent the actual customer requirements. My own experience, gained while studying this subject, is also that those collecting the information in the project interface would be keen to improve their methods and practices in doing so, but currently have nothing to benchmark against. Moreover, it would be most valuable to have some guidelines on how to act under different contingencies, as most likely, one approach does not fit all situations. For instance, in some cases, it may just be smarter to rely purely on historical information, second-guess the customer, locate alternative sources of demand information, or just create a highly responsive supply chain.

[1] E.g. Artto et al. 1999
[2] E.g. Crum et al. 2003; Van Donselaar et al. 2001

Against this background, my research is of high practical value, but also of contemporary academic interest. In comparison with other empirical case studies on demand visibility, the broader network perspective and the emphasis on project-based demand is something new. Moreover, this research adds value as it combines ideas from supply chain management and project management; it is a recognized fact that project-based organizations have lagged behind in the acceptance and use of supply chain management strategies[3].

1.2 Case company and research setting

The case company, Nokia Networks (NET), division of Nokia Corporation, is a provider of network infrastructure, service delivery platforms and related services to mobile operators and service providers. The company only serves business customers, mainly large telecommunication operators who use the products in running their business. NET plays many roles in the telecommunications infrastructure value chain. The company handles the implementation of the networks as projects, it is a manufacturing company producing telecom equipment and a care company serving equipment. It also offers value-adding professional services to operators in network implementation and operation.

At any given time, the case company has tens of active network infrastructure projects in its delivery project portfolio. The role of NET in the overall customer investment project varies from turnkey deliveries where Nokia is responsible for delivering the complete network to mere equipment deliveries without any service content. In the projects studied, the company assumes the responsibility of solely delivering and installing the network equipment while leaving many activities to other firms in the project delivery network. In this mode, the company does not own the main project planning information, but rather responds to orders initiated by the customer. The exact timing of future orders is hard to determine as they are at the mercy of changes in construction timetables as well as the availability of capital to fund the projects. The research is further limited to one example product type, the base station, which is a volume element of any mobile network.

At NET, Customer Account Teams, or CATs, form the organizational customer interface, where this research is conducted. The CAT is fully responsible for the business within a particular geographical area for a specific customer. This includes the complete business and operational relationship, including delivery project management. In a way, each CAT can be regarded as an individual enterprise; CATs have full responsibility for the account strategy, objectives, business plans and efficiency of operations, market position with the customer, and continuous improvement in customer satisfaction. One of the account teams' responsibilities toward the global organization is planning their demand; the process which is of interest in this study. Chapter 8 provides more information on the case company and the product in question.

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[3] Yeo et al. 2002, Venkataraman 2004

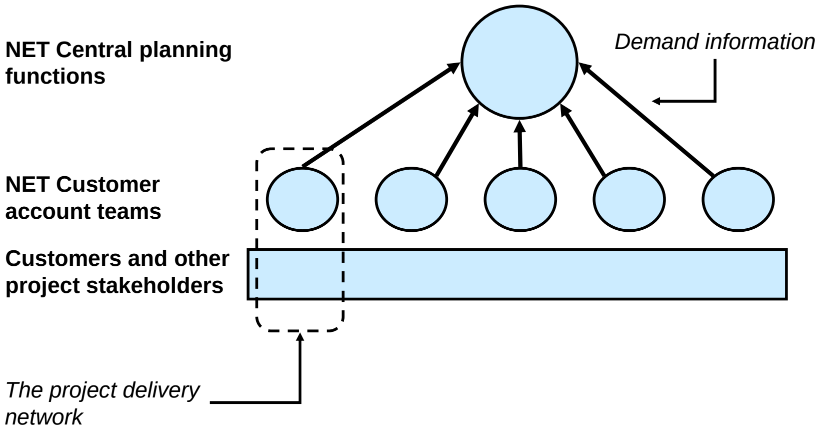

Figure 1: Overview of the case setting

An overview of the research setting is presented in Figure 1. The bar at the bottom of the figure illustrates all actors involved in the project excluding NET. Together with the NET customer account team, the other project stakeholders form the *project delivery network*. The account teams are responsible for deriving demand information from the project network and creating their own demand plans. These numbers are later consolidated at the division level in order to create a variety of plans. The field research is conducted in two separate account teams

This research forms a small part of an internal development program at NET aiming to improve and simplify demand planning at the customer interface.

1.3 Research questions and objectives

The overarching theme of this study is demand visibility in supply chains. The actual phenomenon being studied is capturing of advance demand information from project delivery networks. In this study, advance demand information is defined as any demand information beyond the actual order. The main research question is:

How can advance demand information be derived from a project delivery network for demand supply planning?

The main research question is divided into four sub-questions, which are answered relying purely on empirical evidence. As the first sub-question shows, the case-specific context and dynamics receive much attention in this study.

1. What is the planning context?

2. In the project delivery network, where and in what form is information on future demand located? What is the quality of demand information at source? To what information is there access?

3. What is the process of collecting and sharing demand information in the project delivery network? What is the flow and evolution of demand information from its origins to the final demand plans?

4. What are the collaborative arrangements related to demand visibility between network stakeholders?

The main objective of the empirical research is to create example-like case descriptions of how demand information is captured from project delivery networks in different situations for benchmarking and communication purposes. The managerial relevance of this study comes from the conclusions and action plans that can be drawn from the case analyses. As the researched area is still quite pristine, the goal from the academic perspective is to raise issues of interest and identify directions for further research. Finally, the implicit objective of this research is also to raise the awareness of demand planning in the organizational units responsible for capturing demand information.

1.4 Limitations

Table 1 presents the scope of this research. Firstly, I limit myself to cases, where NET plays a first-tier subcontracting position in the project delivery network. In these cases, Nokia does not control the whole project. The empirical research is conducted within the boundaries of the customer account team, and the phenomenon is examined from a demand planning viewpoint. Moreover, the research is scoped down to the project execution phase and to the demand planning of a volume element of the mobile network, the base station.

Table 1: Limitations of the study

Dimension	Limitation	Explanation
Phenomenon	Capturing of demand information from project delivery networks...	-
Position in project network	...when the case company is in a subcontracting position...	In the subcontracting position, the case company does not own the demand information.
Organizational context	...by the sales and projecting organization at the customer interface...	-
Process	...for Demand Supply Planning…	Demand Supply Planning is a sales and operations planning process at NET. Financial planning is excluded from the scope.
Project phase	…in the project execution phase...	The project execution phase is interesting in terms of producing information for the short-to-medium term planning processes.
Product	...for base station rollouts.	The base station, a volume element of mobile telecommunication networks, and the respective installation services are within scope.

I would further like to highlight the problem of delimiting a business network. According to Halinen et al., the primary guideline to be used in the definition of network boundaries is the content of the research problem[4], a guideline which I have followed. In the case research I have limited myself to the network which has been relevant in producing or manipulating demand information.

1.5 Approach, methodology and material

This chapter explains how the study was conducted. I begin with some theory on conducting inductive case studies, after which the actual research process is described. This multiple-case study is primarily descriptive and exploratory. Neither the theory, nor the practical knowledge on the phenomenon is sufficiently well developed to create and test hypotheses explicitly.

1.5.1 Case study approach

An inductive case study approach was adopted for the research following the footsteps of Eisenhardt.[5] Inductive approaches generally rely on building theories from data; sometimes these are also called "grounded theory" approaches[6]. In contrast to the inductive research logic, deductive approaches are concerned with developing propositions from current theory and testing them in the real world. Eisenhardt, unlike Yin[7], who is another opinion leader in case study research, argues that that theory developed from case study research often can be novel, as well as testable and empirically valid. Yin focuses rather on the role of theories that exist prior to the study. Both Yin and Eisenhardt are used as sources for the following general description on case studies, although an inductive approach is adopted.

Case studies typically aim to explore, describe or explain complex phenomena. A case study examines a phenomenon in its natural setting, often employing multiple methods of data collection to gather information from one or a few entities. The underlying idea for case research is said to be the many-sided view it can provide of a situation in its context. Case studies thus provide "deeper" understanding of the specific phenomenon rather than statistical representativeness.

Case studies can utilize qualitative, quantitative material, or both, and there can be one or several cases involved. The basic principle is that the more cases are selected, the more work is required and shallower the results for the effort put in. Multiple cases on the other hand, permit cross case analysis, and make results more valid and easier to generalize. As was already mentioned, multiple data collection methods, including direct and indirect observation, structured and unstructured interviews, existing documentation and numerical

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[4] Halinen et al. 2005
[5] Eisenhardt 1989
[6] E.g. Järvenpää et al. 1996, p.7
[7] Yin 1994, p.27

data, can be employed. Triangulation – the use of multiple sources of data - is desirable to make the conclusions about the phenomenon more convincing. The case method has been mainly criticized for the reliability and generalization problems due to the small number of cases, its arduousness and difficulty to conduct.[8]

According to Yin[9], case study research is appropriate when investigators desire to:

- define topics broadly and not narrowly,
- cover contextual conditions and not just the phenomenon of the study, and,
- rely on multiple and not singular sources of evidence.

Case studies are particularly useful, Yin argues, when the researched phenomenon is not readily distinguishable from its context.[10] In my research, filling well the selection criteria presented above, case study research is a well-suited method. I have two cases, a number which serves exploratory purposes well, but also gives a possibility to do comparative analysis to a limited degree. I utilize both qualitative and quantitative data, and several methods to collect it. A more detailed description of the material and the actual research process is presented next in the next chapter.

1.5.2 Case research process

Table 2 presents the eight-step process of inducting or building theory from case study research as presented by Kathleen Eisenhardt[11]. An additional column to the right has been added to the process description to describe the real research process that took place. Although this quite established process was found to be very useful, it cannot really capture the iterative nature of doing explorative research, as Dubois et al. argue.[12] They find the researcher constantly going back and forth from one type of research activity to another and between empirical observations and theory rather than working in a linear fashion. I find the following quote from their work very descriptive of what I experienced: *"Learning takes place in the interplay between search and discovery. Where search is concerned, the current framework is used to guide the research process in a cumulative manner. Discoveries, which cannot be planned in advance, force us to reconsider the prevailing framework."*[13]

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[8] Eisenhardt 1989
[9] Yin, 1994, p.xi
[10] Yin 1994, p.3
[11] Eisenhardt 1989
[12] This is understandable as Eisenhardt focuses on multiple cases with better defined constructs
[13] Dubois et al. 2002

Table 2: Process of building theory from case study research[14]

Step	Activity	Reason	This study
Getting Started	Definition of research question	Focus efforts	Rough research questions defined beforehand.
	Possible a priori constructs	Better grounding of construct measures	No a priori constructs.
Selecting Cases	Neither theory nor hypotheses, Specified population	Retain theoretical flexibility Constrains extraneous variation and sharpens external validity	Case selection done mainly based on case company needs. Polar types.
	Theoretical, not random sampling	Focus on theoretically useful cases i.e. those that extend theory by filling conceptual categories	
Crafting Instruments And Protocols	Multiple data collection methods	Triangulates evidence	Yes.
	Qualitative and quantitative data	Synergistic view of evidence	Yes.
	Multiple investigators	Divergent perspectives	No.
Entering the Field	Overlap data collection and analysis, including field notes	Speeds analysis and reveals useful adjustments for data collection	Yes, constantly.
	Flexible and opportunistic data collection methods	Take advantage of emergent themes and unique case features	Yes, iteration and redirection central.
Analyzing Data	Within-case analysis	Gain familiarity with data and preliminary theory generation	Yes.
	Cross-case pattern search using divergent techniques	Forces researchers to look beyond and view evidence through multiple lenses	Yes.
Shaping Hypotheses	Iterative tabulation of evidence for each construct	Sharpens construct definition, validity, and measurability	Yes.
	Replication, not sampling logic across cases	Confirms, extends, and sharpens theory	Yes.
	Search for evidence of "why" behind relationships	Builds internal validity	Yes.
Enfolding Literature	Comparison with conflicting literature	Builds internal validity, raises theoretical level, and sharpens construct definitions	Yes.
	Comparison with similar literature	Improves generalizability, raises theoretical level, and sharpens construct validity	
Reaching Closure	Theoretical saturation when possible	Ends process when marginal improvement is small	Yes.

Selecting cases: Selecting cases is an important aspect of building theory from case studies as it defines to what extent the research results can be generalized. Often sampling of cases is

[14] Modified slightly from Eisenhardt 1989

founded on some theoretical basis, and it sometimes makes sense to choose cases such as extreme situations or polar types in which the object of interest is clearly observable. In this research, two cases quite different from each other were selected. The case selection was ultimately made by representatives of the case company. In line with the inductive-descriptive nature of the research, no hypotheses were made at the outset of the research.

Data collection: The empirical data collection activities can be roughly divided into three phases:

1. The *Pre-study* phase, which included interviews, company intranet searches and some practical project work with the Nokia development organization in order to gain the required pre-understanding of the business and the demand planning process. The main sources of information at this stage were the different process descriptions and interviews.

2. In the *Preparation* phase, the case projects, one in the United Kingdom and one in the United States, were selected, any information that could be remotely gathered was collected, and some quantitative analyses on the project demand planning behavior and historical planning performance were done. This was mainly done based on rollout project planning and demand planning data retrieved from the company information systems. In reality, very little material or support could be retrieved directly from the accounts before entering the field. An introductory letter, enclosed as appendix 5, was sent to the interviewees in the account teams prior to entering the field.

3. In the *Case* phase the projects were researched on-site. For each case, some four days of intensive research was carried out. The time was spent interviewing, observing, collecting local planning material, and to a large extent analyzing the findings, refining the research approach and preparing for the coming events. Thus, the research was very iterative in nature. Indeed, a key feature of theory-building case research is the freedom to make adjustments during the data collection process[15]. **Table 3** presents the professional profiles of the people interviewed. As can be seen from the table, some roles could be interviewed several times.

Table 3: Interviewee profiles

Case Tango, July 2005, USA	Case Cinderella, May 2005, UK
Account Manager	Account Controller x2
Account Controller x2	Senior Project Manager x2
Business Controller	Project Manager
Project Director	Account Logistics Manager
Senior Project Manager	Cost and Progress Manager
Project Manager	
Account Logistics Manager	
Processes and Tools Specialist	
Cost and Progress Manager	

[15] Eisenhardt 1989

The research in the case account teams started with a kick-off workshop, where the study was presented to the participants and some initial insights were collected regarding the best way to proceed. After this, the material was collected. Based on the findings, a presentation was prepared and the findings were presented in a closing workshop where feedback on the work was collected. The starting session was found essential in directing the research efforts and the ending session good for validation and sharing the findings and action plans.

The outcome that NET wanted from the study was a description of how demand was and captured and planned at the account. Creating this overview was thus the main goal of the research. As I did not have the privilege of structuring the research very well prior to entering the first case, I had to adopt an approach of working towards creating the overview bit by bit in an iterative manner; each interview contributed a new piece to the puzzle and shaped the next interview based on what information was missing. Of course, I also had to account for the fact that the interviewees had their own areas of expertise, so it would have been a waste of time to ask the exactly same questions from everyone. The interviews did thus not follow a very standard format, although certain themes recurred in each interview and a special analysis framework was used. For a detailed description of the analysis framework, see chapter 9.1.1.

Data analysis: In the data collection phase, data was continuously analyzed parallel to its collection and documentation in order to direct the research and to be able uncover links and relationships. This on-site documentation formed the backbone of further analysis. After the data was collected, the process continued with within-case analysis followed by the search for cross-case patterns. The overall idea of within-case analysis is to become intimately familiar with each case as a stand-alone entity, and let unique patterns emerge. The output of this analysis was two case descriptions, which were compared against each other in the cross-case analysis phase.

1.5.3 Literature review and timeline

In descriptive case studies, theory helps determine the priorities for data collection; collecting information about everything just does not work. Yin refers to descriptive theories as opposed to explanatory theories. According to Yin, descriptive theories give clues about what aspects of a case to include in a description, and what should be excluded.[16] Also Strauss et al.[17] stress the importance of entering into the research situations with some background in what they call technical literature. Although, they argue that there is no need to review all of the literature beforehand. Rather, the need for specific theory is created in the process. This was also what happened in this study; the literary review was an ongoing process aiming to find the relevant questions to ask, and to choose the relevant theory considering the empirical findings.

[16] Yin 1994, p.22
[17] Strauss et al. 1990; quoted in Dubois et al. 2002

I focused my literary searches to project management, operations management and supply chain management literature. Figure 2 presents an overview of the research process against a timeline.

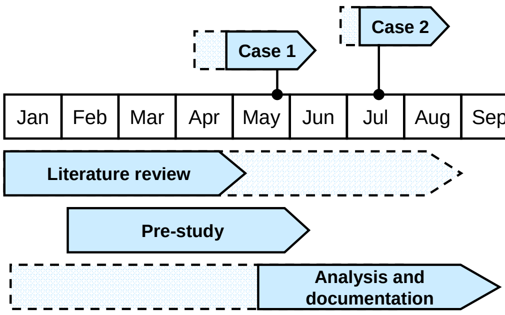

Figure 2: Research process

1.6 Structure

The left side of Figure 3 portrays the structure of the work. After the introduction, in chapters two through seven, the results of the literary review will be presented and summarized. The results from the empirical part of the research will be presented in chapters eight through ten. Chapter 11 is for discussion and conclusions.

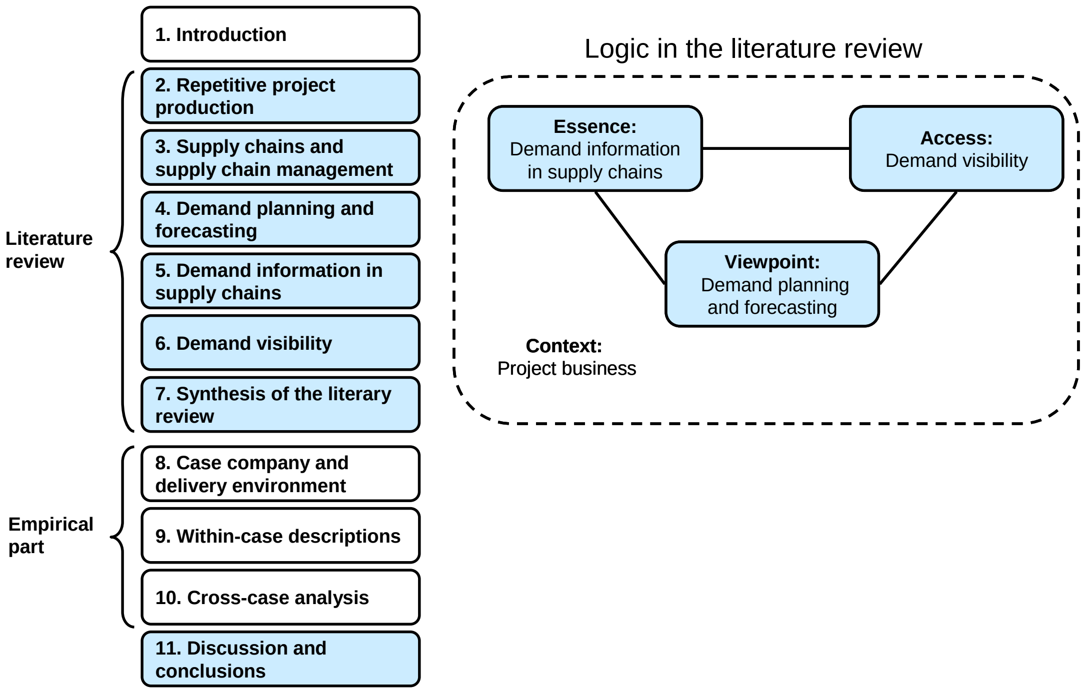

Figure 3: Structure

The nature of the research problem is reflected in the literary review part of this study. Rather than concentrating on a single topic in depth, I have chosen to provide a more holistic description of the whole. The right hand side of Figure 3 presents the high-level logic of the literary review. There are three foci in the theoretical discussion. The first one is the *essence* of this study, demand information in supply chains. The literary review aims to describe what demand information in supply chains is, and what it is not. The second focal area is *access* to demand information. The discussion here is mainly how to attain visibility to demand and alternatives to visibility. The third area is demand planning and forecasting, which is the *viewpoint* of the study. Moreover, although much of the discussion draws on supply chain management literature, the project business context is considered throughout each theme. Each chapter concludes with the most important findings.

The empirical part is rather straightforward. First, I present what is known about the specific case setting based on company-internal documentation and research conducted in this specific context. In chapters nine and ten, the case framework and the results from the two cases will be presented and analyzed.

2 Repetitive project production

This chapter starts with introducing the overall project business context of the study, and serves as background for further discussion. I will describe the nature of projects, what is characteristic for project business, and what strategies companies in project business can apply to deal with the peculiarities of project production.

2.1 Projects and operations

Generally, work can be categorized as either projects or operations, although the two sometimes overlap. Projects aim to create something new as operations are concerned with maintaining the ongoing. Compared with operations, projects are by definition[18]:

- *Temporary*. Projects have a finite duration; they have a beginning and an end. As a direct consequence of this projects have also a finite organization; an ad hoc combination of human resources. Finally, projects are finite in content; they have defined objectives. Operations, on the other hand, are ongoing and repetitive.
- *Unique*. Projects are one-off undertakings, which never exactly repeat. This causes uncertainty and risk.
- *Complex*. Projects are often also complex ventures that require inputs from several organizations, and are characterized by shared resources and competition for these resources. From a personnel perspective, a team / consortium approach is needed to handle the diverse competence requirements caused by complexity.
- Projects have identifiable *goals and objectives*. Projects tend to be strongly goal-oriented as they have strictly defined goals in terms of scope, time, cost and quality.

2.2 Project suppliers and repetitive project production

Companies which deliver unique products to their customers have adopted projects as an instrument to carry out their deliveries. Such companies having projects in their product line are defined in this study as *project suppliers* and their business as *project business*[19]. According to Artto[20], project suppliers can be divided in groups based on their core competencies. Manufacturers have flexible and efficient production resources, Integrators have technical expertise in the needed integration tasks and Designers' competence is based

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[18] E.g. Project Management Institute 2000, p.6; Artto 2001, p.75
[19] E.g. Meklin et al. 1999, Artto 2001 use the term project companies for the same purpose
[20] Artto et al. 1998 et al., pp.30-31

on process and equipment knowledge and related design services. Sometimes businesses are very specialized and perform only a small activity in the project-based value chain, sometimes the company adopts several of the above roles.

What project suppliers try to accomplish is to provide unique project products and services to meet exact requirements of single customers, and at the same time, implementing these products using as standard a process as possible. According to Meklin et al.[21]: *"The project approach [of project suppliers] emphasizes the individual nature of each customer case while the process approach highlights the fact that these cases have a lot of common features, which allows processing them through a common delivery process."*

In this research, the focus is on such repetitive delivery projects, where the key to commercial success is combining serial production efficiency with the ability to tailor customized solutions. Unique as the project products are, it is possible to base them on common product platforms. This is done by applying modular products and processes that are standardized to certain extent, thus reducing the inherent uniqueness and uncertainty in projects.[22] Jahnukainen et al.[23] see the same development as the separation of product and delivery processes. The separation of the product and delivery processes means that the company is no more living in the middle of a continuous prototype process, but the processes are well defined and organized. When some parts of the products and processes can be modularized and standardized, the need for customer specific engineering is reduced and the design cycles are shortened.

Yet, projects can never be as efficient as repetitive manufacturing because delivery projects are open production systems[24] typically susceptible to external shocks such as scope changes and dependency. Manufacturing on the other hand, is done sealed away in a standardized environment. According to Koskela[25], the open project environment, or a set of peculiarities characteristic to the construction industry, are often presented as reasons, or excuses – when well established and useful procedures from manufacturing are not implemented in construction. The four peculiarities, one-of-a-kind nature, site production, temporary multi-organization and regulatory intervention are somewhat overlapping with the previous general discussion of project but offer some more practical insights.

The four peculiarities are presented in Table 4 in order to provide an overview of the problems of process control and process improvement in projects, and the strategies used to manage them. In the table, *process control* refers to the management of a project, *process improvement* to the development efforts of the permanent organizations in construction, such as designing, manufacturing of materials and components and contracting.

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[21] Meklin et al. 1999, p.27
[22] E.g. Artto 1998, p.75; p.93; Koskela 1992, p.44; Hameri et al. 1998
[23] Jahnukainen et al. 1995
[24] Wikström 2000, quoted in Hellström et al. 2005
[25] Koskela 1992, p. 45

Table 4: Challenges and solutions related to construction peculiarities[26]

Peculiarity	Process Control Problems	Process Improvement Problems	Structural Solutions	Operational solutions for control	Operational solutions for improvement
One-of-a-kind	No prototype cycles Unsystematic customer input Coordination of uncertain activities	One-of-a-kind processes do not repeat, thus long term improvement questionable	Minimize the one-of-a-kind content in the project	Upfront requirements analysis Se up artificial cycles Buffer uncertain tasks	Enhance the flexibility of products and services to cover a wider variety of needs. Accumulate feedback information from earlier projects
Site production	External uncertainties: weather etc. Internal uncertainties and complexities: flow interdependencies, changing layout, variability of productivity of manual work	Difficulty of transferring improvement across sites in procedures and skills.	Minimize the activities on site in any material flow	Use enclosures etc. for eliminating external uncertainty. Detailed and continuous planning Multi-skilled work teams	Enhance planning and risk analysis capability Systematized work procedures
Temporary organiza-tion	Internal uncertainties: exchange of information across organization boundaries	Difficulty of stimulating and accumulating improvement across organization borders	Minimize temporary organizatio nal interfaces (interdepen-dencies)	Team building during the project.	Integrate flows through partnership
Regulatory intervention	External uncertainty: approval delay			Compression of approval cycle Self-inspection	

In terms of planning demand these factors have several implications; demand information is received in unsystematic format, the high level of internal and external uncertainties make forecasting a real challenge, and common planning development efforts are hard to implement due to discontinuity, just to mention a few.

2.3 Conclusion

This chapter introduced the special characteristics of project work as a basis for further discussion. It will, for instance, be discovered that project networks are in many ways

[26] Koskela 1992, p.49

different from those in purely repetitive environments, projects have their own characteristics as sources of demand, and projects require their own approaches for demand planning and forecasting. Moreover, it is important to introduce the project business context as most of the references that are used in the literature review come from studies conducted in repetitive operational environments, the applicability of which to project environments need to be evaluated separately.

3 Supply chains and supply chain management

The organization of how value is created through the activities of firms is changing. Replacing traditional arrangements are leaner, more flexible firms focusing on core technology and processes. The network paradigm, following porterian[27] thinking, assumes that flat is better, and each part or process or function should be the responsibility of a specialized, independent and efficient entity of world class competence. Citing Webster[28], *"The bias has shifted from make to buy, from ownership to partnership, from fixed cost to variable cost, but in the context of long-term stable relationships"*. The logic behind this decoupling is increased flexibility because under uncertain environmental conditions, resource bundles – now exchanged rather than owned - can be reallocated cheaply and quickly to meet changing environmental demands[29]. In line with this development, the managerial focus and challenges have shifted from company-internal matters to the various links joining companies. Supply Chain Management literature, drawing on fields such as purchasing and supply, logistics and transportation, operations management, marketing, organizational theory, management information systems, and strategic management, focuses on addressing this new reality[30].

The chapter will open with a rather general discussion of business relationships, which are found to be a lubricant for demand information flows. Supply chains and some ideas behind the supply chain management paradigm will be introduced next. Then, a short review of the Bullwhip Effect, which arguably can be countered by improving demand visibility in supply chains, will follow. The discussion continues with a review on the idea of supply chain differentiation, relating to building responsiveness into supply chains as an alternative to demand visibility. The chapter will close with studying project supply chains and defining project delivery network.

3.1 Inter-firm exchange ties

According to Skaates et al.[31] there are two nested levels of relationship management in the marketing of industrial projects. The first level is that of managing networks and relationships related to individual projects from beginning to end. The second level is the level of multiple projects; it encompasses relationships during a longer period of multiple

[27] See Porter 1998 work on value chain concepts of functional value added and the need to focus on those areas where competitive advantage can be maintained.
[28] Webster 1992
[29] E.g. Jones1997; Nassimbeni 1998
[30] Chen et al. 2004
[31] Skaates et al. 2002

project activity, including possible periods in which there are no projects.[32] Out of the two levels, I am interested in relationships within a single project.

In terms of capturing demand information, relationships are interesting as it has been found that buyer-supplier, or supplier-supplier, relationship status is strongly correlated with the intensity and quality of information flows.[33] Heikkilä[34], for instance, argues that a *"good relationship between the customer and the supplier contributes to reliable information flows, and reliable demand information flows in turn contribute to high efficiency."*

Business relationships should not be seen as black and white extremes; they rather form a spectrum of different possible configurations. Webster[35] has originally presented a model illustrating various relationships in which organizations may be involved. The model, shown in Figure 4, portrays a continuum of relationships from pure market transactions at one end to transactions internal to the company at the other end.[36] The lower part of Figure 4 illustrates the mirror image of relationships; a continuum of governance forms with two extremes: perfectly competitive markets and vertically integrated hierarchies. An intermediate form of governance is the network.[37] Two relationship archetypes, arm's-length relationship and collaborative, are discussed in the following.

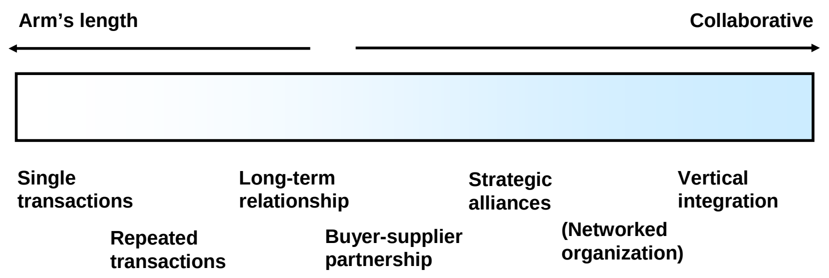

Figure 4: Range of marketing relationships[38]

In the ideal-type atomistic market, exchange partners are linked by arm's-length ties. Self-interest motivates action, and actors regularly switch to new buyers and sellers to take advantage of new entrants or avoid dependence. The exchange itself is limited to price data, which supposedly distil all the information needed to make efficient decisions, especially when there are many buyers and sellers.[39] Information exchange between companies in such relationships is often minimal.

Arm's-length relationships have been the traditional way to execute projects. These projects are structured around contractual relations, in which suppliers are awarded contracts through

[32] E.g. Skaates et al. 2002; Cova et al. 2002
[33] E.g. Heikkilä 2002; Black et al. 2000; Cheung et al. 2002
[34] Heikkilä 2002
[35] Webster 1992
[36] Webster 1992
[37] Williamson 1985
[38] Modified from Webster 1992
[39] Uzzi 1997, p.36

a competitive bidding process to provide pre-specified goods and services at a predetermined price. What is to be supplied is largely determined by the owners. How it is to be supplied is largely at the discretion of the supplier.[40] Still, compared to repetitive production environments, even at arm's length project participants need to do significant amounts of coordination because of the high level of task interdependence.

Collaborative relationships[41] emphasize the state of openness and collaboration between a buyer and a supplier. The relationships of this type are socially embedded[42]. A good example of embedded relationships can be found in the Japanese industries, in the Japanese auto industry in particular.[43] Embedded relationships are characterized by their long-term nature, trust, joint problem solving mechanisms, thick information exchange of tacit and proprietary know-how and commitment to share both good and bad times. They are typified by trust and impersonal ties, rather than explicit contracts, and these features make expectations more predictable and reduce monitoring costs of other parties' actions.[44] Given the effort involved in creating and sustaining partnerships, clearly a firm must focus on the trading partners it considers most important in the long run, and in all situations companies should not even strive for close relationships.[45]

Existing research thus indicates that the concepts of power and trust are at the heart of all business-to-business relationships[46]; relationships are partly grounded in economics of power and partly the emphasis is on social values and trust. In practice, the two approaches exist simultaneously. It is also recognized that an adversarial or competitive relationship between parties does not exclude the possibility of collaboration. This is due to the fact that collaborative practices can be forced on the weaker party, or they occur as a result of interdependence.[47] According to Wu et al.[48] such *co-opetitive* relationships are becoming more common.

3.2 Supply and demand chains

I define Supply Chain following Christopher's proposal:

> "**Supply chain** is a network of organizations that are involved, through upstream and downstream linkages in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer."[49]

[40] E.g. Black et al. 2000; Cheung et al. 2002; Hobbs et al. 2001
[41] See Smith et al. 1995 for a review on co-operative relationship.
[42] E.g. Granovetter 1985; Uzzi 1997
[43] E.g. Womack et al. 1990, p.150
[44] Uzzi 1997
[45] E.g. Lambert et al. 2000; Corbett et al. 1999; Bensaou 1999; Cooper 1997
[46] E.g. Cox 2001, Kraljic 1983, Bensaou 1999
[47] Cox 2001
[48] Wu et al. (forthcoming)
[49] Christopher 1998, p.15

A typical supply chain could include, in different configurations, raw material suppliers, manufacturing units, distribution centers, retail outlets and end customers.

As Christopher's definition implies, supply chains have become more complex, and the use of metaphors such as webs and nets to describe these new business models implies that more complex interrelationships are replacing the supply chains with which we have become familiar.[50] Another paradigm shift in supply chains is the notion that individual businesses no longer compete as pure autonomous entities, but rather as supply chains, or networks.[51] Not everyone shares this assumption. Yet, according to Wu et al., chain-to-chain competition has become reality for instance in the telecommunication industry, where the competing chains often represent competing technological standards.[52]

Finally, some works emphasize the dual aspects of the chain, that is, both demand and supply. E.g. Vollmann et al. suggested that supply chains should be rather termed demand chains to emphasize the shift from efficient supply to meeting the needs of the customer.[53] It has become clear, that there are fundamental differences between agile chains that focus on markets and customer, and chains that focus on efficient physical supply.[54] However, the term demand chain is reserved for another use in this work; I will adopt the definition by Hoover et al.:

> "**Demand Chain** is the chain of activities that communicates demand from the customer to the supplier." [55]

When combined, the demand and supply chains form the demand-supply network, which is an end-to-end network where demand is passed from markets to supply sources and value offerings passed from supply sources to consumers.[56] The concept of Demand Supply Network is illustrated in Figure 5.

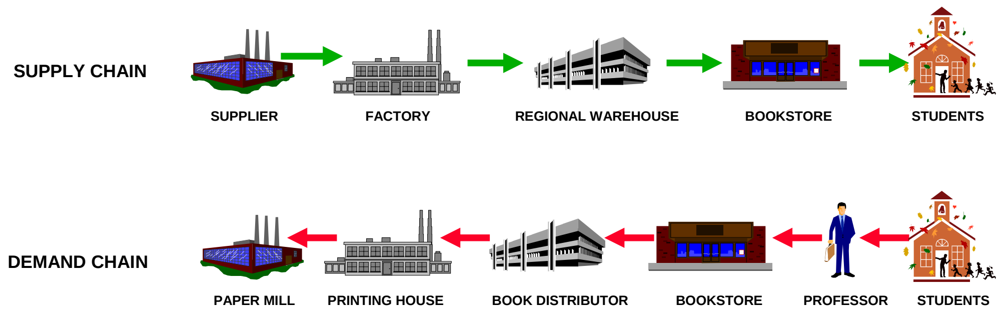

Figure 5: Demand supply network[57]

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[50] E.g. Hewitt 2000; Christopher 1998, p.18
[51] Lambert et al. 2000; Christopher 1998, pp.18-19
[52] Wu et al. 2003
[53] Vollmann et al. 2000
[54] Fisher 1997
[55] Hoover et al. 2001, p.71
[56] Hoover et al. 2001, p.72
[57] Eloranta 2005

3.3 Supply chain management paradigm

A number of definitions exist for Supply Chain Management. I will adopt Christopher's which is probably the most widely used:

> **"Supply Chain Management** is the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."[58]

The key concern of supply chain management is the coordination of the flows of materials and information across companies and functions, recognizing that major improvements are gained in the overall coordination. This should be translated to reduced waste, better customer service and competitiveness for the whole chain. The shift in thinking implies a change toward a more cooperative business relationships, in which information, processes, decisions and resources are shared among partner companies.[59]

Figure 6 presents the main objectives of supply chain management. After Eloranta[60], supply chain management is about "*managing the material, information and financial flows of the demand supply chain to create customer satisfaction for maximizing current and future network profitability*". Current and future network profitability consists of asset performance, cost efficiency and customer satisfaction. Thus, there are two somewhat conflicting main objectives of supply chain management, enhancing end-customer value and, at the same time, focus strongly on cost and asset efficiency throughout the supply chain.

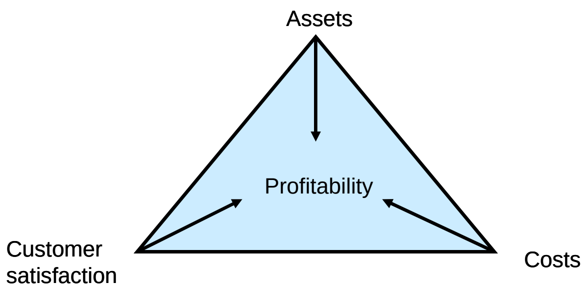

Figure 6: Goals of demand supply network management[61]

Alongside supply chain management, the term demand chain management has been used in the literature to stress the importance of customer-oriented thinking. According to Vollman et al.[62], the idea of demand chain management is based on the principle of using demand instead of supply as the factor integrating the information needs in the supply chain. In supply chain management, the starting point for planning and controlling is the material supply push, whereas in demand chain management it is the end user demand pull. What is

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[58] Christopher 1998, p.18
[59] E.g. Cooper 1997; Vollman et al. 2005, p.577; Christopher 1998, p.18-19
[60] Eloranta 2005
[61] The exact term Eloranta 2005 uses is demand supply network management.
[62] Vollman et al. 2000; Korhonen et al.1998

clear is that the ability to capture end-user demand and to physically respond to that demand in a timely manner is the new priority, and thus, demand driven processes are essential.[63]

In practice, it still seems that most attempts companies take to manage the supply chain focus on the immediate neighboring organizations. This approach to SCM does not require total central coordination and control, which can be both difficult and costly. And, the biggest gains from the company's perspective can be gained from nearby.[64]

3.4 Bullwhip Effect in supply chains

One of the main system issues in supply chain management is the Bullwhip Effect. Although the term Bullwhip effect was popularized quite recently by Lee et al.[65] in 1997, the phenomenon was originally discovered by Jay Forrester[66] already in the 1950s. In between these two events, many researchers including Towill[67], Burbidge[68] and Houlihan[69] have researched the phenomenon. Yet, in order to avoid mixed terminology, I will use Lee et al.'s.

The Bullwhip Effect refers to the phenomenon where variability in end customer demand is amplified when moving upstream the supply chain. The amplification of demand leads to many problems in the supply chain, such as high inventory levels, low capacity utilization, delivery problems and unfulfilled orders. Parties upstream in the supply chain are forced to keep inventories in order to respond to the fluctuating demand they face, which is translated to higher costs for the whole supply chain.[70]

Lee et al. has identified four root causes for the phenomenon. What they call Bullwhip Effect is argued to be caused by demand signal processing, order batching, price variation and rationing game. *Demand signaling* refers to each echelon in the supply chain doing individual demand forecasting. When this is done, a small change in the end-customer demand is amplified when each company updates their forecasts one-by-one. According to Lee et al, *order batching* is the most fundamental reason for demand distortion. It is caused by company ordering behavior; when companies order at certain time intervals or in fixed quantities, time lags are created in transferring demand. *Price fluctuations*, such as periodical discounts, cause advance buying and raise inventory levels as companies are after the best deals. Finally, *rationing and shortage gaming* occur in a constrained supply situation when companies want to secure the amount they want in case of a shortage.[71] Houlihan originally

[63] E.g. Hewitt 2000
[64] Cooper 1997
[65] Lee et al. 1997
[66] Forrester 1958
[67] Towill 1992
[68] Burbidge 1989
[69] Houlihan 1987
[70] Lee et al. 1997
[71] Lee et al. 1997

reported that when shortages and missed deliveries occur in supply chains, customers tend to overload their schedules or order some more in order to be on the safe side.[72]

The solutions that Lee et al. propose for dealing with supply chain dynamics are removing any unnecessary batching in ordering and transportation, changing inventory control principles, different kinds of supply chain collaboration, including sharing demand information, vendor managed inventory and planning collaboration, and establishing new business rules for pricing and supply allocation.[73] Some of these remedies will be discussed more in detail in chapter 6 in the context of demand visibility. Table 5 collects causes, contributing factors and possible counter-measures for the Bullwhip Effect.

Table 5: Causes of and counter-measures for the Bullwhip Effect[74]

Causes	Contributing factors	Counter-measures
Demand signalling	No visibility of end demand Multiple forecasts Long lead-time	Access sell-through or point-of-sale data Single control of replenishment Lead-time reduction
Order batching	High order cost Full truckload economics Random or correlated ordering	Electronic data interchange, computer assisted ordering Discount on assorted truckload, consolidation by 3rd party logistics Regular delivery appointment
Fluctuating prices	High-low pricing Asynchronized delivery and purchase	Every-day low price strategy Special purchase contract
Shortage gaming	Proportional rationing scheme Ignorance of supply conditions Unrestricted orders and free return policy	Allocate based on past sales Shared capacity and supply information Flexibility limited over time; capacity reservation

3.5 Supply chain differentiation

Marshall Fisher[75], a household name in supply chain management, suggests classifying products based on their demand patterns, which leads to two categories of products: functional and innovative. The categorization is argued to be useful in determining the appropriate supply-chain design to support a certain type of demand. *Functional products* are commodities that have predictable demand patterns, such as light bulbs and toothpaste. These products have many substitutes, command low margins, have long lead times and are rarely stocked-out. *Innovative products*, however, have unpredictable demand, relatively

[72] Houlihan 1987
[73] Lee et al. 1997
[74] Lee et al. 1997
[75] Fisher 1997

high margins, few substitutes if any, short lead times and face frequent stock-out situations. Drastic markdowns are applied to clear excess inventory.

Fisher basically proposed that supply chains should be efficient for functional products, whereas they should be built to be responsive for innovative products. A physically efficient process supplies predictable markets with low cost, and are highly dependent on forecasts and plans. On the other hand, market responsive supply chains need to respond quickly to unpredictable demand to be able to capture the short-term opportunities and minimize forced markdowns and inventory obsolescence costs. Table 6 presents some more detailed perspectives on how the different supply chain types should be managed. [76]

Table 6: Physically efficient versus market-responsive supply chains[77]

	Efficient supply chain	Responsive supply chain
Primary purpose	Supply predictable demand efficiently with the lowest possible cost.	Respond quickly to unpredictable demand in order to minimize stock-outs, forced markdowns and obsolete inventory.
Manufacturing focus	Maintain high average utilization rate.	Deploy excess buffer capacity.
Inventory strategy	Generate high turnovers and minimize inventory throughout the chain.	Deploy significant buffer stocks of parts or finished goods.
Lead-time focus	Shorten lead-time as long as it does not increase cost.	Invest aggressively in ways to reduce lead time.
Approach to choosing suppliers	Select primarily for cost and quality.	Select primarily for speed, flexibility and quality.
Product design strategy	Maximize performance and minimize costs.	Use modular design in order to postpone product differentiation for as long as possible.

Heikkilä criticizes Fisher's idea that the selection of supply chain structure primarily depends on the industry demand characteristics. He argues that this is too simple an approach and suggests that several different chains are needed within a single industry to meet various customer needs and situations.[78] According to Heikkilä, the search for a good balance between good customer satisfaction and supply chain efficiency should start with the customer, and follow with developing a range of modular service offerings adapted to individual customer situations and needs. Later, Collin identified the accuracy of the customer project plan and the level of collaboration in the customer relationship as dimensions for supply chain segmentation in project business, indicating that the information available in the project should be the starting point for choosing a supply chain.[79]

[76] Fisher 1997
[77] Fisher 1997
[78] Heikkilä 2002
[79] Collin 2003, p.196

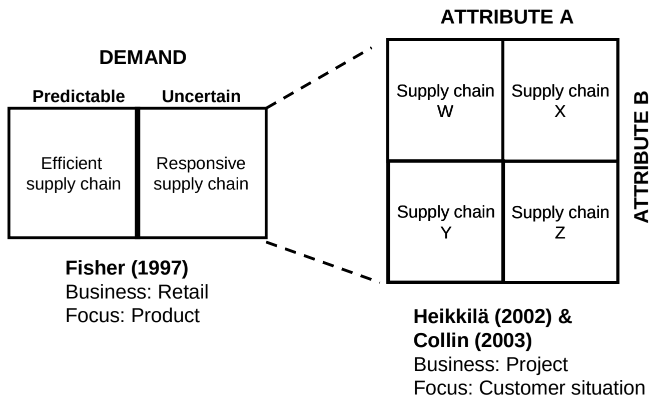

Figure 7: Segmenting supply chains

Figure 7 presents a recap of supply chain differentiation. By exploring the customer situations in depth, the still unknown attributes A and B used for segmenting customers and differentiating value offerings can perhaps be identified.

3.6 Project supply chains

The broader networking development is noticeable also in project business as project suppliers that assume the responsibility to deliver larger functional entities are most likely to rely both on the capacity and capabilities from a network of service and equipment suppliers.[80]

I see delivery project supply chains as a special case of supply chains. They are typically V-shaped, or converging, as material is directed to site and the end-product is assembled from incoming materials.[81]

3.6.1 Project delivery chain

The project delivery chain model by Artto[82] should be useful in understanding demand and supply relationships in project business. The following definition is slightly modified:

> **A project delivery chain** is understood to be an entity formed by interlinked customers and suppliers at different levels at a networked value chain. The highest level of project delivery chain comprises the customer's investment project, which is realized through the projects of project suppliers forming the value chain.[83]

Figure 8 presents the project delivery chain -model. As can be seen, the highest level of project delivery chain comprises the customer's investment project, which is realized through the projects of project suppliers forming the value chain. The nature of the project and also their duration differ in each level of a project delivery chain. Projects at the upper

[80] Hellström et al. 2005
[81] Vrijhoef et al. 2000
[82] Artto et al. 1998, p.35
[83] Artto et al. 1998, p.35

level are typically very large and complex. When proceeding downwards in the hierarchy, the scopes of projects get narrower and their final outcomes start to look like standard products. At the bottom level companies may be equipment manufacturers or mass producers whose contribution to final customer's investment project can hardly be called projects any more. A project in the chain might be a part of the preparation phase of customer's investment project whereas some other project might belong to the customer project's execution phase. Some sub-delivery project in the lower level might be a part of the after-sales services of the delivered product.[84]

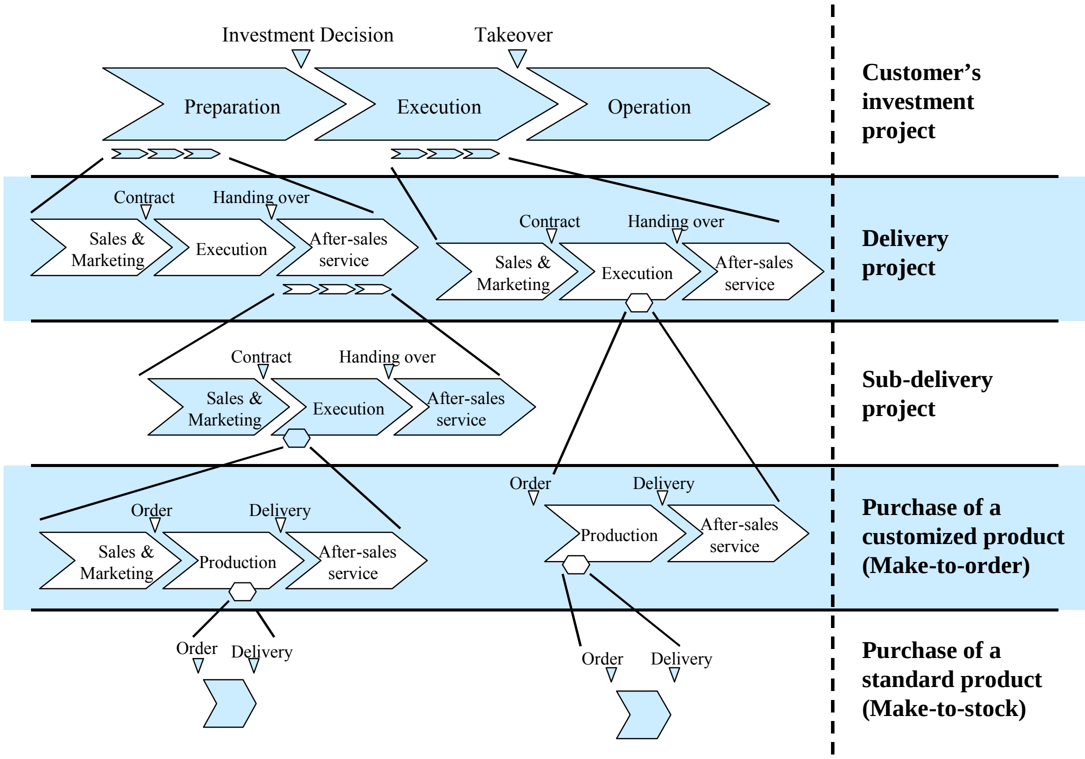

Figure 8: Project delivery chain hierarchy[85]

The term project delivery chain relates closely to concepts of supply chain and company networks. A project delivery chain can be considered, in a way, to be supply or demand chain in project, or one-of-a-kind environment. More permanent and profound network relationships can be found in the repetitive process environment but also in a one-of-a-kind project environment.[86]

3.6.2 Projects and supply chains

As can be seen from the project delivery chain hierarchy, projects and supply chains interface at many levels. Vrijhoef et al. have studied the interface between construction

[84] Artto et al. 1998, p.35
[85] Artto et al. 1998, p.22
[86] Poskela 2001, p.11

projects and supply chains, and recognized four major roles of supply chains in the interaction between projects and supply chains. The contractor whose main interest is in site activities will adopt a focus where the primary concern is to ensure dependable material and labor flows to the site and avoid disruption to the workflow. If the contractor focuses on the supply chain itself, his goal is to reduce logistics costs. A third focus may be on transferring activities from the site to earlier stages of the supply chain to achieve concurrency and avoid inferior site conditions. Finally, the emphasis may be in the integrated improvement of the supply chain and the site production as a whole.[87]

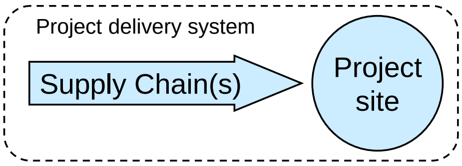

Figure 9: Project - supply chain interface

Vrijhoef et al. argue that problems and waste in project supply chains are largely caused by obsolete and myopic control of the chain, which is in line with the ideas of supply chain management.[88] What makes the management of the interface challenging is that project and supply chain systems tend to have contradictory perspectives.[89] In projects, material shortages can prove costly as they often have cascade effects due to task interdependencies. A delay can cost dearly if the shortage occurs for a task on the critical path, which can bring the whole project to a standstill.[90] As the consequences for material shortages are severe, and the overarching goal is to deliver the project in time to the customer, materials are often ordered too early[91]. On the other hand, personnel in the supply organization are often more concerned with reducing material buffering.

Uncertainty also flows from projects to supply chains, not only the other way around. According to Goldratt, three types of uncertainty exist in project planning and scheduling: task time certainty, path time uncertainty and resource uncertainty.[92] If the project for some reason is not on schedule, or resources are constrained, materials are not needed when originally planned or they may be needed sooner than planned. Issuing orders too early or late leaves the supply chain with uncertain demand and extra safety stock.[93] Concessions need thus to be made either in project progress or material buffer levels at the site or in the supply chain. According to Collin[94], eliminating buffers totally is not an option, quote: *"the*

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[87] Vrijhoef et al. 2000
[88] Vrijhoef et al. 2000
[89] Meklin et al., p.27; Collin 2003, pp.181-182,
[90] Ala-Risku et al. (forthcoming); Vrijhoef et al. 2000
[91] E.g. Alarisku et al. (forthcoming)
[92] Goldratt 1997; quoted in Yeo et al. 2002
[93] Ala-Risku et al. (forthcoming); Vrijhoef et al. 2000
[94] Collin 2003, p.191

supply chain starts to behave in a chaotic manner when these two systems [the project and supply chain systems] are forced to work together without either time or material buffering."

3.6.3 Characterizing project delivery networks

Researchers both in the fields of project marketing and project management have presented the idea that for project networks, a distinction should be made between, on the one hand, actors working in a project specific network, and, on the other hand, wider networks of actors that regularly cooperate.[95] As a result of discontinuity in projects, the network is temporally limited and reconstructed from one project to the next. This discontinuity also limits the level of investment that companies are willing to make in the relationships in terms of processes, information technology, or relationships as it would be difficult to recover a viable payback for the investment during the lifetime of the project supply network.[96] The risk is that the relationship may not be carried over to the next project.

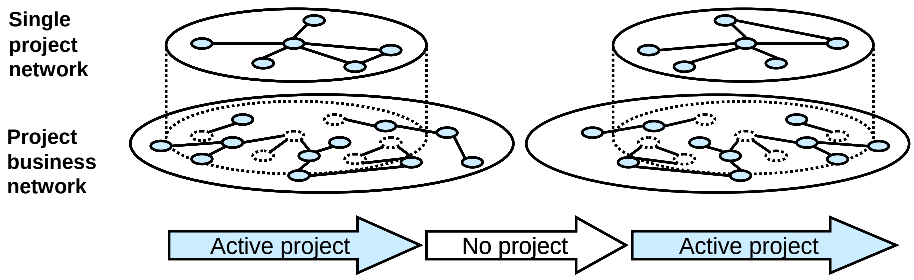

Figure 10: Two levels of networks in project business

Another important notion is that the project network takes very different forms in different project phases, as actors enter and exit the project, or commit to it after winning a tender. The design process of major projects is fuzzy, with a variety of committed and potential stakeholders involved; the process takes a long time and is hard to capture. The implementation phase on the other hand, is much more structured and takes place in semi-hierarchical networks. In the execution phase, the client and the main contractor, have in principle the final say on most of the cost and design decisions.[97] I define project delivery network in this study as follows:

Project delivery network is the temporary, often semi-hierarchical, network of companies set up for the duration of the project execution phase of a single project.

Understanding the power structure and coordination of project delivery networks is interesting from the perspective capturing demand information. According to Wilkinson et al.[98], marketing has tended to assume the existence of a primary actor, channel captain, chain master, or orchestrator in a network who initiates control and directs the network. The actor

[95] E.g. Hellström et al. 2005; Cova et al. 2002; Skaates et al. 2002
[96] Kärkkäinen et al. 2004
[97] Hellgren et al. 1995
[98] Wilkinson et al. 2002

is in a leading position in the network due to his financial power or exceptional knowledge of products and processes. The network literature, on the other hand, sometimes assumes the absence of a hierarchical top capable of making final decisions which are binding for the network as a whole[99].

Nassimbeni's research seems to strengthen the assumption that a central actor exists in a project delivery network. He claims that when the end product is the result of separately manufactured components the supply network assumes a tree-net configuration. The main contractor on top of the network coordinates and integrates the companies producing the components. The main type of interdependency in this type of network is in work flow, as interdependencies arise with internal production activities and external material flows need to be synchronized. Accordingly, the main coordination mechanism is direct supervision by the strategic and operational brain of the main contractor. Delivery projects are often such assembly exercises, where the uniqueness and complexity of the product requires strict central coordination of the work performed by the different stakeholders.[100]

3.7 Conclusion

This chapter was an introduction to business relationships, supply chains, both regular and project, and selected issues in supply chain management. The Bullwhip Effect, its main causes and the management of the effect, was presented. The main countermeasure was found to be increasing demand visibility in the supply chain. Also, literature on the grounds for differentiating supply chains was reviewed and discussed for later use. The most important takings from this chapter were the following:

- Networks of leaner, more flexible firms focusing on core technology and processes are replacing traditional arrangements. In line with this development, the focus of management has shifted from the internal issues toward inter-firm relationships.

- Several studies indicate that close relationships are positively related to more frequent sharing of better quality information between business partners. The closeness of the relationship is determined by a complex fusion of various factors, e.g. trust and power. These factors are by no means independent and it often is difficult to distinguish the cause from the effect. E.g. effective and open communication is needed to induce trust and this applies also vice versa. In any case, the different relationship dimensions are most probably a major determinant for capturing demand information.

- In demand-driven and responsive supply chains, the ability to capture end-user demand and to physically respond to that demand in a timely manner is of utmost importance. Against this background, understanding the processes of demand creation and evaluating the quality of information is paramount.

[99] E.g. Wilkinson et al. 2002; Cooper et al. 1997; Hewitt 2000; Stadtler et al. 2003
[100] Nassimbeni 1998

- Good demand visibility has been identified as a remedy for the Bullwhip Effect in supply chains.

- Responsive supply chains can be seen as an alternative to demand visibility.

- Projects and supply chains interface at many levels, and the concepts of project and supply chain are overlapping. Projects and supply chains, if seen as separate entities, have conflicting goals.

- Project delivery network is defined as the temporary, often semi-hierarchical, network of companies set up for the duration of the project execution phase of a single project. Thus, a central coordinating actor is probable in project delivery networks. It is probable that such an actor is a gatekeeper of information.

4 Demand planning and forecasting

This chapter deals with demand planning and forecasting. Especially for innovative products, it is important to have business processes in place to maintain a proper balance between demand and supply[101]. In order to be able to plan supply, an estimate of future demand is needed, which is the job of demand planning and forecasting.

The first topic in this chapter is planning in supply chains; an overview, which is required to put demand planning and forecasting into context. Next, two classifications on demand will be reviewed after which the matter of balancing supply and demand is briefly covered. Towards the end, the role of demand management will be reviewed and finally, several themes under the heading of demand planning and forecasting will be discussed.

4.1 Planning in supply chains

Along a supply chain, thousands of individual decisions have to be made and coordinated every minute. These decisions range from a rather simple decision about how to schedule a particular job on a machine, to whether to open or close a factory.[102] Planning takes place on different levels of aggregation, over different time horizons, and in different cycles depending on whether the planning is strategic, tactical or operational[103] (or long-, mid- or short-term[104]). The more important the decision is, the better it has to be prepared and planned.

Stadtler's[105] Supply Chain Planning Matrix, shown in Figure 11 classifies the planning tasks in two dimensions of *planning horizon* and *supply chain process*. The matrix presents the idea of a hierarchical planning system, which is about decomposing the total planning task into planning modules, i.e. partial plans. On the upmost level, there is only one module, the development of enterprise-wide, long-term but very rough plan. The lower the levels are, the more restricted are the supply chain sections covered by one plan, the shorter the horizon and the more detailed the plan. The modules are linked by horizontal and vertical information flows.

[101] E.g. Vollman et al. 2005, p.61; Hoover et al. 2001, p.136
[102] Stadtler et al. 2002, p.82
[103] Van Landeghem et al. 2002
[104] Stadtler et al. 2003
[105] Stadtler et al. 2002, p.87

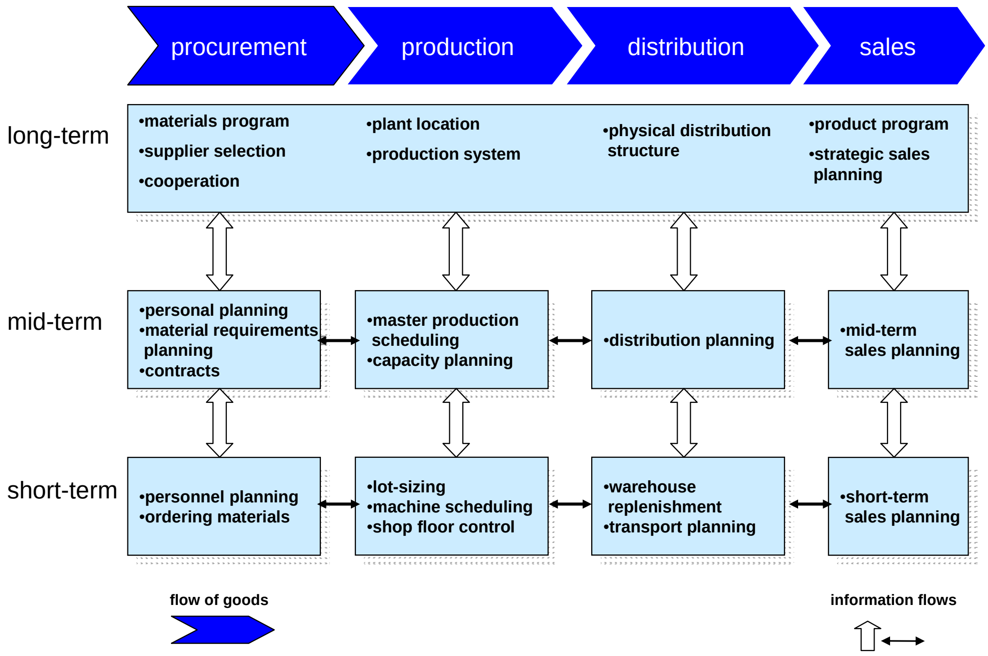

Figure 11: Supply chain planning matrix[106]

Strategic-level decisions should create the prerequisites for the development of the enterprise or supply chain in the future. The planning horizon is usually several years into the future. Typically, they concern the design and structure of a supply chain. Bounded by the decision made at the strategic level, tactical planning determines an outline of the regular operations. Rough quantities and timing of production are planned months ahead so that aggregate supply and demand can be matched. The lowest planning level has to specify all activities as detailed instructions for immediate execution and control, where the planning horizon is typically from days to a couple of months.[107] The decisions taken at lower levels are restricted by the structure and decisions taken at upper levels.

This research focuses mainly on the tactical or mid-term level of planning. The main task in mid-term sales planning is forecasting the potential sales for product groups in specific regions. The forecast is used for balancing supply and demand, which is topic of chapter 4.3.

4.2 Demand basics

Next, I will present some central notions on demand. Two well-known classifications of demand will be presented along with some discussion on demand uncertainty.

4.2.1 Demand patterns

What does demand look like? According to Krajewski et al., the five basic components of demand are the average, trend, seasonal influence, cyclical movement and random error. The

[106] Stadtler et al. 2002, p.87
[107] Stadtler 2005

average is the mean around which demand fluctuates, whereas trend is a systematic increase or decrease in demand in the long term, when a market is steadily moving toward some direction. Some products are more seasonal than others showing peaks and valleys over a fixed time period, a good example being Christmas-time toy-shopping. Cyclical demand patterns are about gradual increases and decreases over extended periods of time, years or decades, following certain business and technology life cycles. Finally, random error is the component of demand that makes every forecast wrong.[108]

The level, timing and composition of goods and services bought are influenced by to a large extent by factors outside the control of the company; buying behavior, competitors' actions, and the health of the economy, among other things. Yet, even though the company cannot influence all aspects of demand, demand has also a proactive component. For instance, in the long run demand is the result of the actions a company takes to develop products and services and, in the short term, the company's marketing decisions can be used to influence demand.[109]

4.2.2 Independent, dependent and derived demand

From a sales and operations planning point of view demand is often classified into independent and dependent demand[110]. Mentzer and Moon have added the concept of derived demand for the supply chain context.

The amount of product demanded by time and location by the end-customer of the supply chain is called *independent* demand. Demand forecasts for these items are typically projections of historical demand patterns. Demand is considered *dependent* when it comes from production schedules for other items. These component demands should be calculated, not forecasted. [111]

Derived demand is demand resulting from what companies further upstream in the supply chain do to meet demand from their immediate customers. An example of this type of demand could be demand for washing machine motors derived from demand for washing machines. In Mentzer and Moon[112], derived demand differs from dependent in the sense that the demand is transferred across company borders and is uncertain.

This classification is based on the idea that the techniques, systems and processes necessary to deal with derived and dependent demand are quite different from those of independent demand.[113] A given item may also have both dependent and independent demand at any given time, take spare parts for example.[114]

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[108] Krajewski et al 1990, pp.347-348
[109] Crum et al. 2003, p.27
[110] See e.g. Christopher 1998, p.182; Chase 1997
[111] Chase 1997
[112] Mentzer et al. 2004
[113] Mentzer et al. 2004
[114] E.g. Vollman et al. 2005, p.134

4.2.3 Demand uncertainty

Demand uncertainty is a central phenomenon behind each and every discussion in this study. I could not find a proper definition for demand uncertainty for my use, so I needed to come up with one of my own. Uncertainty in general usually refers to risk or volatility[115], and a mathematician would probably define demand uncertainty as the degree of variability in the demand pattern. But does a highly volatile demand pattern result automatically in high demand uncertainty for the company? Not necessarily, as at the same time uncertainty is a measure of how poorly we understand or can predict something. From the perspective of this work, it is an interesting notion that one can reduce perceived demand uncertainty.

Yet, it is commonly recognized that some types of businesses inherently have a higher level of demand uncertainty than others, which represents the objective component of demand uncertainty[116]. It is typically much easier to determine the timing, volume and composition of demand for toilet paper, for example, than for base stations. In addition to requiring a more agile supply chain, unpredictable demand also requires different planning and forecasting approaches than predictable one.

4.3 Balancing supply and demand

It is important to have business processes in place to maintain a proper balance between demand and supply, and to provide early warning signals when they become unbalanced, especially true in turbulent environments. Various sales and operations planning processes are concerned with achieving and maintaining this balance in companies.[117] Also the Supply-Chain Council's *Supply-Chain Operations Reference* (SCOR) model identifies balancing supply and demand as the central point in increasing supply chain efficiency; SCOR *Plan* process is defined as those processes that balance aggregate demand and supply for developing actions which best meet sourcing, production, and delivery requirements.[118]

Sales and operations planning is concerned with getting the big picture right, that is, to balance supply and demand volumes, while leaving the details of mix - how much of each separate variant of the product - to master production scheduling.[119] This is an important distinction as there are several approaches to plan volume and mix. For instance, in the 3C approach standing for Capacity, Commonality and Consumption, the principle is to plan the sales based on capacity, leverage commonality to reduce inventory and produce according to consumption, or actual demand.[120] Thus, rough demand information can be used to reserve manufacturing capacity, and the exact composition of demand needs to be known only very close to delivery.

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115 e.g. Brealey and Myers 2003, p.161
116 Langabeer et al. 2001
117 Vollman et al. 2005, p.61; Hoover et al. 2001, p.136
118 Supply-Chain Council 2005
119 Vollman et al. 2005, p.60
120 Fernandez-Ranada et al. 1999; quoted in Hoover et al. 2001, p.100

The managerial objective of sales and operations planning is thus to develop an overall business plan, which integrates the various functions' planning. A common plan replacing conventional stand-alone and separate plans of marketing, distribution, production and procurement at different stages in the supply chain is needed to coordinate the organization towards a common target.[121]

To balance supply and demand, sales and operations planning requires input information on market demand and supply capability. A demand plan reflecting market demand is the input for supply planning, where the capacity and materials to meet the demand are calculated considering any constraints. After this, demand and supply figures are massaged commonly by the functions in order to reach consensus on the right figures and to deal with any supply constraints. By fixing the plan, management and the different functions involved commit to the plans and resulting actions. The decisions, of course, need to be quickly and accurately communicated throughout the supply chain.[122]

4.4 Demand management

The development of demand management starts as far as 30 years ago when forecasting of demand was almost nonexistent.[123] Today, the criticality of planning and managing demand has become increasingly important as companies and supply chains are increasingly demand driven. According to Vollman et al. demand management is about how a firm integrates information from and about its customers, internal and external to the firm, into the manufacturing planning and control system. As such, it is where market intelligence is gathered, forecasts of demand are developed, and status information on customer orders is maintained. A key element of the demand management system is providing the information to help balance the supply of products with the demand.[124]

The position of demand management in the manufacturing planning and control system is shown in Figure 12. The external aspects of the demand management module are depicted as the double-ended arrow, which highlights two-way communication; information is gathered from and about the market doing things like forecasting customer demand, entering orders, and determining exact customer requirements. Moreover, it is through this module that the company communicates with its customers by promising delivery dates[125], confirming order status and communicating changes. Internally, demand management provides longer-term demand information to sales and operations planning and shorter-term information to master production scheduling.[126]

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[121] Christopher, 1998, p.14; Hausman et al. 2002
[122] Hoover et al. 2001, p.136
[123] Langabeer et al. 2001
[124] Vollman et al. 2005, p.44
[125] Vollman et al. 2005, pp.176-179
[126] Vollman et al. 2005, p.18

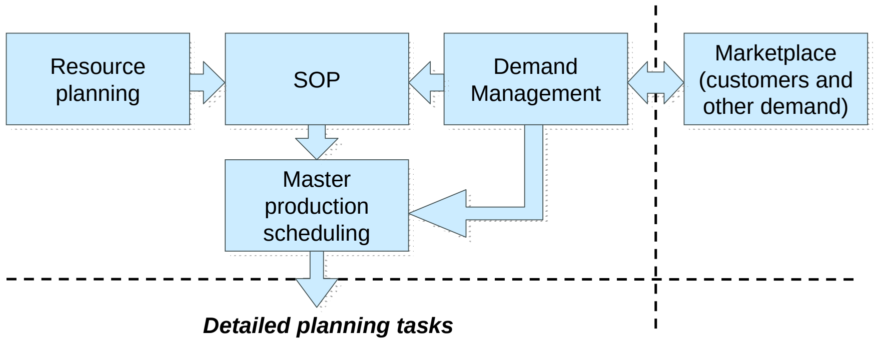

Figure 12: Demand management in the manufacturing planning and control system[127]

Figure 13 presents the demand management process from a somewhat broader management perspective using a model by Crum et al.[128] The process steps are:

1. *Planning demand*; this involves more than plain forecasting. Planning and forecasting will be discussed more extensively in the following chapter.

2. *Communicating demand*, which includes communicating the demand plan to the supply and finance organizations, and increasingly to supply chain partners.

3. *Influencing demand* becomes actual when demand is constrained. This includes marketing and selling tactics, product positioning, pricing, promotions, and other marketing and sales efforts. The raison d'être of marketing and sales organizations is to convince customers to buy products in such a way it supports the company's objectives.[129]

4. *Managing and prioritizing demand* is needed when supply is constrained. This includes managing customer orders to match available supply, as the volume, timing and mix of demand never realize exactly as planned, or as the supply organization almost always have some form of constraint that makes it unable to produce to plan. [130]

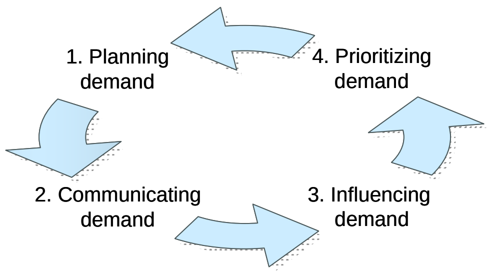

Figure 13: Demand management process model[131]

[127] Adapted from Vollman et al. 2005, p.18
[128] Crum et al. 2003, p.11
[129] Crum et al. 2003, p.59
[130] Crum et al. 2003, p.74
[131] Crum et al. 2003, p.11

4.5 Demand planning and forecasting

Demand planning is the first step in most company planning processes of the demand-oriented company, and all the following steps are based on the results of the activity. Lucent, for instance, regards demand planning as critically important to its business because of the large number of internal customers the demand planning process has. Just to list a few, the following activities or business processes use demand plans as input: inventory planning, production requirements planning, sales team commitments and product allocation, supplier coordination, strategic planning, installation planning, and last but not least, revenue forecasting and planning.[132]

Bad demand planning has both top- and bottom-line effects. From a top-line perspective, companies cannot take advantage of demand for their products and services if, first, they fail to accurately forecast that demand and, second, they fail to develop and implement appropriate plans to build the required supply chain capacity to fulfill that demand. At the bottom line, raw materials, component parts and logistical services can be purchased more cost-effectively by accurately forecasting production needs, and production can be scheduled better. Moreover, as inventory exists to provide a buffer for inaccurate forecasts, inventories can be reduced. [133]

The paradox of demand planning is that the companies or people that most need to implement demand planning - those closest to customer - have the least economic motivation to do so.[134] Sales and manufacturing units in supply chains traditionally pursue different goals and targets. Sales and marketing organizations are by nature target oriented, and focus strongly on their customers. They do not understand the impact of forecast numbers they provide upstream the supply chain, and their incentives are often not in line with expected forecasting behavior. What motivates is having products available when needed and meeting the sales goals.[135] A quote from Crum et al illustrates what happens: *"In too many companies the sales organization has enough time to expedite orders caused by inaccurate forecasts, but will not take time to provide input that would have prevented the imbalance in the first place.[136]"*

The literature on demand planning and forecasting emphasize the relationship, and differences, between forecasting, planning, and goal setting. Sales forecasts are educated guesses on what demand will look like, given certain environmental conditions. That is, they are always uncertain. Sales plans, on the other hand, should be seen as a management decision or commitment to what the company will do during the planning period. A sales plan is drawn based on the forecast, and its purpose is to drive numerous tactical and strategic management decisions, realistically considering the constraints the company has to

[132] Moon et al. 2000
[133] Moon et al. 2000; Moon et al. 1998; Vollman et al. 2005, p.17-18; Crum et al. 2003, p. 8
[134] Mentzer et al. 2004
[135] Petersen 2003
[136] Crum et al. 2003, p.19

live with.[137] Whereas the sales forecast and the sales plan should be closely linked, the sales goal may be quite independent. [138] If the forecasts and goals are linked, the sales force may be tempted to underestimate future sales in order to keep their goals on a lower level.

Finally, planning and forecasting is to a large extent a systemic and a human issue. Take trust, for an example: When a forecast is chronically inaccurate, people who are supposed to use it second-guess the forecast figures or they are not at all used to drive operations or financial projections. For instance, according to Moon, in one company a "black market" forecasting system was created as the production scheduling department was so distrustful of the forecasts developed by marketing. Finally, when the demand forecast is not utilized, the people responsible for providing input into the forecast see their efforts as a waste of time, which causes the forecast quality inevitably to deteriorate. This, again, boosts the belief that the forecast cannot be trusted.[139]

4.5.1 Lead times and forecasting

Investment in forecasting should be justified in business terms. Resources poured into forecasting may have a better ROI elsewhere especially if there are availability and lead-time problems.

Christopher's[140] Lead-time gap, presented in Figure 14, expresses the gap between the customer's order cycle and the logistics lead-time. The customer's order cycle is the time that customers are willing to wait for the product, that is, the time from ordering to delivery. The logistics lead time, on the other hand, is the amount of time the company needs to procure, manufacture and deliver a product. Conventionally, the gap between the logistics lead time and the customer order cycle is bridged carrying inventory, which normally implies that a forecast is needed. That is, information beyond orders is needed for planning operations. If the lead time gap is zero or negative, the order penetration point can moved upstream and planning can be done quite straightforwardly based on order backlog.

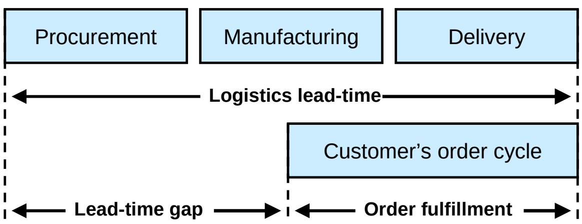

Figure 14: Lead time gap[141]

[137] E.g. Moon et al. 2000, and Vollman et al. 2005 distinguish between planning and forecasting
[138] Moon et al. 2000; Moon et al. 1998
[139] Moon et al. 1998
[140] Christopher 1998, p.168
[141] Christopher 1998, p.168

Reducing the gap can be achieved by shortening the logistics lead time whilst simultaneously trying to move the customer's order cycle closer by gaining earlier warning of requirements through improved visibility of demand. In the meantime, forecasting is a necessity. [142] Thus, to a large extent, the requirements for advance demand information depend on the company's operational capabilities and lead time requirements; responsive operations reduce the reliance on advance demand information.[143] I refer to chapter 3.5 for more information on the strategies for achieving supply chain responsiveness.

4.5.2 Forecasting methods

Most demand forecasting techniques fall into two categories: those that rely on the subjective assessments of a person or a group are called qualitative or judgmental methods; and those that rely on past sales history alone or jointly with other variables are known as quantitative or mathematical methods. Quantitative methods can further be broken down to time-series methods and causal method, respectively. Of course, multiple planning and forecasting techniques can be simultaneously used, and the listing presented in this chapter is by no means exhaustive.[144]

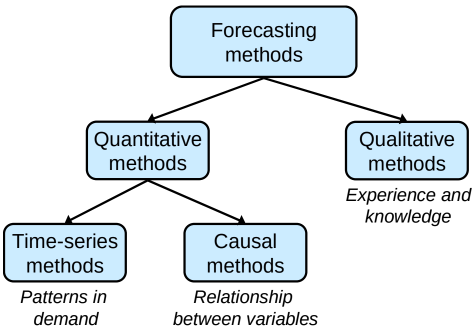

Figure 15: Forecasting methods[145]

Time series forecasting produces forecasts solely based on sales history have the advantage of relative simplicity and possibility for automation. Though, they do not fit situations where the demand pattern is highly variable or there is no historical data. Examples of forecasting techniques in this category are naïve forecast, exponential smoothing and simple and weighted moving averages. Forecast smoothing is done to level the peaks caused by random variation. Causal forecasting methods are based on a known or perceived relationship between the factor to be forecast and other external or internal factors. Probably the best-known causal methods are simple regression, multiple regression and econometrics.[146]

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[142] Christopher, 1998, p.168
[143] De Treville et al. 2004
[144] Chase 1997
[145] Chase 1997
[146] Chase 1997

Qualitative forecasts are used when there is no historical data available; often in new situations, or when the demand pattern is highly variable. Generally, the idea is to extract and utilize experts' knowledge and information. The challenges with qualitative forecasting is that the methods are often time-consuming and require expert input, who may not always be very motivated to do this, and produce often less consistent forecasts than quantitative methods due to the forecaster's personal bias.[147] There is a wide range of techniques to retrieve expert information, distinctions can be made between the techniques based on the number of experts, interaction between them in the forecasting situation, especially anonymity, and so forth. Chase lists as the most widely used techniques independent judgment, committee judgment, sales force estimates, and juries of executive opinion.[148]

Which method should then be chosen from the variety of different options? Figure 16 illustrates the approach that Crum et al. present for choosing the right planning and forecasting approach for different contingencies. The idea in this two-by-two matrix is to classify products using demand volume and variability as dimensions. All the boxes are not covered in detail as they are quite self-explanatory. Only the quadrant where volumes and demand variability are simultaneously high will be explained, as this is where my research can be positioned.

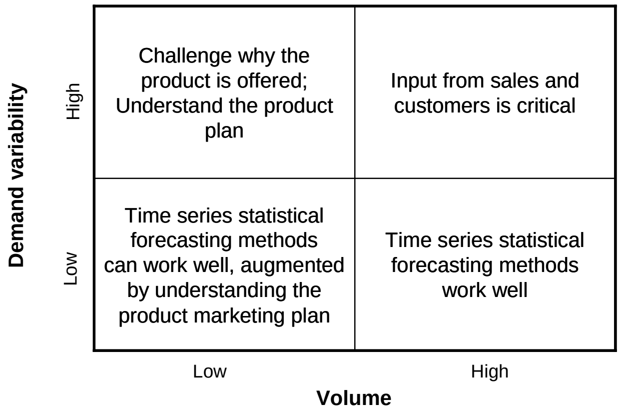

Figure 16: Choosing the right forecasting method[149]

High-volume products with high demand variability are often tied to specific programs or projects. The unit volumes for such demand are small, the products typically require unique design configurations and are thus usually dependent on the customer's engineering criteria, and are capital intensive to produce and buy.[150] Thus, past demand data provides very poor information on future requests, at least on the end item level. Statistical forecasts are rarely helpful in planning this kind of demand as the purchases are rare and the timing usually dependent on the progress of some sort of facility construction or replacement of current

[147] Chase 1997
[148] Chase 1997
[149] Crum et al. 2003, p.139
[150] Crum et al. 2003, p.145

equipment. Projects, and project demand, are frequently delayed as they are at the mercy of construction timetables as well as the availability of capital to fund the projects.[151] On the other hand, a long and informative design, planning and purchasing process often precedes the order release.

According to Crum et al.[152], as a general rule, the products with highly variable demand patterns require more attention from the sales organization to achieve improved accuracy of the demand plan. In project business, the sales and projecting organizations have the best knowledge of the design specifications as well as the likelihood that the project will go forward, or of any new business beyond the current projects. Crum et al. argue that the critical task to improve the quality of demand plans is to provide the sales force an efficient means to communicate the information to the demand planning function.

The three cornerstones for supporting sales force involvement in forecasting by Småros are:[153]

1. Sales need to be provided with adequate training
2. Forecasting must be made part of the sales peoples' job and forecast accuracy an important goal through e.g. measurement, rewards and responsibility for inventory.
3. Forecasting needs to be as simple and quick as possible through e.g. forecasting on product family level for configurable products, and using category forecasting.

4.5.3 Forecasting and aggregation

There are several reasons for aggregating product items in both time and level of detail for forecasting purposes. It is a well-known phenomenon that long-term or product-line forecasts are more accurate than short-term and/or detailed forecasts. This merely verbalizes a statistical verity.[154]

When the number of products a company offers is large, defining the forecasting and planning level is important, yet often difficult. It is always easier to make aggregate forecasts than predict the demand for a single product type as aggregation tends to cancel the demand variation of lower level items and locations. According to Holmström, the conventional approach to forecasting product demand is based on defining a *demand forecasting unit* (DFU). The demand forecasting unit is defined by two dimensions: the level of aggregation for the product and the level of aggregation for the consumer. The product dimension of the DFU can be on the SKU-level or done based on product family, brand name or basically any product characteristic. The market-level dimensions for aggregation can be demand for the

[151] Crum et al. 2003, p.145; Zotteri et al. 2001
[152] Crum et al. 2003, p.143
[153] Småros 2005b
[154] Stadtler 2002

total market, major wholesaler groupings, retail chains or geographical groupings. In addition to the product and market dimensions, one also needs to consider the time dimension of the forecasting process.[155]

4.5.4 Forecast error metrics

According to Gilliland[156], a forecasting process has two main goals: to make the forecast more accurate and to make the forecast less biased so that forecasts are not overly optimistic or pessimistic. The basic metrics of forecast quality mirror these goals; typically, the performance of the forecasting process is evaluated on accuracy measures, such as mean absolute percent error (MAPE) and bias. Table 7 presents one way of calculating these measures of forecast quality. However, several other formulas exist as forecast error metrics can be calculated for a single product, several products, over different time periods, per individual or group or any combination of these.[157]

Table 7: Forecast error metrics and their significance[158]

Error Metric	Significance
$MAPE = 100\% \cdot \sum \frac{\lvert forecast - actual \rvert}{actual} / n$	Shows how accurate the forecast is.
$Bias = 100\% \cdot \frac{\sum forecast}{\sum actual} - 100\%$	Shows over- or under-forecasting. A positive result means over-forecasting and negative under-forecasting.

Bias can be observed due to various reasons. For instance, the forecaster's incentives and attitude towards risk, and the life cycle stage the product is in may cause bias to the forecast. Positive bias is usually observed in products that are in the phase of declining demand and negative bias in new and growth oriented products. [159]

The forecasting measures should always be interpreted against the underlying demand pattern. It may not be wise to compare MAPEs of different companies, markets or product families. If the demand for one product is more volatile, it will naturally experience worse forecast accuracies when measured by MAPE.[160]

4.5.5 Forecasting process and uncertainty

The forecasting and planning process defines how information will be gathered and reconciled into a picture of the future in a consistent format. In the process different weights can be given to mathematical models versus input from participants to develop the final

[155] Holmström 1998
[156] Gilliland 2002
[157] E.g. Vollman et al. 2005, p.37; Petersen 2003; Gilliland 2002; Lapide 1998
[158] Gilliland 2002
[159] Petersen 2003
[160] Lapide 1998, Gilliland 2002

consensus plan. Both uncertainties in demand and internal performance of operations need to be reflected in designing the process.

One way to cope with the uncertainties is planning on a rolling horizon. Nearly always, reality will deviate from plan. The deviation has to be controlled and the plan has to be revised if the discrepancy is too large. Planning on a rolling horizon basis is an implementation of this plan-control-revision interaction. The planning horizon, the time period which will be considered in the planning process, (e.g. one year) is divided into periods (e.g. months). At the beginning of the second period, a new plan is made considering the actual developments during the first period and updated forecasts for the future periods.[161]

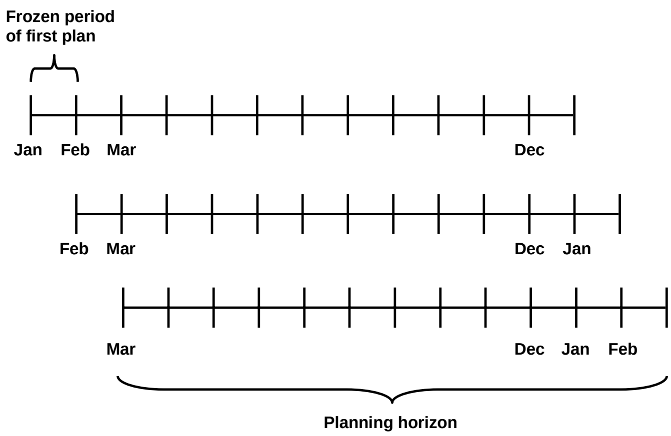

Figure 17 Planning on a rolling horizon basis[162]

Consider the quality and appropriate level of detail in forecasts. It is an empirical fact that the further ahead the forecasting horizon, the greater the error is. This diminishing quality of forecasts in time is not a problem as such as the uses, and the corresponding requirements for detail, are often different in the short and the long term. Yet, what this means for a planning system is that different levels of detail, or even completely different methods are used for forecasting in the short and long run. Furthermore, the forecasting responsibility for different sub-horizons can be divided between separate parties with different perspectives to demand. Finally, it is of high importance to choose the correct planning frequency, or cycle, for the planning process.[163] Updating plans too often causes extra work both in front-end demand planning and in manufacturing planning and control, although it may improve demand planning accuracy especially in turbulent markets.

Determining the time variables in the planning process including the planning horizon, frequency, period, and bucket, somehow feels highly case dependent. Again, one can take the requirements of the supply side as a starting point for designing the planning and

[161] Stadtler et al. 2002, p.84
[162] Stadtler et al. 2002, p.84
[163] Reary 2002

forecasting process or, the starting point can be the availability and quality of demand information.

4.6 Conclusion

This chapter dealt with demand planning and forecasting from several perspectives. Understanding the basics of demand planning and forecasting was an essential prerequisite for being able to conduct the field work, both in terms of creating the analysis framework, presented in chapter 9.1., and in terms of being able to ask the right questions and understand the human side of planning.

In addition to providing background information, the most relevant insights this chapter had to offer were:

- Some types of businesses inherently have a higher level of demand variability than others, and project businesses usually belong to this category. Statistical approaches are rarely helpful in planning this kind of demand as the purchases are rare and the timing usually dependent on the progress of some sort of facility construction or replacement of current equipment. In this kind of environments it seems that it is better to rely on knowledge than traditional forecasting. Project-based demand will be discussed more extensively in chapter 5.4.

- In turbulent environments, it is important to have business processes in place to maintain a proper balance between demand and supply. What goes into this process determines what will come out in the form of plans and managerial action. In line with the "garbage-in-garbage-out" principle, understanding the input to the process is crucial.

- Planning and forecasting is a systemic and human issue.

- Capturing demand is not the same as forecasting. The need to operate based on uncertain forecasts can be reduced by having real knowledge on demand, or alternatively, by reducing lead times. Resources poured into forecasting may have a better ROI elsewhere especially if there are availability and lead-time problems. Visibility to demand is reviewed in detail in chapter 6.

This chapter has focused on the single-company aspects of planning and forecasting. Broadening the perspective from one company to the supply chain reveals sometimes much greater rewards than what companies can achieve by themselves. As Ireland and Bruce have discovered, *"value chains that have 25 to 50 different forecasts from end to end and side to side are unlikely to be accurate"*.[164] The problem of separate forecasts, basically forecasting the same thing at two sides of organizational boundaries, was also observable in the cases.

Today though, this does not have to be the case as technological hurdles for cooperation are being broken; with recent developments in technology, especially Internet, companies no

[164] Ireland et al. 2000, quote originally found in Lakervi 2003, pp.21-22

longer need to wait in line to receive information from the next company in line, but all companies can potentially exchange information simultaneously with other actors.[165] The network view on planning and forecasting is taken in chapters 5 and 6 under the headings *Demand information in supply chains* and *Demand visibility*.

[165] Hewitt 2000, Bowersox et al. 2000

5 Demand information in supply chains

Vast amounts of information move around in supply chains including transaction data, planning and control information, tracking data and more. The starting point for why information should and need to be shared among members of the supply chain is because the information held by different supply chain members is asymmetric. For example in a retailer-manufacturer dyad, a retailer should have better conception of end customer demand information and, of course, of its own inventory levels. On the other hand, the manufacturer has better information about products, delivery lead-times and production capacity than the retailer. Moreover, different actors' information needs change depending on the role the company has and on its location in the chain.[166] Along a supply chain, there are several sources and types of information of different quality, coverage and usability. Thus there is a challenge in choosing the most beneficial data sources and in making the best use of the data.

In this chapter, the information concept is reviewed. Then, a typology of demand information in supply chains is presented, and mechanisms of transferring information from one actor to another are discussed. The chapter will close with a review of demand in project delivery networks and conclusions.

5.1 Information

There are various approaches to information, which are useful for understanding and classifying information in supply chains.

5.1.1 Information typologies

Some writers do not see a difference between data and information, while some see the distinction as crucial. The hierarchical view sees information and knowledge being fundamentally different from data, which is a rather intuitive thought. The Data – Information – Knowledge - Wisdom hierarchy is commonly referred to by many names. In much of the Knowledge Management literature the hierarchy is referred to as the *Knowledge Hierarchy*, while the scholars in information science refer to the same hierarchy as *Information Hierarchy* for obvious reasons. [167]

According to Tuomi[168], data is simple facts representing the real world - events, phenomena, attributes, names and so forth. Data is raw, it simply exists and has no significance beyond existence. Data become information when combined into meaningful structures. Information becomes knowledge when a person internalizes it to a degree that it is available for

[166] E.g. Simatupang et al. 2001; Lee et al. 1998
[167] Tuomi 1999
[168] Tuomi 1999

immediate use for problem solving or explanation. Knowledge is sometimes also seen as a pool of information. Figure 18 presents an illustrative example of the hierarchical nature of information; unfortunately, the exact terminology used in the cartoon fails us but the message is nevertheless the same.

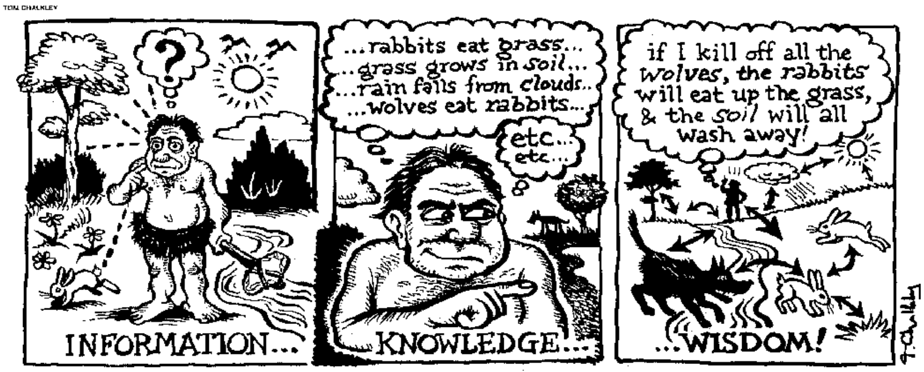

Figure 18: Data – information – knowledge - wisdom hierarchy[169]

Polanyi[170] classifies human knowledge into *tacit* and *explicit* knowledge, implying that we can know more than we can tell. Another proposal is to categorize information based on the cost of transfer. Based on Jensen et al.[171], something called *specific* knowledge is costly to transfer among users whereas *general* knowledge is inexpensive to transmit.

From the perspective of capturing demand information, it is worth to notice that demand information can be separated into local knowledge near the customer, such as intuition for local market conditions, that cannot be economically transferred, and data that can be transferred, such as past sales and inventory levels. Thus, much qualitative information is often lost in transmission.[172]

Three inferences can be drawn from these theories. Firstly, not all information can be transferred. Secondly, it is not economical to transfer all information. Thirdly, contextual information is needed to interpret transferred data.

5.1.2 Information quality

Just as a material product has quality dimensions associated with it, an information product has information quality dimensions. For instance, think about what is the quality of an accurate stock quote delayed by 15 minutes to a real-time stock trader? What is the quality of the same information for a market analyst creating a quarterly forecast? [173]

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[169] Harland 1985; quoted in Sharma 2005
[170] Polanyi 1966; Nonaka et al. 1998
[171] Jensen et al. 1992; quoted in Simatupang et al. 2001, p.3
[172] Simatupang et al. 2001
[173] Wang et al. 1998

The brief discussion presented next on information quality revolves around a widely used data quality framework by Wang et al.[174] The framework lists 16 information quality dimensions, grouped into four categories that reflect the information consumer's perceptions of what constitutes quality information. As shown in Table 8, the intrinsic information quality category captures the fact that information has quality in its own right. The contextual category highlights the idea that quality must be evaluated in context. Representational IQ and accessibility emphasize the importance of the role of information systems. It goes without saying that some of these quality characteristics are more important in one context than the other.

Table 8: Information quality categories and dimensions[175]

Information Quality Category	Information Quality Dimensions
Intrinsic	Accuracy, Objectivity, Believability, Reputation
Accessibility	Access, Security
Contextual	Relevancy, Value-Added, Timeliness, Completeness, Amount of data
Representational	Interpretability, Ease of understanding, Concise representation, Consistent representation

Lillrank[176] criticized Wang's customer requirements based approach to defining information quality, as in many situations users of the information have difficulties in defining what they are supposed to know *ex ante*. Lillrank had a different approach of listing three quality attributes for the content of information: reliability (true or false), validity (relevant or irrelevant) and accuracy (effective or ineffective). A piece of information may have various combinations of measures along these attributes such that information that is true, relevant, and effective is of highest quality. Lillrank continues that the quality of information cannot be improved independently of the processes that produced this information and of the contexts in which information consumers utilize it.[177]

If you consider demand supply planning, for instance, you may find it difficult to define what good quality information is from a customer perspective; there are several users for the information who all have different needs. What seems to be the value of formal processes is that the value of the information is greater if it can be captured consistently in a coherent format.

[174] Wang et al. 1998
[175] Wang et al. 1998
[176] Lillrank 2003
[177] Lillrank 2003

5.2 Demand information shared in supply chains

In their work on inter-organizational sharing of logistics information, Seidmann et al.[178] have identified four levels of information sharing in supply chains, namely sharing of ordering, operational, strategic, and strategic and competitive information. Several other classifications, including the ones by Simatupang[179] and Lee et al.[180], include similar components. This research focuses mainly on the operational rather than strategic information.

According to Lee[181], the main types of operational information shared in supply chains, are orders, forecasts, inventory level, sales data, demand forecast, order status and production schedule.

Order is the basic type of demand information shared in supply chains, although sharing of orders may not be the right expression. By issuing a purchase order, a customer expresses the, often legally binding, intention to buy a certain amount of goods at a certain time.

Forecasts estimate future demand. As the downstream echelon of the supply chain is usually better positioned to forecast market demand, information is commonly passed upstream for capacity planning purposes. According to Lee, multiple forecasts in the supply chain should be avoided to counter the Bullwhip Effect[182].

Inventory level is one of the most common data shared between supply chain partners. Sharing inventory level information enables also the transfer of inventory control to an upstream partner. The practice of sharing inventory level information is discussed later in more detail.

Production plan information can be shared to a supplier to improve the supplier#s own production schedule. Sharing of inventory levels is prerequisite for making use of production planning information.

Sales data is a form of demand information that is currently shared in retail business. For instance, Wal-Mart has introduced a web-based system for sharing point-of-sales data with more than 4000 suppliers.[183] Sales data gives a smoother presentation of end-customer demand than plain inventory level information or batched orders. In projects, though, it is hard to find an analogy for POS data.

Recently, supply chain members have started sharing their *order status* and *tracking* information to be able to follow where the goods move in the supply chain.[184]

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[178] Seidmann et al. 1998
[179] Simatupang et al. 2001
[180] Lee et al. 1998
[181] Lee et al. 1998
[182] Lee et al. 1997
[183] Bradley et al. 2002; quoted in Småros 2005a
[184] Lee et al. 1998

Other examples of information sharing in a supply chain include performance metrics and capacity. Through sharing capacity information with downstream partners, the supply chain can better coordinate and prepare for possible shortages. Performance metrics such as quality data, lead times and forecast accuracy create feedback loops.[185]

5.3 Levels of demand information transfer

De Treville et al.[186] have defined three levels of demand information transfer in a supply chain. These are full demand information transfer, partial demand information transfer, and no demand information transfer. *Full* demand information is transferred from customer to supplier with no distortion. It is codified, somewhat certain and needs little interpreting. Examples of such information transfer can be found for instance from the integrated supply chains in the automotive industry or in Internet-supply chains, such as Dell's. *Partial* demand information transfer is about transferring early observations of demand, or information that improves the accuracy of demand forecasting upstream in the chain. De Treville et al. propose that partial demand information is more difficult to use than fully observed demand information because of the difficulties in building the needed customer–supplier relationship to collect it as well as the difficulty of transforming partial demand information into useful data. When *no* demand information is transferred, the only demand information received by the manufacturer comes from the actual order. This picture of demand is often distorted.[187]

Figure 19 presents how the supplier in a customer-supplier dyad observes customer demand. Before T_0 observations are either unlikely to lead to useful estimates of demand or are too costly to undertake. Between T_0 and T_1, partial information is available to make or refine forecasts. At time T_1, full demand information is observable to the customer.[188]

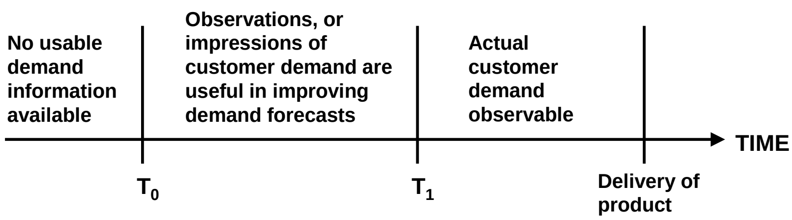

Figure 19: Supply lead time relative to the observation of demand information[189]

[185] Lee et al. 1998
[186] de Treville et al. 2004
[187] de Treville et al. 2004
[188] de Treville et al. 2004
[189] Modified from de Treville et al. 2004

A distinction should be made between the information observable by the supplier, and the information the customer really possesses. Just because demand information is available to the buyer does not mean that the buyer is willing or capable to transfer it to the supplier.

5.4 Project-based demand

Previous research implies that project-based demand is highly variable. Most projects are characterized by an extreme technical, financial, political and societal complexity and uncertainty, which is experienced as highly variable demand.[190] Furthermore, just like any business demand, project demand follows seasonal effects, and may be sensitive to quarterly and yearly capital budgeting, tax and accounting issues.[191] This chapter aims to study project demand information in a more detailed fashion than typical introductory comments such as those above.

The *project delivery chain* model, which was presented in chapter 3.6.1, shows clearly that demand exists at many levels in a project, and is derived in nature.[192] At the top of the project delivery chain the demanded product is truly unique, but when moving down the chain, the demand is broken down to basic standard components manufactured in thousands. Take a mobile phone network for example. The demand for network capacity, a completely new network or expansion of an existing one, is driven by changes in the usage of wireless devices. The network operator may decide to add incremental capacity and order a completely new base station from the network equipment supplier. This event is translated into component demand for the factories manufacturing the equipment and an order for another company specialized in installing the base station. One major challenge that project suppliers face is managing demand information flows as they pass through the interface between projects and repetitive production.

Figure 20 is an illustration of project demand flowing from the project to a project supplier in three project phases, initiation, execution and operation. The model is created by the author. In the following, demand information in each phase will be discussed.

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[190] E.g. Eloranta 2004; Van Donselaar et al. 2001
[191] Langabeer et al. 2001
[192] Artto et al. 1998, p.22

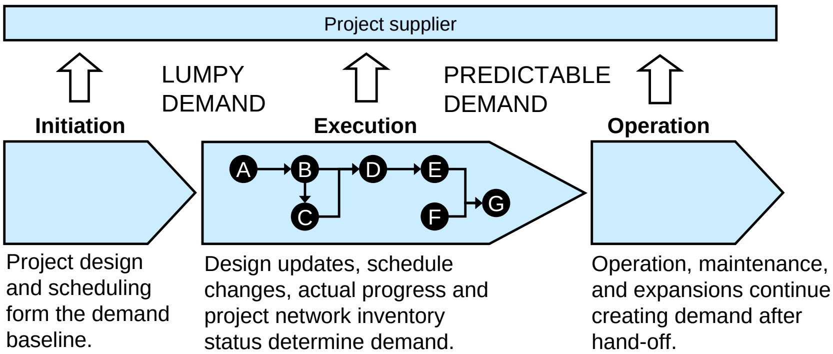

Figure 20: Project as a source of demand

In the *Initiation* phase, as part of the project engineering and purchasing process, well in advance of placement of any actual orders, schedules and specifications are developed somewhere in the project delivery network.[193] Thus, in a full-blooded project with a scope, a beginning, and an end, much of the rough-cut demand is defined long before project execution has even started. A baseline for demand is thus created in this phase.

From a project supplier's point of view, the challenge in the initiation phase is how to be prepared for the possibility of winning the case. During tendering, the project customer may communicate the material requirements for a project subject to winning the bid. If the demand does not materialize and the manufacturer has decided to act on the uncertain information, he risks holding excess inventory.[194]

In the *Execution* phase, the project contracts have been awarded to a number of project suppliers. Demand starts to materialize in this phase in the form of orders and call-offs for services and equipment. As Figure 20 shows, most of the demand information is not stable in a project, although an exception may be the project contract defining the terms of the delivery to the customer. The project plan establishes the base for the project data in the initial stage. During the project, the plan is updated, the product is designed in detail and the data about project events, for example, orders, deliveries, and reviews is created. The sources of the new data are distributed: It is created by the customer, the company team and different subcontractors.[195] According to my logic, in the project execution phase, the project schedule, project progress and the current inventory position in the project delivery chain should determine the demand for project equipment.

In the *Operation* phase, when the project has been handed over to the customer, demand for project system related components often continue due to maintenance and expansion work.

As can be seen in Figure 20, the demand a project equipment manufacturer typically faces is a sum of regular demand from many small orders and very irregular, lumpy demand from infrequent, large orders. In order to be able to meet the lumpy type of demand, the

[193] Van Donselaar et al. 2001; Crum et al. 2003, p.145; Zotteri et al. 2001
[194] Van Donselaar et al. 2001; Thonemann 2002
[195] Karvonen 1999

manufacturer needs to carry large safety stock.[196] Tenhiälä et al. argue that in such an environment, collecting advance demand information is especially important, as it allows the manufacturer to reconcile the lumps in demand with their production planning, see Figure 21.[197]

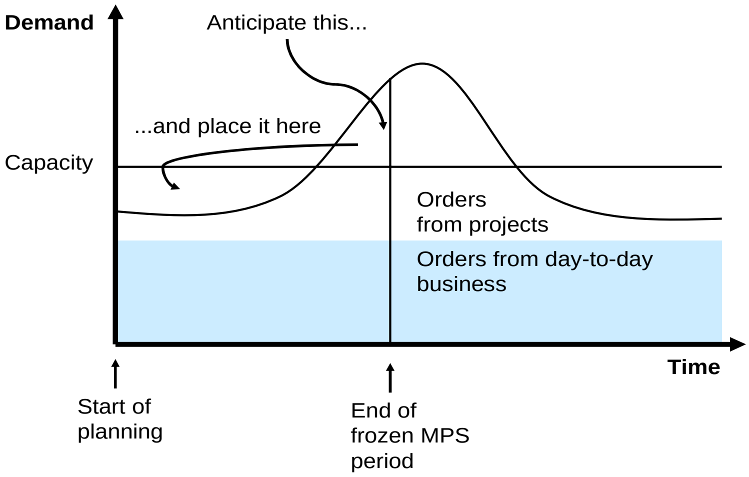

Figure 21: Master production scheduling and lumpy demand[198]

From the previous discussion it can be stated that some fundamental differences in the processes generating demand and the sources of information in project networks. Firstly, rough-cut demand information exists a long time prior to delivery. Yet, due to the high levels of uncertainty and openness of design, demand information is usually not stable in projects. A second notion is that demand information in projects is in a concentrated form; at least in theory, component and service demand can be derived from various project plans and schedules that define the project end-product and its building process.

5.5 Conclusion

In this chapter, demand information in supply chains was broken down to components from several perspectives. Several concrete sources of demand were identified in supply chain context, and a model describing demand information transfer, highlighting the impact of information uncertainty, was presented. The chapter ended with a review of demand information in projects and project delivery networks. The main takings from this chapter are:

- From the perspective of capturing demand information, it is worth to notice that demand information can be separated into local knowledge near the customer, such as intuition for local market conditions, that cannot be economically transferred, and data that can be transferred, such as past sales and inventory levels.

[196] Van Donselaar et al. 2001
[197] Tenhiälä et al. 2005
[198] Tenhiälä et al. 2005

- A distinction should be made between the information observable by the supplier, and the information the customer really possesses. Just because demand information is available to the buyer does not mean that the buyer is willing or capable to transfer it to the supplier.

- Demand information in project delivery networks is not usually stable due to high level of uncertainty and openness of design.

- Rough-cut demand information should exist a long time prior to delivery in projects due to the long and informative design, planning and purchasing process that precedes project execution and order releases.

- It is likely that the contractor and the customer are superior sources of demand information in project delivery networks.

- The demand in projects is by nature derived or dependent demand. Demand information in projects is in a concentrated form; at least in theory, component and service demand can be derived from various project plans and schedules that define the project end-product and its building process. On a high level, it was reasoned that demand for a certain article in the project delivery network is basically determined by the project plan, project progress and channel inventory.

- Project suppliers typically experience volatile demand that follows seasonal or cyclic patterns.

Despite the differences, many of the challenges with managing data and information in project delivery networks are probably not that different from other environments. Most likely, much of the information is not easily available or understandable, and the confidence of the information in many cases is not known.

6 Demand visibility

Lack of demand visibility has been identified as an important challenge for managing supply chains. Research shows that when orders are the only source of demand information, the result is a distorted picture of demand in the supply chain[199]. Furthermore, relying only on orders gives companies in supplier roles little time to prepare for changes in demand.[200]

The theme of this chapter is demand visibility in multi-company settings. I will discuss what is behind the concept, what the role of demand visibility is in improving demand supply chain performance, and how demand visibility can be achieved.

6.1 Introducing demand visibility

In some cases, supply chain partnerships and cooperative arrangements allow a firm to operate with knowledge of the other firm's needs. Figure 22 illustrates a situation where a supplier has a forecast of demand, some actual orders, and also knowledge on some key customers' situation. If one knows exactly what the customers need with specific timings, one does not need to forecast or wait for them to order. In fact, ordering is not good use of either partner's time. Such knowledge can consist of existing customer contracts or plans, inventory position, production schedule, cross company planning information or service agreements, or any such information on demand which has not yet been turned into orders but are no longer forecast-based either.[201]

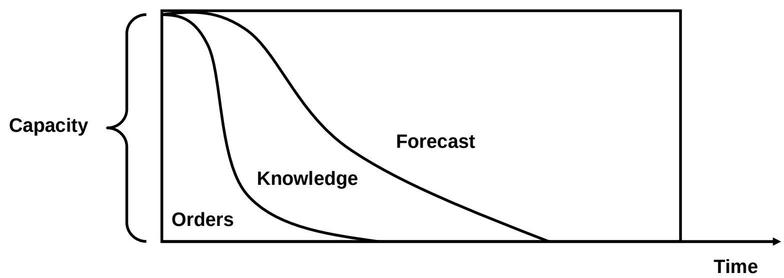

Figure 22: Replacing forecasts with knowledge[202]

In the literature, advance demand information can mean several things, from plain orders placed in advance of actual need[203] to uncertain bits and pieces of sometimes incomplete

[199] E.g. Lee et al. 1997; Forrester 1958
[200] E.g. Hoover et al. 2001
[201] Vollman et al. 2005, p.607
[202] Vollman et al. 2005, p.27
[203] E.g. Özer 2003; Wijngaard 2003

information on future demand[204]. In this study, advance demand information is defined as follows:

Advance demand information is any information on future demand beyond orders, certain or uncertain.

Thus, a company with *demand visibility* is in possession of advance demand information. Having foreknowledge of demand is not found to be equally important in all environments; according to Wijngaard[205], having advance demand information is more effective in cases of a highly variable demand. He also demonstrated that long lead times and high capacity utilization substantially reduce the value of advance demand information in a single-stage supply chain.

6.2 Designing visibility and customer value into the Supply Chain

Hoover et al.[206] present a framework for identifying possible value configurations between two successive supply chain members. By analyzing the demand chain of the customer, the supplier's supply chain, and how the two are interlinked, new win-win supply chain configurations can be engineered.

In the framework, demand and supply chains are considered from an activity perspective. *Demand Chain* is defined as the chain of activities that communicates demand from the customer to the supplier, whereas *Supply Chain* is defined as the chain of activities that creates the products and services that are transferred from the supplier to the customer.[207]

In the following, I will adopt a slightly modified version of Hoover et al.'s example on demand chains. A retailer's demand chain to a grocery supplier consists of assortment planning (deciding what to sell), inventory management (deciding the quantity of supplies needed), and the actual purchasing. On the other hand, the demand chain from a building contractor to an elevator manufacturer starts with the defining requirements for the new building. The next step is the architect's blueprints of the building, followed by the project plan and schedule, and finally supplier selection and purchasing[208].

By analyzing a customer's demand chain or chains – it is likely that several exist – the supplier can better understand the customer's buying processes and what drives them[209]. According to Hoover et al., the four generic decision making steps of the customer demand chain are: [210]

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[204] E.g. Eloranta 2004; Van Donselaar et al. 2001; Thonemann 2002
[205] Wijngaard 2003
[206] Hoover et al. 2001
[207] Hoover et al. 2001, p.12
[208] Hoover et al. 2001, p.72
[209] Hoover et al 2001, p.15
[210] Hoover et al 2001, p.72

1. **Purpose:** What is the purpose for which the customer uses the supplier's product (e.g. retail in consumer goods, rent out office building)?

2. **Planning:** Does the customer plan in advance where and how he will use the supplier's products (e.g. category plan, blueprint for office building)?

3. **Consumption:** When does the customer use the product: Is the use continuous and does the customer maintains an inventory or installed base (e.g. inventory management, project management)?

4. **Purchase:** How does the customer make the actual purchase decision (e.g. replenish order, purchase order)?

Working together, the demand and supply chains create the demand-supply chain. The two chains are linked in two places – the order penetration point[211] (OPP) and the demand visibility point[212] (DVP). The OPP and DVP, and their link to the supply and demand chains will be presented thoroughly in the following chapters.

6.2.1 Linking demand to supply

The OPP is the point in the supply chain at which a product becomes earmarked for a particular customer[213]. Once the order is received, the goods might be allocated from a warehouse, manufactured to order or anything in between. Thus, three basic manufacturing strategies, make-to-order (MTO), assemble-to-order (ATO) and make-to-stock (MTS) can be linked to the different OPPs. Make-to-stock includes both the pack-to-order (PTO) and ship-to-order (STO) modes of operation. The material flow is controlled by customer orders downstream this point and by forecasts and plans upstream this point. Furthermore, the OPP is where product specifications in most cases get frozen and it is the last place at which inventory is held[214]. Figure 23 shows how three different order penetration points link demand to supply.

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[211] Order Penetration Point is also referred to as Order Decoupling Point (e.g. van Hoek 1998) or Demand Penetration Point (e.g. Christopher 1998) in the literature.
[212] Demand Visibility Point is also known as Value Offering Point (VOP) after Hoover et al. 2001.
[213] Hoover et al. 2001, p.74
[214] Sharman 1984; quoted in Collin 2003

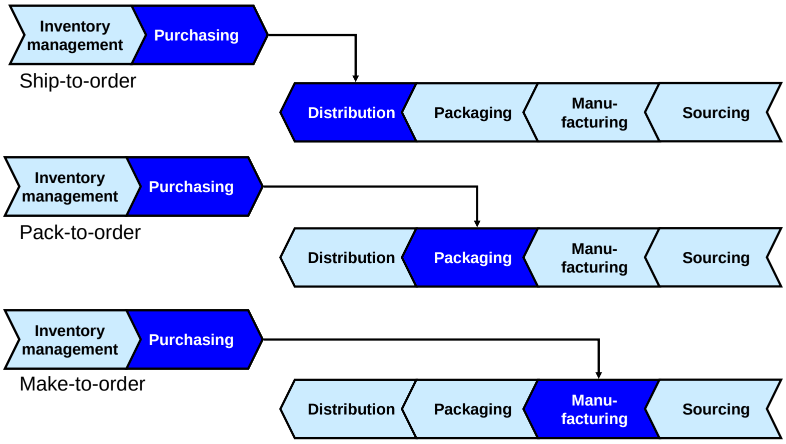

Figure 23: Three order penetration points[215]

Hoover et al. propose using the OPP for customizing the supply chain for an individual customer, where the OPP links the customer's demand chain to the supplier's supply chain. Each order penetration point has different costs and benefits for both the customer and supplier. If the item is delivered from stock, the customer can assume rapid delivery, but the supplier has to carry high inventory. On the other hand, if the OPP is moved back to packaging or manufacturing, the customer must accept longer delivery times, but the supplier does not have to carry as much stock as in the MTS situation.[216]

6.2.2 Linking supply to demand

The demand visibility point is the second point that links the demand and supply chains. It is the point in the customer's demand chain where the supplier fulfills demand, and also, the point where the supplier can actually see the customer's demand.[217]

Figure 24 presents the three major DVPs: Offer to purchase, offer to inventory management and offer to planning. An offer to purchase represents the traditional, arm's-length buyer-seller relationship, where the demand is visible when the order arrives. By an offer to inventory management, the supplier assumes the responsibility of fulfilling demand based on what the customer consumes. In this kind of collaboration the customer needs to weight the integration costs against the perceived service gains. Thanks to better visibility on the supplier side, demand may be fulfilled more efficiently, but it may have to consider – in relation to its other relationships – whether it can take over such a responsibility in an economically feasible manner. An offer to planning moves the DVP to assortment planning in retailing, to production planning in manufacturing, or to project planning in projects.[218] Again there is a tradeoff between better responsiveness and collaboration costs.

[215] Hoover et al. 2001, p.74
[216] Hoover et al. 2001. p.74
[217] Hoover et al. 2001, p.74
[218] Hoover et al. 2001, p.77

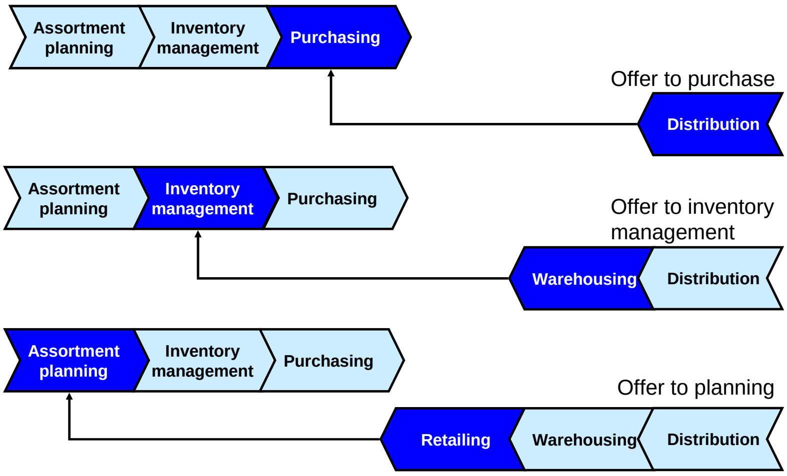

Figure 24: Three demand visibility points[219]

6.2.3 *Linking demand and supply*

The two points – DVP and OPP – link the demand and supply chains to each other. By changing how demand is linked to supply, the supply chain can be synchronized better, and by moving the link from supply to demand, the value added to customer can be increased. To elaborate on the possible benefits, moving the DVP back in the demand chain reduces the risk that the customer does not get the necessary products to operate efficiently. Responding to demand earlier in the customer's decision-making process gives the supplier better information to act on, and more time to act.[220]

The key to finding win-win configurations is time. Moving the OPP back in the supply chain increases the time needed to respond to customer demand, and moving the VOP increases the time available to respond. This means that even though taking more responsibility for the customer operations requires more work from suppliers, they can benefit from taking more responsibility from moving the VOP if they simultaneously move the OPP. [221]

6.2.4 *Points of demand visibility in projects*

Collin[222] has found that the individual demand chains of NET's customers are significantly different, and that the logic for making purchasing decisions on base station equipment seems to be project-specific. The following quote is illustrative: "*Some customer projects place call-off orders based on their rolling project plans and some always wait until a certain milestone in their site implementation process has been reached. There was also a customer that places orders based on material consumption in its warehouse. Furthermore, there are examples of customer projects that, at certain points of time, did not have any*

[219] Hoover et al. 2001, p.77
[220] Hoover et al. 2001, p.79
[221] Hoover et al. 2001, p.72, tarkista suora lainaus.
[222] Collin 2003

agreed procedures in place, ordering was done on a case-by–case basis." [223] Nevertheless, in the particular project environment, Collin distinguishes three points to which NET could link in the customer's demand chain. Figure 25 illustrates these alternatives.

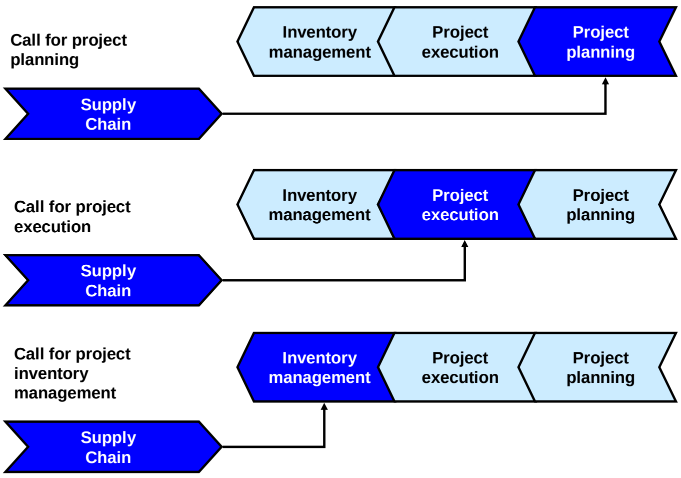

Figure 25: Three types of operator demand chains[224]

In the first option, the *call for project planning*, the customer orders based on the customer's existing project plan. In *call for project execution*, the customer orders only when a certain pre-defined project or process milestone has been reached in the site implementation process. In the third option, *call for project inventory management,* the demand visibility point is positioned in the customer's project inventory management, and the supplier's supply chain is built to serve the customer's inventory replenishment process. [225]

From the viewpoint of this research, the model is valuable as it reveals the determinants of operational demand information in projects; the project plan, project progress, and inventory position. The model also indicates that the quality of project planning information and the reliability of execution processes in the project determine how the supply chain can be designed.

6.3 Antecedents of demand visibility

The following discussion on different types of coordination is built around the model by Simatupang et al., and the idea is to point out the fact that coordination in supply chains or in any other inter-company system cannot be achieved by only concentrating on one aspect of the whole. As is illustrated in Figure 26, Simatupang et al. have identified four coordination modes: logistics synchronization, information sharing, incentive alignment, and collective learning. The interplay between the different coordination nodes is outside the scope of this

[223] Collin 2003, p.178
[224] Collin 2003, p.178
[225] Collin 2003, p.178-180

study. Yet, the model hopefully offers some insights on what is important in creating a setting where capturing demand information is on the whole possible. The model is also used as structure for presenting some results from the empirical research.

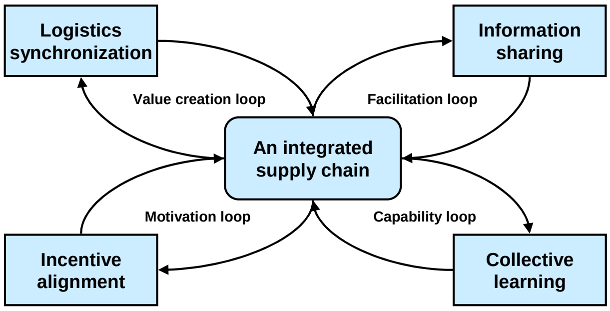

Figure 26: Four modes of coordination of an integrated supply chain[226]

The coordination of *logistics synchronization* is responsible for ensuring alignment between logistics process activities of the different companies in the supply chain. This means recognizing and converting improvement initiatives such as vendor managed inventory, a replenishment concept which will be described in chapter 6.4.1. The coordination of *information sharing* attempts to realize the coherency of information, making relevant, accurate, and timely information available for decision makers. Implementing cross-organizational information systems is often costly, time-consuming and risky.[227]

Probably the biggest hurdle or enabler for all collaboration is that of *incentive alignment* of partners. Incentives define how decision-makers are to be rewarded or penalized for the decisions they make, and, practically always incentives are tied to the action of reducing the internal costs of one stage of the supply chain. The goal of incentive alignment is thus to provide various mechanisms to distribute benefits, risks and workload to motivate independent actors toward supply chain goals. It would be naïve to think that cooperation will automatically increase company profits. In fact, the profit associated with superior information is often called informational rent.[228] Often the required efforts and expected benefits from collaboration do not go hand in hand, and there are always risks of some partner abusing sensitive information. For example, supply chain partners seldom share information that relates to sensitive cost data, e.g. production yield data or purchase prices of parts.[229]

Finally, the coordination of *collective learning* refers to dealing with the coherency problem of initiation and diffusion of knowledge across borders; often in the longer term.[230] Learning in general has been identified as a problematic area in projects due to discontinuity.[231]

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[226] Simatupang et al. 2001
[227] Simatupang et al. 2001
[228] Lee et al 1998, p.13
[229] Lee et al 1998, pp.13-14
[230] Simatupang et al. 2001

6.4 Basic supply chain configurations for collaboration

What forms can collaboration take in supply chains? Holweg et al. have identified four basic supply chain configurations for collaboration. The configurations are divided into four quadrants determined by the dimensions of inventory and planning collaboration. The four basic configurations are: traditional supply chain, information exchange, synchronized supply, and vendor managed replenishment. As Holweg et al themselves admit, there are more dimensions that one can collaborate on, including promotions or new product introductions. However, the ones included in the model are the most commonly used in practice.[232] Even though this two-firm collaboration model has been developed with the retailer – supplier dyad in mind, it should be generalizable to project environments as well.

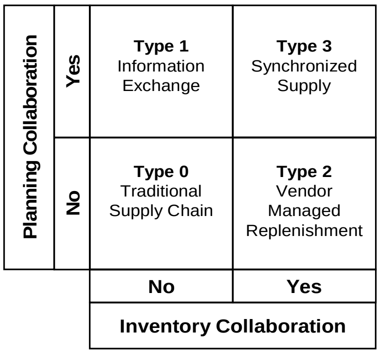

Figure 27: Basic supply chain configurations for collaboration[233]

Traditional Supply Chain in the first quadrant refers to a situation in which each level of the supply chain issues orders and replenishes stock without considering the supply chain as a whole. In this rather typical situation, there is no formal collaboration between the customer and supplier.

Information Exchange, or information sharing, refers to companies exchanging demand information and action plans in order to align their forecasts for capacity and long-term planning. Ordering is still handled independently. Taking information sharing one step further is collaborative forecasting, also included in this category.

Vendor Managed Replenishment means that the task of generating the replenishment order is given to the supplier, who then takes responsibility for maintaining the customer's inventory, and subsequently, the customer's service levels. Traditionally, both the buyer and seller try to optimize their own operation independently resulting in a sub-optimal performance of the combined operation.

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[231] E.g. Koskela 1992 p.49
[232] Holweg et al. 2005
[233] Holweg et al. 2005

In *Synchronized Supply* the relationship includes both planning and inventory collaboration elements. This type of collaboration merges the replenishment decision with the production and materials planning of the supplier.

Bacon et al.[234] from AMR Research categorize collaboration somewhat similarly under three forms of relationships: transactional relationships, information-sharing relationships and joint planning and development of business plans. Transactional relationships correspond to type 0, information sharing relationships to types 1 and 2, and joint planning and development of business plans to type 3 of the division by Holweg et al.

6.4.1 Vendor managed inventory and supplier managed availability

Vendor Managed Inventory (VMI) is often referred to as Vendor Managed Replenishment, or Continuous Replenishment Programs. In practice, VMI is employed by two neighboring partners in a supply chain. As the name vendor managed inventory indicates, the supplier is responsible for managing the customer inventory and sometimes even owns the inventory. In a typical arrangement, the buyer shares its inventory data with the vendor and asks the vendor to manage his inventory within certain commonly agreed inventory levels.[235] Through better visibility, the inventory investment needed for certain customer service levels can potentially be reduced. However, as Lee et al. point out, VMI does not leave much for the vendor to use her judgment on future market demand.[236]

Hausman takes the concept of VMI a step further in *Supplier Managed Availability* (SMA). SMA recognizes that inventory at the downstream site is not a goal in itself; the true goal is availability of product when and only when a particular site needs it. SMA extends the supplier's options considerably as means other than inventory, including premium transportation and surge capacity, can be used to provide desired availability to the customer.[237]

6.4.2 Collaborative Planning Forecasting and Replenishment

The Collaborative Planning and Forecasting initiative created by the Voluntary Inter-Industry Commerce Standards (VICS) organization[238] is another attempt to create structure to inter-firm supply collaboration. It is a formal process model uncommitted to any specific technical solution or position in the supply chain guided by three principles. The principles guiding planning and forecasting collaboration in this model are:

1. The trading partner framework places the operating process focus on consumers and orients them toward value chain success. The actual framework is case dependent.

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[234] Bacon et al. 2002; quoted in Lakervi 2003
[235] Lee et al. 1998, p.3; Holweg et al. 2005; Christopher 1998, p.195
[236] Lee et al. 1998, p.8
[237] Hausman 2003
[238] VICS 2004

2. Trading partners manage the development of and agree upon a single shared forecast of demand that drives planning across the value chain, including decisions on what forecasting techniques or information sharing technologies are used.

3. Trading partners jointly commit to the shared forecast through risk sharing in the removal of supply process constraints.

The actual CPFR process is divided into three consecutive phases: planning, forecasting and replenishment and further into nine activities. These activities can be managed jointly by the participating organizations, by the buyer or the seller. The CPFR model is presented in reduced form in Figure 28.

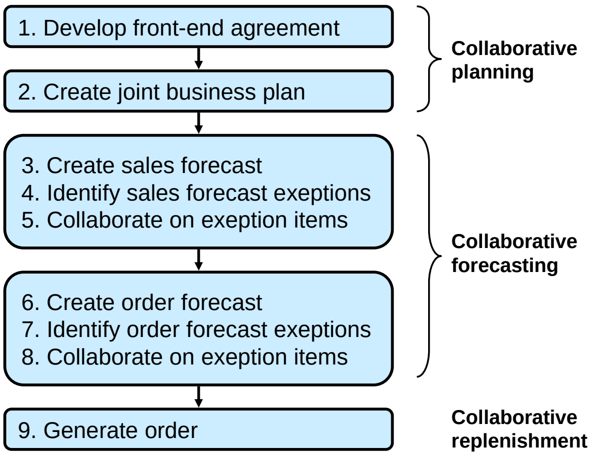

Figure 28: Simplified CPFR process model[239]

According to Småros, the CPFR process is currently too labor-intensive for many companies, and she argues that there is a need for more streamlined approaches.[240]

6.5 Conclusion

The theme of this chapter was demand visibility in multi-company settings. The concepts of order penetration point and demand visibility point were introduced as tools for designing value for the customer and visibility for the supplier. Moreover, the antecedents for demand visibility and basic configurations for supply chain collaboration were presented. The concluding ideas from this chapter are:

- Coordination in supply chains or in any other inter-company system cannot be achieved by only concentrating on one aspect of the whole.

[239] VICS 2004, modified
[240] Småros 2003

- ► The key to demand visibility is finding win-win configurations; to be successful, collaboration requires incentive alignment.

- ► By changing how demand is linked to supply, the supply chain can be synchronized better, and by moving the link from supply to demand, the value added to customer can be increased.

7 Synthesis of the literary review

As was taken up in the methodology section, according to Yin[241], descriptive theories give clues about what aspects of a case to include in a description, and what should be excluded. The results of the literary review have pointed out a number of such aspects that have influenced the data collection in the field, the final form of the sub-research questions, and the research framework, which is presented in chapter 9.1.1.

The goal of the literature review as a whole was to answer the question: **"How can advance demand information be captured from project delivery networks for demand supply planning?"** This question was answered through reviewing literature covering three main themes; demand information in supply chains, access to that demand information, and planning and forecasting demand. Moreover, the project context has been considered in all chapters. The three foci in the theoretical discussion are re-presented in Figure 29.

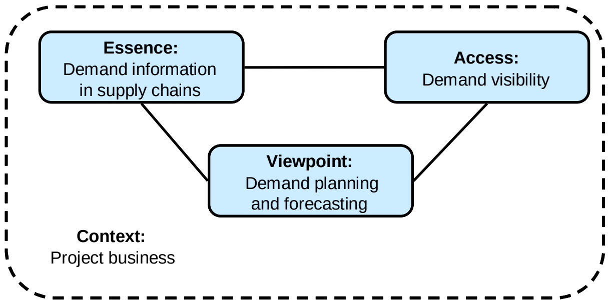

Figure 29: Foci of the theoretical discussion

It was found that in turbulent environments, it is important to have business processes in place to maintain a proper balance between demand and supply, and the ability to capture end-user demand and to physically respond to that demand in a timely manner is a matter of survival. Against this background, understanding the processes of demand creation and evaluating the quality of information at source is paramount.

Conceptually, project delivery networks are considered in this study as containers of operational demand information. Project delivery networks were defined as temporary, often semi-hierarchical, network of companies set up for the duration of the project execution phase. This multi-layered and converging supply network carries out both the manufacturing and assembly activities in order to produce the unique project product. Based on the literature review, it would be quite feasible to assume, that in most cases, the project network is coordinated by a single project stakeholder, often the project customer or the main contractor. Companies in these roles are likely to serve as gatekeepers to demand information.

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[241] Yin 1994, p.22

Demand information in project delivery networks was found to have certain special characteristics. Firstly, it was found that rough-cut demand information should exist a long time prior to the actual requirements in projects due to the long and informative design, planning and purchasing process that precedes project execution and order releases. Secondly, demand in project settings is by nature derived or dependent demand. Demand information in projects is in concentrated form; at least in theory, component and service demand can be derived from various project plans and schedules that define the project end-product and its building process. Thirdly, demand information in project delivery networks is usually unstable due to high level of uncertainty and openness of design. Finally, many major challenges in managing data and information in project delivery networks are probably not that different from other environments. Most likely, much of the information is not easily available or understandable, and the confidence of the information in many cases is not known.

The different relationship dimensions, including trust and the power balance between the buyer and supplier, are found to be major potential determinants for capturing demand information. Backing up this assumption are several studies that indicate that close trusting relationships are positively related to more frequent sharing of better quality information between business partners. Yet, probably the overarching hurdle or enabler for any demand collaboration is that of incentive alignment between partners. Thus, the key to demand visibility is finding win-win configurations. At the same time, it needs to be recognized that true integration in supply chains cannot be achieved by only concentrating on one aspect of the whole, for instance introduction of new information systems.

One answer to the research question – how can advance demand information be captured from project delivery networks – seems to be: *It depends*. The contingency argument in projects is always strong due to projects' uniqueness in terms of the end product, local institutional settings, project network build-up, customer requirements and supply chain configuration, to mention but a few. Moreover, the complexity, uniqueness, and discontinuity of projects make finding a common language between companies more difficult than in a continuous standardized environment; investing in cross-organizational information systems and close relationships may not provide a sufficient payback in temporary settings.

In the end, it must be kept in mind, that achieving demand visibility is not an end in itself. Rather, the goal that companies strive for is supply chain performance defined in terms of efficiency and customer satisfaction. When facing unpredictable demand, companies need to evaluate the soundness of improving the demand part of the demand supply chain, where the major challenges are improving demand visibility and planning, or to strive for responsiveness on the supply side.

8 Case company and delivery environment

The purpose of this chapter is to acquaint the reader first with some general matters of mobile networks, the base station product, and their deployment. Then, some company-specific background on logistical operations and planning project rollouts and demand will be presented. The information used in the company-specific part of this chapter comes mainly from company-specific documentation, including written documents, presentations, web-pages, and from interviews. These scattered references will not be included into the final reference list.

8.1 Mobile network systems and base stations

The cellular telecommunication network is built from hi-tech equipment, characterized by high product value, extremely short lifecycles and a large amount of embedded software. A typical mobile radio system contains at least the following network elements: mobile station, base station, switch and databases for authentication, roaming, billing and such purposes (Figure 30).

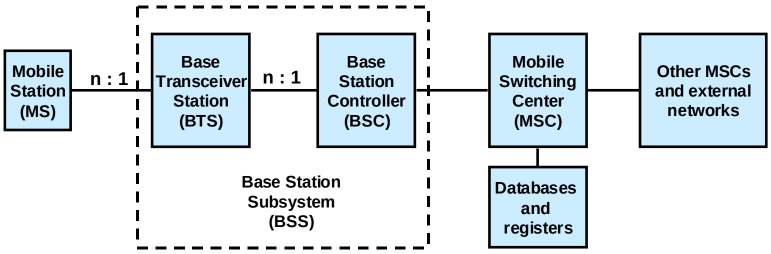

Figure 30: Overview of mobile network elements[242]

Mobile Station (MS) is the physical equipment used by the subscriber such as a phone and a subscriber identification chip. When a call or data service is used, the mobile station forms a connection to the Base Transceiver Station.

Base Station Subsystem (BSS) usually includes several Base Transceiver Stations (BTS) and one Base Station Controller (BSC). The BTS, which is commonly referred to as a base station, has network elements that communicate with mobile stations (for instance, mobile phones) across a standard air interface and with the BSC network element via fixed transmission lines. It houses the radio transceivers that define a cell and handles the radio-link protocols with mobile phones. The BSC network element, which acts as a link between base stations and the mobile switching centre, co-ordinates the radio resources for several

[242] Ojanperä et al. 1998; quoted in Heikkilä 2000, Appendix 2-1;

base stations, including handling radio-channel set-up, frequency hopping and cell hand-overs.[243]

Mobile switching centre (MSC) is an exchange that performs all the switching and signaling functions for the mobile stations in a geographical area. The mobile network connects to other MSCs, and networks through these switching centers. The MSC provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, hand-overs and call routing to a roaming subscriber.

This research focuses on capturing demand for base transceiver stations, also referred as BTS, base stations or sites. BTSs are the volume product of mobile networks, as there can be several thousands base station sites in an average network. Each site has its specific location, design and function in the network. A complete site consists of three main parts: the base transceiver station, site solution material and, optionally, a microwave radio link (Figure 31).

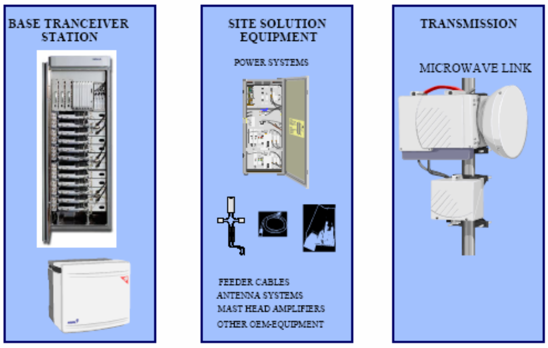

Figure 31: Base station site[244]

A base transceiver station consists of transmission units, power supply, cabinets, mechanics, filters and combiners. Site solution material consists of special equipment needed for installing a working base station site for particular circumstances. These are products like additional power systems, antennas, antenna lines, feeder cables, amplifiers, combiners and a number of accessories. Microwave radios enable a cellular transmission when a fixed line is not available, so they are not always used.[245]

According to Collin and Heikkilä[246], mobile network systems fall in the category of *innovative products* in Fisher's classification. The mobile infrastructure market is thus characterized by turbulent demand fluctuation, short product life-cycles, and a need for product variety and customized solutions. High demand uncertainty increases the risk of shortages and excess inventory. This, combined with short product life-cycles, price erosion and rapidly growing markets lead easily to substantial costs of lost sales and obsolete inventory. At the same time, operators insist on short order fulfillment times in order shorten

[243] E.g. Collin 2003, pp.71-72; Heikkilä 2000, Appendix 2-1
[244] Collin 2003, p.73; NET internal documentation
[245] Collin 2003, p.73-74, Heikkilä 2000, p.17-21
[246] Heikkilä 2000, p.198; Collin 2003, p.5; Collin et al. 2005

their time-to-revenue. The competitive advantage attained from good demand visibility is thus emphasized in this kind of an environment.

8.2 Site process for base station production[247]

This chapter explores the building of base stations. From the production and delivery perspective, mobile networks are quite peculiar products. They are deployed in a mode resembling both project production and mass production; the product is rather standard but configurable, the installation is in every case similar, yet different, and the material and installation service work flows need to be coordinated against each other and the progress of the total project. Furthermore, building mobile networks is characterized by a multi-site delivery environment, as network elements are located around the country. For example, a network can consist of more than ten thousand base station site locations.

Figure 32 presents the site process for base stations. Understanding the process for deploying individual base stations is the key to understanding and managing the network rollouts. It is a powerful representation as every base station has to go through the exactly same activities to be constructed. The main phases of the process are network planning, site acquisition, construction work, equipment delivery, installation and commissioning, and finally the integration of the base station into the network. The site process is described in Figure 32. From a demand planning perspective it is important to note that the site process activities drive both NET project planning and demand for Nokia equipment and services in the short to medium term. For instance, a delay in any of the front-end activities can postpone demand for Nokia.

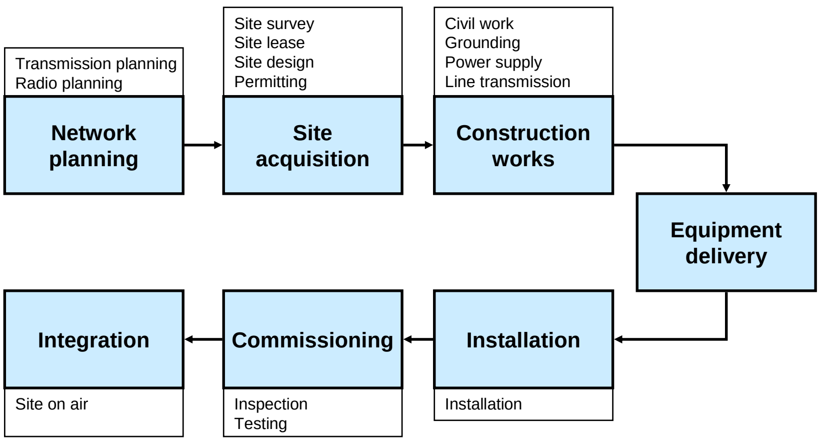

Figure 32: Site process for base station production[248]

[247] This chapter is based on Heikkilä 2000; pp.17-19; Collin 2003, pp.73-77; and NET internal documentation

[248] Heikkilä 2000, pp.17-19; Collin 2003, p.74

Network planning is the phase in the site process where the number and locations of base stations are planned against the network operators capacity needs. Radio network planning determines the cells and sites that need to be installed, commissioned and integrated.

Site acquisition is the process of acquiring the required site locations based on the information from network planning. The site acquisition phase starts with site surveys where potential site locations are identified, evaluated and ranked. When a proper location has been surveyed, lease negotiations with landlords, permit negotiations with local authorities and detailed site design can begin. Site acquisition usually takes a long time and includes many uncertainties.

The *Construction work* phase is about building the site location so that the equipment can be installed. This phase includes activities such as ground works and linking the site to a power supply. The type of construction works depend on location: in rural areas base station sites are often constructed in high places or on radio masts to get maximum coverage from the base station. If in city, the construction is more driven by esthetics, traffic and safety regulations. The material call off is usually done when the completion of construction works has been completed and typically only at this point the exact implementation timing and configuration is known.

Equipment delivery is the phase when the actual base station, related solution material and possibly a microwave radio link are delivered to the site for installation. Various processes exist for actually delivering the material to the site, but the most common arrangement is to deliver material to a local drop-off point as a complete site delivery. From the drop-off point, the material is either picked up by the installation team or delivered to the site.

Installation and commissioning is about implementing the BTS site in the network. The implementation team inspects the equipment and verifies that the site constructs are ready for implementation and then works against site-specific installation work instructions. Installation inspection is an important work phase in the implementation as minor defects can cause big problems in the whole system. It is also essential for installation teams to update project plans based on the facts of the installation. Furthermore, often installation is the invoicing trigger for the customer order. After the actual installation, in the commissioning step of this phase, the network element is tested to ensure that its units are functioning properly after transportation and installation, and to prepare it for integration.

Integration is to integrate the individual base station with the rest of the network. Only at this point the investment in the new network elements starts making money for the operator.

As Heikkilä[249] noted, many of the steps in the BTS site building and installation process have high uncertainty. It is often not certain whether the owner of a site will agree to lease it or if a permit is received from the authorities, or when this will happen. Construction and installation times are also subject to uncertainties external to the case company due to a

[249] Heikkilä 2000, p.18

variety of reasons, for instance, missing transmission lines or wet concrete due to bad weather.

Adding to the complexity, the sites of cellular networks are interrelated; as a base station configuration of a site may affect the configuration of neighboring sites, and due to other uncertainty sources in the production process, the building can be quite iterative in nature.[250] The following quote from the case research carried out in the US illustrates the short-term uncertainty well:

> **" In the short term, couple of weeks or months from now, civil construction causes much uncertainty. When you build these sites, before we can go and install our equipment, much work outside our scope has to be done, including laying the foundations and building the actual sites and transmission links. So before we can go in and do our thing, everything has to be ready. I see that our project managers in the field wrestle with the problems of receiving information on a very short notice and a constantly changing situation. The forecast for the coming month, a piece of information that our factories look very closely, may be 50% wrong just because our customer has not been able to complete the site works or transmission links in time. We receive this information just a couple of days before we need to go install our gear to the site."**
>
> *- Account Manager, describing challenges in demand planning*[251]

8.3 Case company

This chapter aims to provide the company and process related background required in order to understand the actual case descriptions. The discussion will start with an operational overview, then the different business scopes and how they relate to demand planning will be described. The chapter will close with a short introduction to the processes of project rollout planning and demand planning.

8.3.1 Demand-supply chain overview

Figure 33 presents an overview of a common configuration of a telecommunications equipment demand supply chain with an emphasis on the customer end. The organizational units relevant in this figure are the customer and other project stakeholders, the customer account team, the distribution center, and a variety of factories and suppliers feeding the distribution center with equipment. *The order flows and planning information flows have been separated as they pass through different processes*; the orders go generally into the ERP system and the planning information passes through a process called demand supply planning, which will be presented later in more detail. The material flows are depicted with the thick arrows.

[250] Hoover et al. 2001, p.176
[251] Quote translated from Finnish

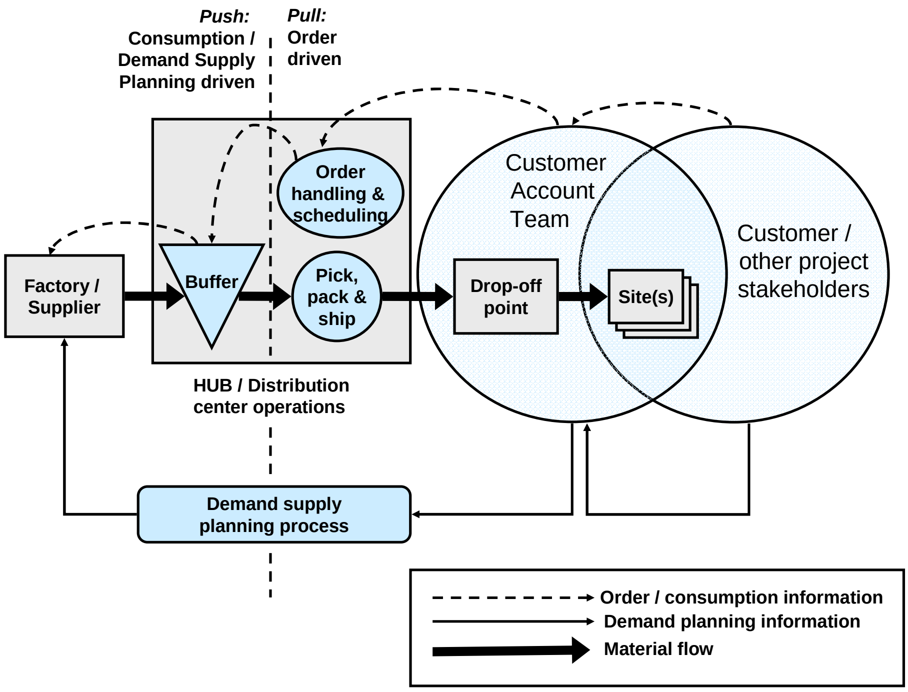

Figure 33: Overview of a typical demand supply chain configuration at NET[252]

Different network elements, the building blocks of base stations, are manufactured in multiple locations wherefrom they are transported to a regional distribution centre, also known as HUBs. From the HUB, there are two options for material deliveries: direct site delivery or delivery via drop-off point (DOP), out of which the latter and more common one is depicted. DOP is an interim delivery address defined for global equipment delivery from the HUB, first tier suppliers or local material suppliers. DOP is used to merge deliveries from different sources and to switch to local transportation taking the materials to the site. At least in theory, all equipment in a DOP is allocated to a specific customer site and packages are not opened or repackaged in the DOP.

Deliveries of global products are executed from the HUB, first-tier suppliers or from local vendors against project call off. Locally procured materials are excluded from the figure because they are not in the scope of global demand planning. Project call-offs can be triggered by various events: the customer may place an order, a site may have reached an appropriate milestone, or a site may be ordered just in case or in expectation of an order. Also the order penetration point is usually located in the HUB. This means that the network elements are manufactured or purchased to stock and then decoupled into complete system deliveries in HUBs based on the ordered configuration. The division also sells network elements to some customers as such. For those customers, the delivery is from the NET's warehouse to the customer's warehouse. The decoupling into system configurations is in these cases carried out by the customer.[253]

[252] Modified from Kaski 2005
[253] Valonen 2004, pp.51-52; NET internal documentation

What drives the back-end operations is demand planning information retrieved from the hundred or so customer account teams. The majority of the base station elements are manufactured or purchased against this information.

8.3.2 Delivery scopes and demand planning[254]

Three different business scopes of delivering networks exist at the case company. These are called turnkey, telecom implementation and box delivery. In the *turnkey* mode, the case company delivers to the operator a complete mobile network solution that is designed and implemented according to the rough specifications of the customer. In this kind of a situation, successful demand planning should be rather easy because Nokia is in a controlling position in the project delivery network, and possesses the project master plan and progress information. According to Collin, turnkey is selected as business model when the main emphasis is to gain market share and get the network launched as quickly as possible.

The other extreme, *box delivery*, refers to a business model where the customer purchases individual network elements from the system supplier. In box business, there are no services embedded in the deliveries and the operator or a third party is responsible for all planning and implementation activities. The supplier, or NET, only delivers individual base stations configurations or bulk equipment to customer inventory. This strategy is typical to operators who already have a mature network, and whose focus is on gradual improvement and expansion of the network.

Both of the cases analyzed in this work are of the third type, *telecom implementation*. In this value chain configuration Nokia delivers and installs the complete site, but the order does not cover any services prior to base station delivery. In this kind of a configuration, NET plays a central role in the project delivery network, but is not the main node as was the case in turnkey mode. In a situation like this, the integration to customer and to possibly other project network stakeholders processes is more important from the perspective of retrieving demand information than in the other two cases. From the operator's perspective, the telecom implementation mode enables easy use of several system suppliers to expand network capacity.

Related to the above discussion, it is important to note that in telecommunications implementation, two fundamentally different contract types, volume and frame, exist. *Volume contracts* have a clear scope with time line and quantity targets whereas *frame contracts* have open scope for quantities during defined time horizon. In fact, frame contracts are not real project contracts, but rather supply agreements where the customer has no real obligation for volume or scope.[255] As no binding baseline information exists, as is the case usually in projects, demand planning cannot be based on it. This is important to acknowledge as in both cases studied, the customer committed neither to volume nor monetary value.

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[254] This subchapter is based on Collin 2003, p.76 unless otherwise stated
[255] Poskiparta 2004, p.17

Due to a variety of different business scopes, demand also comes in at several levels. In telecommunications implementation mode, the demand is usually in the form of complete orderable base station configurations, that is, a complete site, installed and functional. In this kind of an environment, the company tries to avoid partial deliveries. In the case of box deliveries and care, orders come in on a more granular level of individual network elements. Nokia's global planning system has to be able accommodate both types of demand presented above and everything in between.

8.3.3 Planning structure

This chapter aims to describe some relevant characteristics about the product structure and planning principles at NET. Firstly, base stations are modular, configurable products; In NET, the number of individually customized end-products is tens of thousands.[256] As all end products do not have their own product codes, and the orders are inputted as a group of sales items, the number of end-products delivered is not even known to the division. Secondly, the bulk of base stations are sold as bundles of hardware, software and services. The guideline is that all the hardware, services and resources that are linked to a certain delivery/site should be planned in one package.

Figure 34 presents a simplified view of the demand planning structure. The almost infinite product variety and differences in business scope are handled so that customers can order a limited number of customer-specific configurations defined by their contract, and so that customer account teams themselves define the packages they use for planning. The packages are built from a number of globally defined sales items, which represent the smallest granularity of the sales structure. Sales items can be physical equipment, services, software or documentation. Usually, the sales package level is used for planning, and the equipment needs are broken down from there to the sales item level.

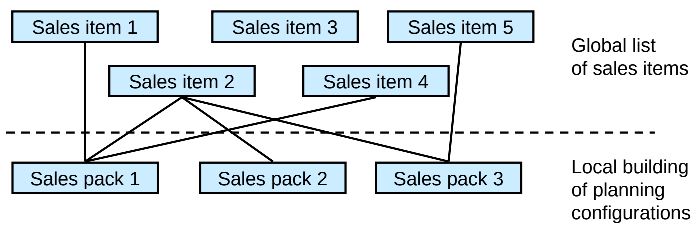

Figure 34: A simplification of planning structure at NET

8.3.4 Demand planning[257]

Demand Supply Planning (DSP) is a sales and operations planning process at NET. The process aims to ensure a balance between demand and supply capability, and creates a basis

[256] Valonen 2004, pp.51-52
[257] This subchapter is based on NET internal documentation

for financial and strategic planning. One of the major demand supply planning process targets is to create the NET *Agreed Sales Volume Plan* and *Agreed Supply Plan* at the aggregate level, ensuring that the global supply is able to meet the global demand and consequently, NET products availability to projects and the customer. An overview of the process is presented in Figure 35.

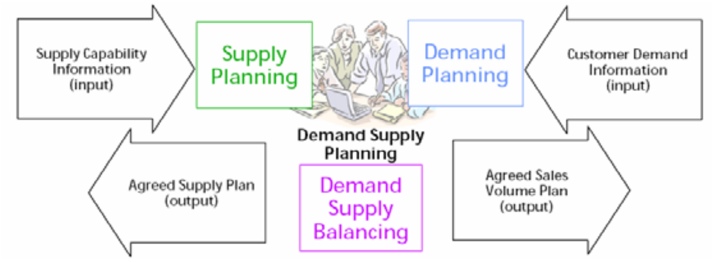

Figure 35: Demand Supply Planning at NET: inputs and output and the sub-processes[258]

The three main sub-processes of DSP are Demand Planning, Supply Planning and Demand Supply Balancing. *Demand Planning* is a continuous process in the customer account teams aiming to create executable volume demand plans based on customer forecasts and any other information they are able to derive from different sources. *Supply Planning* uses the consolidated demand plan as its input, and, in *Demand Supply Balancing* demand plans are balanced against supply plans and one set of numbers are agreed on to be used in the whole organization till the next planning cycle is approved. Next, the demand planning process is described in more detail.

Demand planning is the vehicle used to understand future sales of Nokia Networks. The volumes planned are the basis for buying components, and reserving production and service capacity. In the longer term these numbers are used to employ people and make capital investments. Furthermore, demand planning information is the basis of financial estimates and reports for NET management and investors. Finally, demand planning figures are used for sales availability management in constrained supply situations. Demand planning process is performed on a rolling basis for 13 months to come in monthly cycles. The first three months of the plan can be updated more frequently. The volumes are planned for the week the delivery takes place.

The customer account team is responsible for collecting and consolidating all demand for services, equipment and software. The team utilizes the best information available on the market and considers any product ramp-up and –down plans. Customer demand and project plans, the contract, delivery history and trends, customer and account inventory, project work in progress, order book, project plan and care plans are some of the key information sources. According to NET processes, the preferred way of preparing the demand plan and latest estimate is to start by planning the volumes in collaboration with the customer and possible telecom implementation partners. If this is possible, the main source of information

[258] NET internal documentation

is the customers demand plans, prepared together by the account team and the customer. Though, customer collaboration is not always possible for various reasons.

8.3.5 Project rollout planning

Project rollout planning is a critical part of project planning of NET. The purpose of the rollout planning process is to support tendering and start up phase and after that to enable efficient follow up and communication of rollout progress in project execution phase.[259] At NET, base station rollouts are managed with common processes, milestones and tools.

For base stations, the rollout plan is basically a volumetric progress schedule, which is defined by product, scope of work, geographical area, time, site process milestone, time and volume. The rollout plans are made in two main categories. The primary category is the progress baseline, which is defined already in the preliminary project plan and is left untouched during execution, whereas the secondary category, the forecast, is updated with the best estimate of the future progress available on a weekly basis.[260] The actual project progress can be compared against both baseline and forecast in a specific tool.

Figure 36 presents a simplified rollout plan baseline. To the left, milestones related to the site process are listed. The x-axis is time. The numbers in the matrix represent the planned amount of sites that will pass a certain milestone during a certain week. For instance, during week four, 10 sites should be installed. The forecasts or actual progress information would also look similar to the baseline. The rollout plan physically reminds of a master production schedule rather than a project schedule in the traditional sense. In the customer account teams, rollout planning is done using the Rollo-tool.

Rollout Plan Sample

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Site works agreed for TI	5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15						
Delivery		5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15					
Installation			5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15				
Commissioning			5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15				
Integration			5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15				
Site Acceptance					5	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		

Figure 36: NET rollout plan example[261]

[259] NET internal documentation
[260] Poskiparta 2004, pp.27-30
[261] Poskiparta 2004, p.30

9 Within-case descriptions

In this chapter, I will describe how demand information is captured from the project delivery network in the two cases that were studied. The first case is titled *Case Tango*, representing the idea that it takes two to tango. The dancing-partner you are interested in may decide to dance solo, prefer someone else in the ballroom, or, simply be a lousy dancer. The second case, I regard as a start of a Cinderella story in terms of deriving demand information, thus the name *Case Cinderella*. Instead of company names, the companies' roles, such as Operator, General Contractor, or Service Supplier, are used in the text.

As a whole, this chapter is structured so that first the analysis framework and the project network will be introduced, then both cases will be described separately. Each case opens with some background information and then proceeds to presenting how demand information is being captured and shared in the project delivery network. The process description answers how demand is captured and a description of the planning context should shed some light on why the process looks the way it does.

9.1 Introduction to the cases and the analysis framework

This chapter describes the analysis framework used and introduces the case environment.

9.1.1 The analysis framework

As the project and account team personnel need to be able to coordinate their activities with the customer organization, the breakdown of the project on NET's side often reflects the breakdown of the customer organization. As a result, two to three corresponding levels of organization are formed between the operator and NET as shown in Figure 37. The lines in the figure illustrate that the different inter-organizational levels mostly communicate with their counterparts. A rather similar organization could be drawn between NET and the rollout service supplier.

I have named these three levels as *market*, *regional* and *national*, although the actual names used vary between customer account teams. The market-level is where the action is; here the actual network and site building takes place, time horizons for planning are short, as are planning cycles, and interaction between the different project stakeholders is intense. The regional and national levels host diverse support, sales, and managerial activities, and the planning on these levels is less frequent. The research was conducted on the regional level, as it is where the bulk of the mid-term planning activity takes place.

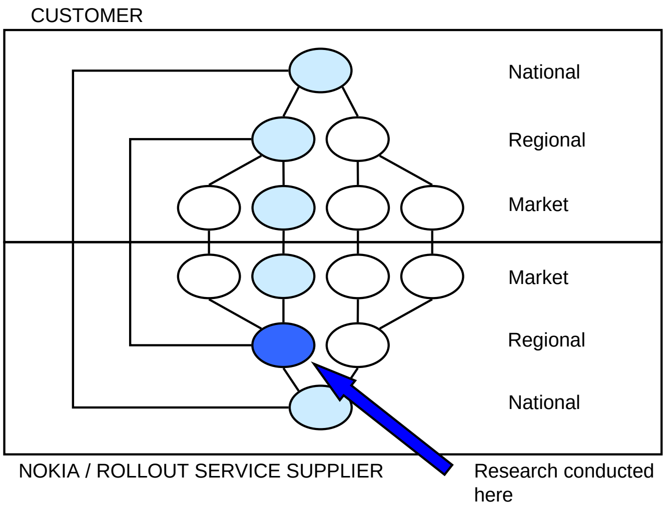

Figure 37: Project organization and point of research

Figure 38 presents the analysis framework that was created for describing the information sources and flows in the truncated project network. The framework's basic idea is to describe the flow and evolution of the information by using activities and objects that are rich in information content. In this case, such objects and activities were mainly meetings and different plans and forecasts that are shared within the project network. Furthermore, when applicable, it is shown in which format or tool the information exists; please note the key in Figure 38. It is acknowledged that several other alternatives for process mapping exist in the literature, one of the best known of which is probable the IDEF family[262]. Yet, such formal modeling methods would have been too rigid for this research.

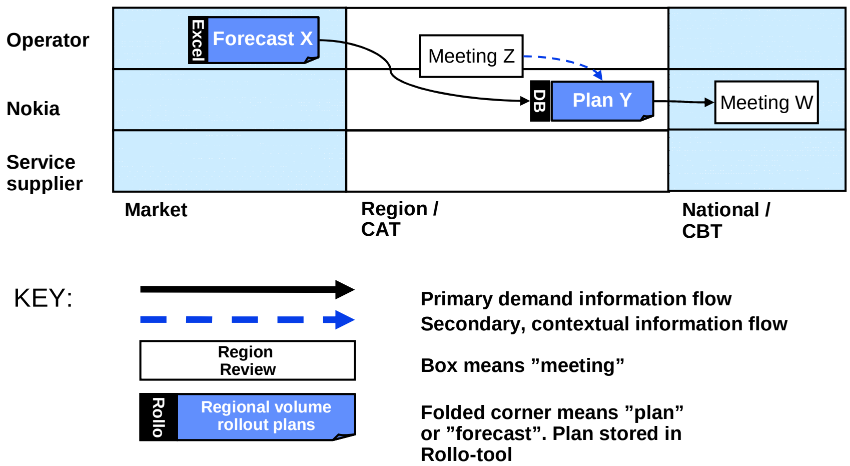

Figure 38: Analysis framework

In the hypothetical situation presented in Figure 38, the main source of information for *Plan Y* is *Forecast X* created by the operator at the market-level. The reliability of this forecast is

[262] E.g. Knowledge Based Systems 1992

evaluated against contextual information from *Meeting Z*, and the resulting plan is used as input in *Meeting W* on the national level. Note, that it makes a difference where the box is located; for instance meeting Z is a shared meeting between the operator and the case company.

The process diagrams are meant for providing an intelligible visualization of the whole; the detailed content of the objects presented in the process diagram are explained in the text and in the appended tables, see appendices 1 to 4. For each case, one table exists for describing the *plans and forecasts* in the diagram, and one describing the *meetings and communication* that takes place. Table 9 presents what information the appended tables contain for each information object.

Table 9: Contents of the documentation tables

Plans and forecasts	Meetings and communication
General description Planning horizon Planning cycle Planning bucket Created by Perceived quality Stored in	Discussion and decisions Present Frequency

9.1.2 Project stakeholders

Next, a short introduction is given to the project stakeholders who were found to be relevant in terms of being able to describe the main demand information flows. The relevant actors were basically the same in both projects, so there is need for only one description of the project network.

Figure 39 depicts the base station implementation process, and shows a rough description of the division of work between the organizations for building a base station in the two cases. The link between the project network and the activity structure has been presented because it helps understanding the role of each actor. Furthermore, the activity structure determines to some extent how the network of companies needs to be coordinated; for instance, NET needs to know when the construction works are finished so it can install the equipment.

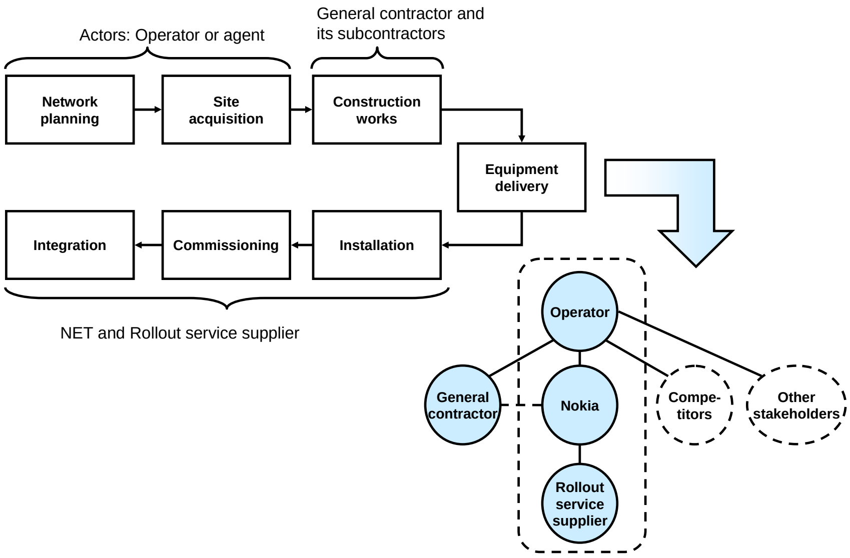

Figure 39: Project activity structure and relevant project stakeholders

In the network, the main information node in the two cases was the operator who is coordinating the whole. Looking from the demand information perspective, the other relevant stakeholders in the network are the rollout service supplier, the general contractor, and of course NET.

A *general contractor* is the company taking care of preparing the site for equipment installation. In the cases, general contractors provide some, but very little, usable demand information, as most of the information needed for coordination passes through the operator. *Rollout service suppliers* are companies that carry out the actual implementation work as Nokia's subcontractors. In the cases studied, there was only one rollout service supplier in each. These companies are not really sources of demand information, but important demand information consumers. By *competitors*, I refer to other large telecommunications equipment manufacturers delivering to the same customer. No demand information was retrieved from them, nor was there any contact, mainly due to the fact that the customer had organized so that the competitors did not need to interface with each other. Yet, it is important to acknowledge that direct competition existed in the both projects, as competition had indirect implications for NET in terms of capturing demand. Several other stakeholders existed as well in the network, but in the end, they were found to be irrelevant enough to justify focusing solely on the triad: Operator – NET – Service Supplier.

9.2 Case Tango

In this chapter the first case will be described. First, the issues that were found having the biggest impact on planning will be highlighted followed by an illustration of the actual process of capturing demand.

9.2.1 Context

This case describes capturing and planning demand planning in a large 2G account in the United States. The NET business in the United States for this customer account is divided into 4 regions, which are further divided into markets comprising of one or a couple of states. As was explained, this division follows the way the customer has organized its own network improvement activities.

In this region, the business relationship with Operator started in 2001 with a contract to build an initial overlay of GSM coverage when Operator changed from the TDMA standard to GSM. This project was highly successful - finished early and on budget – and was a ”real” project with a beginning, an end and a scope. From 2004 onwards though, NET is operating more in day-to-day mode of doing business: the customer orders when he sees appropriate, and NET delivers against these orders, which is typical for more mature markets and customers. In BTS new builds and expansions the current volumes are rather small due to certain internal friction on the customer side. The customer has not committed to any volumes, except loosely through receiving discounts from buying certain yearly volumes. Thus, the contract itself does not offer any information useful for planning.

“Current volumes are ridiculous. Last month we had some 10 new builds and 70 expansions. During the X project, we had 400 new builds per month.”

– Cost and Progress Manager

Supplier status and the customer’s motivation to plan: A shared opinion of the customer account team was that in the BTS business, Operator sees Nokia more as a commodity supplier than as a partner. It was also reported that collaborative schemes are difficult to implement if the counterparty does not share the same goals. Under the current competitive pressures, the customer often does what it wants, and relationship management comes before anything else. This also relates to the customer having no consequences for bad forecasting; the operator does not have incentives to forecast as Nokia will anyway do as they are told to do. What the contract says makes no difference. The customer only needs to shout harder or threaten to shift orders to another supplier to get their own way.

“They [Operator] don’t really treat us as partners”

– Account Logistics Manager

“We try to go back, and show [Operator]; you see, you signed it here and it says you have 90 base stations forecasted. Their answer is something like: Who cares, we are the customer and we want 200 now.”

- Cost and Progress Manager

Somewhat paradoxically, at the same time there seems to be a relatively good working relationship between NET and Operator, a spirit of cooperation exists, and some steps are taken to collaborate in planning and forecasting, as following quote reflects.

> **"They are saying all the right things. Now we are waiting for some actual progress. They say they want to work with us, they say we want to be partners, help us plan better to support them better. They just have to trust us to give that information."**
>
> *- Senior Project Manager*

Merger: Operator is a major US-based telecom operator that was formed quite recently through a merger between two domestic operators. Before that, both companies had a business relationship with NET. Due to the merger, there is an ongoing activity of combining the overlapping networks of the two, in addition to "*business-as-usual*" network capacity expansions. From the demand planning perspective, the merger is problematic because the internal planning processes of Operator are still evolving. According to the account team, sharing demand information with suppliers may not be assigned the highest priority within the customer organization in the current situation.

> **"Customer merged in the beginning of the year, but was disorganized even before. Their planning processes are on the move."**
>
> *- Project Director*

Supply chain configuration: Another issue making planning difficult for this account is that the customer has adopted a new centralized mode of purchasing and distribution. In April 2005, three months prior to the research visit, Operator had shifted from ordering equipment on a regional level as complete site deliveries to ordering equipment and services separately. Operator basically decided that they will not order any more equipment regionally per site. The main reasons for this process change were the need for a national buffer for equipment, a common process for all the competing equipment suppliers, more focused asset management, and possibly the prospect of commoditizing base station implementation services in the future.

Figure 40 presents the new process. Virtually all the equipment is ordered centrally in bulk and delivered to a centralized warehouse in, and from there redistributed to the regions based on site requirements. It is Operator's call to release the equipment to site. When the customer's project manager in the market has a site ready, he calls off the equipment from a centralized warehouse with a work order. The equipment is then shipped from the warehouse down to a local warehouse. When NET / Service Supplier gets their *"ready to sets"*, or site ready notices, they go to the local warehouse, pick the equipment up, take it out and install it.

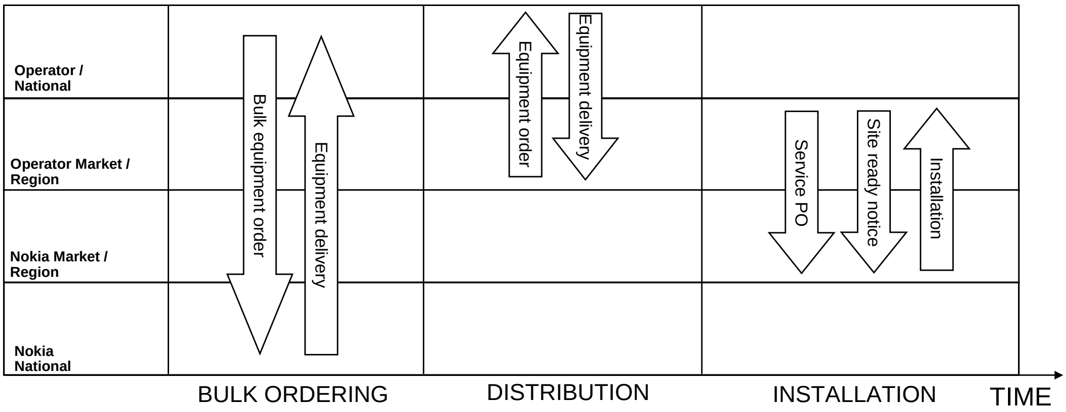

Figure 40: Centralized purchasing process

The process is not working very well at the moment, which adds another source of uncertainty to demand planning; in addition to the question ”Is the site ready for us”, one needs now also try to evaluate whether the right configuration is available on the customer side. As a result, according to the NET Account Manager, some of the customer regions are considering bypassing the centralized purchasing and shift back to direct ordering. For demand planning, centralized logistics mean that:

- Equipment and service planning is separate; services need to be planned in regions and equipment on the national level.
- Projects have no (nor do the customer regions) visibility to what materials Operator has or what has been delivered to them.

From a product point of view, seemingly the problem of planning the right configuration is not really a problem as only services need to be planned in the regions and bulk equipment at the national level. Yet, these problems have only shifted to the customer side; the customer has great problems in putting together the right equipment and ordering the required services for a site.

“The customer is really bad at ordering what it needs”

– Account Logistics Manager

Customer budgeting processes and incentives: The budgeting processes of Operator were seen as a large problem from the planning perspective; money is reallocated between customer regions due to market changes and altering strategic priorities, to a supplier in a seemingly arbitrary way. These reallocations naturally materialize as changes in plans and uncertainty for NET. Also the customer incentive schemes – quarterly and yearly quotas and bonuses – were mentioned as problems when it comes to planning.

“We are more in a reactive mode than a planning mode because their budgets go up and down all the time and are subject to change. If there is something wrong with the industry, they get slashed.”

– Cost and Progress Manager

“The [customer] regions are given a budget. Every year, when you get to the end of the year, they need to spend all this money.”

- Business Controller

Customer’s ability to plan: One reason for planning problems was mentioned by virtually all respondents; the customer lacks a working process for planning capacity extensions or new sites. The subscriber growth has surprised the customer several years in a row. All this, and the above, forces Nokia into a reactive mode.

“One of the biggest challenges in demand planning is that Operator does not have a process of planning capacity extensions or new sites. Everything happens reactively. When they notice that some part of the network is blocking, they start the expansion process and order services and hardware from us.”

– Account Manager

“You should start looking for a gas station when the light goes on. Operator doesn’t”

– Project Director

9.2.2 Process

Next, the actual process of collecting and sharing demand information in this case will be presented. Figure 41 portrays the process. For an explanation of the framework and the symbols used in it, I refer to chapter 9.1.1.

The process will be described starting from the market-level and following the information streams to the regional, and finally national level. The cycle time for the whole process in this case was one month.

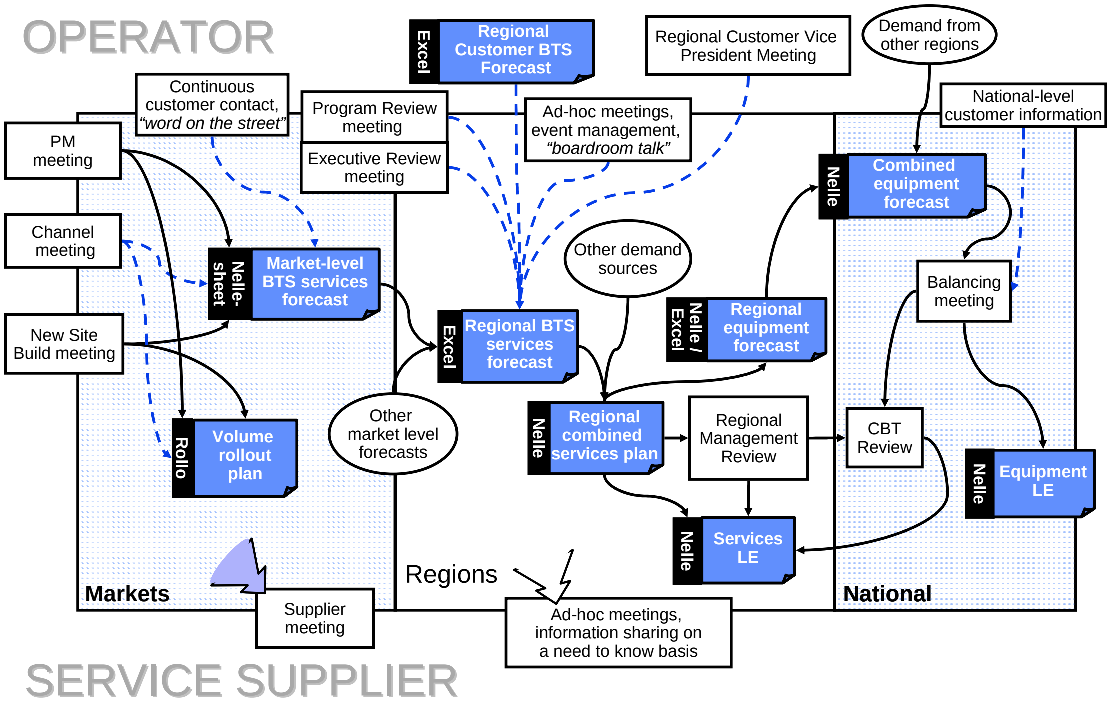

Figure 41: Capturing demand information in Case Tango[263]

Market-level: The markets drive service and equipment forecasting in the short term. The project managers in the markets forecast the service needs three months out based on information shared by the customer, their experience of the market and gut instinct. There is close contact with the customer and the rollout service supplier; at this level it is really a team effort. In some markets, the project managers are actually located in customer premises. The direct link to general contractors is thin as the customer has chosen manage the relationships with General Contractor itself. The only point of contact is really in the weekly *New Site Build meeting*, where General Contractor sits in the same room. The following steps take place in the four markets of the case region[264]:

1. **Demand information inputs**: Project managers get information on progress, future prospects and possible constraints from daily interaction with the customer and from three weekly meetings. The *PM meeting* is a project scheduling meeting, where the customer presents typically the work to be done for the following two weeks. The first week of demand represents frozen work and the second week a forecast. The *Channel meeting* is an operator-hosted meeting where the results of weekly Operator blocking studies are discussed. Nokia is not typically active in the discussion but is allowed to participate. Some indication on when and where new sites will be built can be retrieved maximum 30-40 days into the future. In the *New Site Build meeting* the different project implementation stakeholders sit down and discuss the sites for the month to come. In a typical meeting, Operator presents issues related to zoning and leases, and General Contractor tells what the current standing is in terms of construction and power. In this meeting, NET tries to nail

[263] See appendices 1 & 2 for details
[264] I had the chance to discuss with only on representative but when asked he claimed that the procedure is quite the same in the other markets as well.

down a date when the site will be ready for Nokia. At this level, at the best, the information is reliable two to three weeks into the future.

“If we can see two weeks to the future for services it is usually fairly accurate. After a month, it is really a wild guess.”

– Project Manager on information available at the market-level

2. **Information processing and outputs:** The project managers forecast the service needs for three months to come using Nelle sheets sent to them from the regional level by the Senior Project Manager. No real management adjustments are made on this level. There is also a *weekly meeting with the supplier*, where very-short-term schedules and forecasts are communicated forward. On this level, it was claimed, the supplier possesses more or less the same demand information as Nokia. The demand information produced at this level goes to the Senior Project Manager.

3. **Rollout / demand planning interface:** Basically the same forecast information is also inputted into Rollo resulting in double work. Rollo data is not really used in later phases in demand planning.

Regional level: On the regional level, a services latest estimate and a regional equipment forecast for the national level are produced. The following activities take place on this level:

1. **BTS service forecast creation:** There is no formal meeting for creating the BTS plan. The four short-term forecasts created by the markets are first consolidated by the Senior Project Manager (SPM). The SPM may do small adjustments to the forecasts based on any information she may have from Operator, which is not visible to the market-level. Such information may include progress, material and capacity constraints or new demand. The SPM compares the market-level plans she has received mainly against informal information from the *Program review meeting* and *Executive review meeting*, where progress and forecasts are discussed among other things.

“All that I would do is, if I saw something completely out of whack, I would go back to the guys and propose adjustments. Or first consult and then change”

– Senior Project Management on adjusting market-level plans

The planning sheet is then sent to the Account Manager who is looking at the big picture and is responsible for creating the BTS forecast for the 4-13 month period. The longer term plan is based on a *Regional Customer BTS forecast* which is received quarterly, meetings and ad-hoc interaction with the customer. The customer collects its BTS demand from its markets and combines this information to a region-level forecast for Nokia. The account manager told that the quality of the customer forecast varies strongly from market to market.

“There is access to information to the extent that Operator has prepared it; in many cases Operator has not made project plans or capacity expansion plans. They are not always in written form as plans, and they often change a lot. In practice, the best results

are achieved by actually going to the customer organization to dig for the information and take it in any format it may be in. If we ask or demand them to give a forecast, we usually do not get any response."

– Account Manager

2. **Demand aggregation:** The account controller combines other demand sources, mainly demand from switches, and care business, with the BTS plan. This aggregate plan then makes up the first version of the CAT service Latest Estimate (LE). Before the CBT review, the LE is still reviewed internally by CAT management where adjustments to the volumes can be made.

3. **Equipment forecast creation:** The regional equipment forecast - how many cabinets, expansion cabinets or radios will be needed - is derived from the service LE using dummy items. This is done in a tool which breaks down services into equipment needs based on the expected percentage split between indoor/outdoor implementations and radio frequency. The split is determined based on historical purchases, and the makeup of the network to which the equipment will be delivered by the AM and a solutions and application specialist. This information is then delivered to the national level.

"One aspect [equipment demand] that cannot be derived directly from our implementation work is the work done by rollout management firms using our equipment. For instance, in Louisiana the extension cabinets and new sites are built by our competition, a firm called Competitor. In these cases we have to rely on second hand information of the volumes and timing. I put this information to the forecast as a footnote."

– Account Manager on derived equipment forecasts

4. **Limited information sharing:** The service supplier is informed of changes in the implementation plan on a need-to-know basis. No formal information exchange exists as the partner manager has changed to another position. Previously there was even a template for doing this.

National level: The national level is responsible for planning the equipment needs. Each region derives from its services planning the corresponding equipment requirements using dummy items. At the national level, summary reports of the equipment forecasts are created. After this, the regional forecasts are balanced against input from the Operator national organization. There is absolutely zero visibility to customer inventory but some forecasting collaboration with the customer.

1. **Equipment demand planning:** Before the balancing meeting, reports in Executive Viewer are run showing the CBT decision makers a summary of the regional volumes. Balancing between the regional numbers and the information received from the customer's national organization is done in the *Balancing meeting*. Information received from Operator at the national level is brought in by the sales directors and, at the moment, is in quite informal form. Some formalization in this sense is in sight: the first official forecasting meeting with the customer took place in June and the first official forecast was supposed to be received the week after the case visit. Information up to about six months into the future is received, out of which 3 months is somewhat reliable. All six months of information is used in the

balancing to some extent, and for the remaining seven months, the estimation from regions is used, unless it is "something way overboard". Usually the regional numbers are adjusted downwards and no feedback is given back to the regional level on planning performance.

> **"We had our first official forecasting meeting in June, and we are supposed to receive our first official Operator forecast this week."**
>
> *– Sales Director on nation level equipment forecasting*

> **"The moment the equipment is sent to EPL our visibility seizes. It becomes customer inventory."**
>
> *– Business Controller on inventory visibility on the national level*

2. The CBT equipment LE is created.

3. The CAT / CBT review is carried out, in which there may be still be changes to the regional services LE.

9.2.3 Conclusion

The saying *"It takes two to tango"* seems to hold true in this case. One lesson from case Tango is that you can not capture demand information if there is no information to capture; in this case the partner did not know how to tango. Another lesson is that you may not be any different from the ballroom full of other prospects; competition makes it difficult to argue why the customer should play along.

This case presented an overview of how demand information was derived from a project delivery network in a large project, where the customer was the main node of information. In this case, the planning setting was unenviable, which most probably resulted in moderate planning performance. There was access to demand information but a lot of effort needed to be put into retrieving it from the customer and the information could not be completely trusted as Operator would not plan properly its own needs. Furthermore, Operator was missing incentives to share information and develop collaborative practices, as there were no consequences for bad forecasting for the customer.

The inter-firm demand planning process as a whole was not very streamlined, which is very much affected by the recent merger and the centralization of material logistics. The resultant separation of services and equipment planning can actually be seen as one of the key features of this case. The use of artificial product structures in two separate transitions, from markets to regions, and from regions to the headquarters level probably distorts demand information. In general, demand information was fragmented, and it existed on many organizational levels. Information was collected bottom-up, with adjustments on each level. Formal feedback was not given back to the sources of information. Yet, plans were created by the people who have the best visibility to the execution, or have the best long-term view, and the account team was motivated to plan.

Figure 42 depicts demand visibility in this case. I have drawn no arrows into the picture on purpose. There was no visibility to customer inventory, although it was an item high on the CAT's wish list. There were no explicit processes in place for ordering collaboration, neither. Some forecasts were received on different levels, but most of the information sharing was informal. Customer's business planning has been added as an additional activity to the model, as it was found to affect everything else in the activity chain.

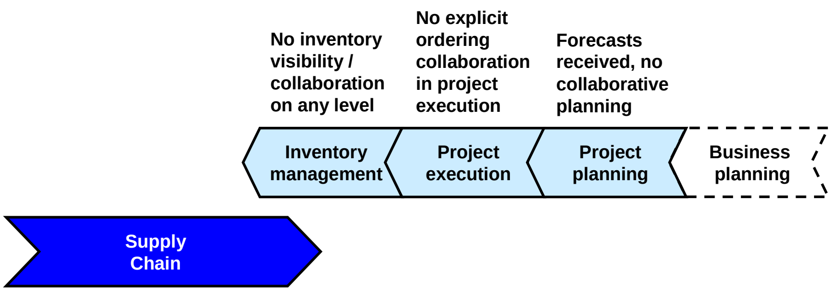

Figure 42: Demand visibility in Case Tango

This process for planning demand was at the time of research not documented, and not really recognized by the account team as a whole.

9.3 Case Cinderella

In this chapter the second case will be described. First, the issues that were found having the greatest impact on planning will be highlighted followed by an illustration of the actual process of capturing demand.

9.3.1 Context

This case describes demand planning in a smallish 3G account in the United Kingdom which has been relatively successful in planning and forecasting demand. The business relationship with the customer in terms of the ongoing project began in 2002 with the building of one of the world's first 3G networks. The rollout started in 2002 and is expected to finish in the end of 2006. Currently, the rollout volumes are rather small in comparison with a high of 200 new sites per month. An approximate total of 200 new sites, 200 upgrades and 100 microwave links will be implemented in 2005. The contract again has no real volume commitment.

Operator coordinates the total investment project and is thus the main information node in the delivery chain. Nokia is in a subcontractor position, and the equipment delivery and installation part of the project is divided in half between Nokia and another supplier. The NET business in the UK for this account is divided into the headquarter-level and two smaller regions, again following the customer's organizational architecture for implementing networks. A good working relationship exists with the customer.

Supply chain configuration: The supply chain setting is radically different in this project as the customer does not have any equipment inventory. When an order comes from the customer, the account team further orders materials from the distribution center to a local Nokia-owned warehouse, which are then picked up and installed by the subcontracted implementation team. Thus the telecom equipment is controlled all the time by Nokia, and the current inventory position is at least in theory one hundred percent visible to the account team.

Low planning complexity: In this customer account team, for BTS business, planning is done for new sites, upgrades and microwave links. Under these categories exact configurations are planned on a more detailed level. For new sites, the customer can order from 11 different configurations, for upgrades, there are eight options and for the links, seven. For new sites, only four configurations are actually planned, and one configuration makes up 80% of the total volume, which can be said to be representative for the upgrades and the links as well. In comparison with many other projects, this is a rather simple environment from a product point of view, as only few configurations need to be planned.

Customer in prioritization mode: In terms of planning, Operator is currently behaving unexpectedly due to a planned IPO next year. Operator has for instance gone into so callesd prioritization mode in which it is acquiring sites but chooses not equip them. Site acquisition and permitting takes a long time, up to six months. Yet, this step represents only a very small portion of the total costs of a base station and the customer has currently adopted a strategy of permitting sites but not building them as a result of cuts in spending in radio access networks. Currently it is more important for the customer to expand core network capacity, but when the emphasis shifts back to base stations, a big peak in demand can be expected.

Ordering collaboration: The account team has tried to impose a more formal BTS ordering process on the customer. There has been some success in this after the year end 2004 when all customer orders could not be satisfied due to a sudden and unexpected rise in demand. As Operator could not communicate the demand early enough, Nokia could not deliver everything despite best efforts. The customer raised its voice and turned to the competitor, but the competing company could neither meet the requirements. According to the account team, this was a major turning point in the Operator's attitudes towards collaborative planning.

Currently, the mode of operation has changed from calling off to formal purchase ordering with delivery date commitment, making shorter lead times possible. According to the collaborative model, the customer should place its purchase orders 6 weeks in advance of the time the equipment is needed on site. In practice this means that purchase orders are placed when the actual building of the site has started. After the shovel has broken the ground for the first time, it is uneconomical for the operator to postpone the finalizing of the site, and the progress from this point is quite predictable. Actual orders are placed for the equipment only 3 weeks prior to the actual need, after a site ready notice is received from a common scheduling meeting.

> **"The customers are gradually starting to understand that if they want 10 sites and they forecast eight, two are subject to normal lead times."**
>
> *–Account Logistics Manager on collaborative ordering process*

Yet, the reality is not always quite this rosy and several problems have been encountered when trying to implement collaborative arrangements. Again, Nokia is constrained by what its competitors are doing as the combination of following quotes show:

> **"We have had quality problems and Competitor is delivering off the shelf so it is quite difficult to argue to the customer that they should make their purchase orders too early."**
>
> *– RAN Project Manager on collaborative ordering process*

> **"Customer sees Nokia as more expensive than Competitor"**
>
> *– Senior Project Manager*

9.3.2 Process

Figure 43 presents the process of capturing demand information in this account. The process will be described starting from the market-level and following the information streams up to the regional level. What happens on the national level could not be researched in detail in this case, but it is also less relevant than in the previous case as both the equipment and services are planned on the regional level. This time, the cycle time for the short-term BTS planning is one week in contrast to one month.

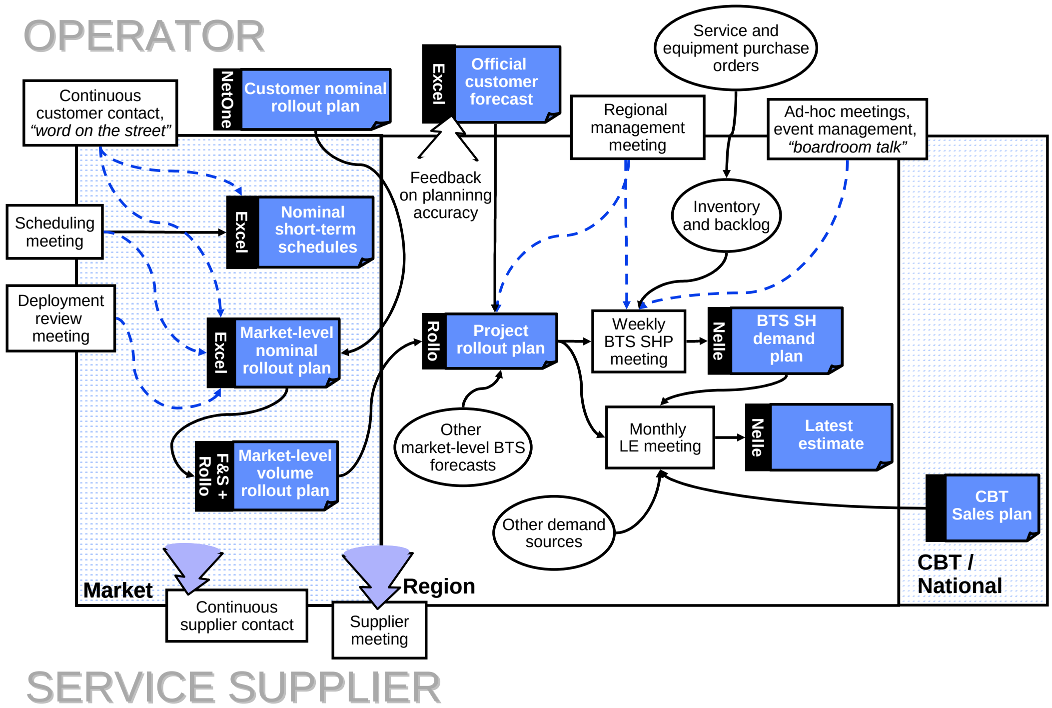

Figure 43: Capturing demand information in Case Cinderella[265]

Market-level: The market-level is the main source of demand information in the short term. Demand is collected from various sources, sent to the regional level and shared with Service Supplier. Market-level plans are created in close collaboration with the customer with visibility to the customer rollout plan. The following should explain the situation more in detail.

1. **Inputs:** There are four main sources of information on this level; the customer rollout plan, a weekly scheduling meeting, the deployment review meeting and continuous contact with other stakeholders. In the customer-run weekly *Scheduling meeting*, the customer, Nokia, and the rollout service company together decide on the detailed tasks to be done for the coming week and less detailed plans are received for the week after. The monthly *Deployment review meeting* is mainly a status meeting in which issues like progress, aborted activities, metrics fault analysis, and other operational issues are reviewed together with the customer. The coming three months are discussed. In addition to the formal meetings, there is continuous contact with both the customer and supplier to handle the ever changing short-term scheduling requirements. For instance, the project engineers in the markets are co-located with the corresponding customer network deployment people.

> **"You start picking up vibes on streets but you can't act before you get the official information from [Customer HQ]."**
>
> *– RAN Project Manager*

[265] See appendices 3 & 4 for details

The *Customer nominal*[266] *rollout plan* is the plan the customer uses to manage the total rollout from site acquisition to network integration. The plan is maintained in NetOne - a customer rollout planning tool somewhat similar to e-Tracker, into which Nokia has full visibility. The customer plans somewhere between 10 to 12 months into the future, which is roughly the time it takes to acquire and build a site. Yet, in terms of telecommunications implementation, the customer plans some 4 months in advance with rapidly deteriorating quality as the time horizon gets longer. The customer rollout organization too, is mostly concerned of getting the next two months right. Oftentimes happens that the database is not updated, and the data cannot be trusted in the long term. The customer rollout plan serves as input for short-term rollout planning activities carried out in the regions.

“In the [markets], we have accurate information four weeks ahead; eight weeks not that good, 12 weeks not at all good. Our guys [Project Managers in the market-level] refuse to give data any further ahead than eight weeks.”

– Senior (RAN) Project Manager

2. **Plans:** The *Nominal short-term schedule* is a pure project execution plan in which actual work tasks are planned on a very detailed level. For each coming week these plans are created in a customer-led scheduling meeting after which changes are updated freely. The *Market-level nominal rollout plan* is for longer term rollout planning purposes; active planning is done for the 8 weeks. The plan is largely based on information coming from the customer rollout planning database. It is also nominal in nature, but with less detail than the short-term schedule. For global demand planning purposes, a *Market-level volume rollout plan* is created in each market. The plan is captured from the market-level nominal rollout plan and the level of detail is the orderable configuration level. The markets will not do forecasting beyond 8 weeks, because information is not available.

3. **Sharing and outputs:** In the monthly supplier meeting, quite similar to the deployment review meeting with customers. Nokia gives feedback on performance, metrics and quality. Also, the customer long-term forecast is communicated using Executive Viewer. If there are important changes, these will of course be released earlier.

“Our partner company [Service Supplier] sits at the same scheduling meeting, so there is no need [to actively share plans]. Also, the supplier gets the same customer forecast information that we do.”

– Senior (RAN) Project Manager

Regional level: On the regional level, several activities take place to produce the services and equipment latest estimate. At this level, the information received from the regions is combined with other information inputs to form an aggregate BTS forecast. For the medium to long term, the customer forecast, customer meetings, and rumors are main sources of information.

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[266] In contrast to volumetric plans, in nominal plans each specific site is identified.

1. **Inputs:** Since November 2004 Operator has provided the account team with a monthly *Official customer forecast* that states their needs for the coming six months on the orderable configuration and market level. The forecast has an official status, and is non-binding; the customer has no obligations whatsoever to order what it has forecasted. There are neither rewards nor bonuses based on forecasting performance. In terms of using the forecast, the BTS project manager inputs the data from the customer sheet into Rollo, and this information is later used for in the planning meetings. The *Regional management meeting* is the only meeting where the long-term forecast is discussed. The monthly meeting is focused more on commercial than operational issues. The people sitting in meetings on this level are responsible for operational activities so they do not have a good understanding of the company's financial planning driving the implementation work in the longer term.

> **"To a large extent, our success in planning depends on customer forecasting capability."**
>
> *– Cost and Progress Manager*

> **"The customer will do their budget in November, once a year. You have to go high in the customer organization to get knowledge like this. "**
>
> *– Senior (RAN) Project Manager*

> **"We never seem to be able to forecast what happens at period end."**
>
> *– SHP Meeting comment*

2. **Short horizon planning meeting:** In the *Short horizon planning meeting*, the official customer forecast is analyzed against market-level forecasts and actuals, own sales plans, and inventory and order backlog using reports from Rollo and SAP. The output of this meeting is an update to the short-horizon demand plan. In this meeting, everyone would sit down for an hour or so, and the final planned volumes are massaged out by the project manager, logistics manager and business controller.[267] Adjustments to the short horizon are seldom made. Planning is done on configuration level of detail for only weeks. After eight weeks, only volumes are planned and a simple averaging is done to break the volumetric plan to configuration level based on historical demand. Separate meetings like this exist for Core and RAN, and some fiddling with numbers is needed to meet CBT targets, as the second quote shows.

> **"We don't do updates for longer periods [than eight weeks] because the situation will change anyway. The other reason why we don't do it is that it is tedious, takes a lot of time"**
>
> *– Project Manager on demand planning*

[267] Although, in the meeting I attended to, the first two months of data came directly from the combined regional rollout plans and was used as such.

> **"CBT is stretching the targets and at the same time [Operator] is not at all supporting this…"**
>
> *– Comment in the Short-horizon planning meeting*

3. **LE Meeting:** Once a month, all demand is collected and massaged in the LE meeting, where the focus is more on the long term.

Sharing and outputs: The customer receives feedback on its demand planning accuracy on a monthly basis. This happens in the monthly customer meetings. According to the CAT, the feedback has made the customer think about its forecasting performance, as the following quote demonstrates. For the near term, the customer forecast needs usually be scaled down by 25%. The supplier too receives forecast information on a regular basis in the supplier meetings.

> **"We are horrible forecasters. Tell us what we can do to improve our forecast."**
>
> *– Customer representative after seeing feedback on their forecasting performance [as reported by the Nokia Senior Project Manager].*

National level: In this case, there was no need to extend the research to the national level, as both equipment and services were planned on the regional level.

9.3.3 Conclusion

A crisis is often needed to bring change about. In this case, for many people in the customer's organization, a personal crisis was that they were not able to reach their targets and get their Christmas bonuses just because Nokia could not respond to an unexpected rise in demand. It seems that after this event, the CAT was able to sell the customer the idea that it was at least partly accountable for what had happened. This, I regard as a *start* of a *Cinderella story*, the current situation being somewhere between rags and riches.

The environment in this case was perhaps easier to manage as a result of smaller volumes, low product variability, and a more cooperative customer.

Figure 44 presents an overview of demand visibility in Case Cinderella. Due to the operational mode where equipment and services were ordered in one package, customer inventory visibility is not really an issue. As was mentioned, there was an ongoing effort by Nokia to impose a collaborative ordering process on the customer, which should allow the project supplier to get anticipatory warnings of demand. Furthermore, the whole project delivery chain was planning in a more integrated manner as the customer shared its implementation plan with its subcontractors.

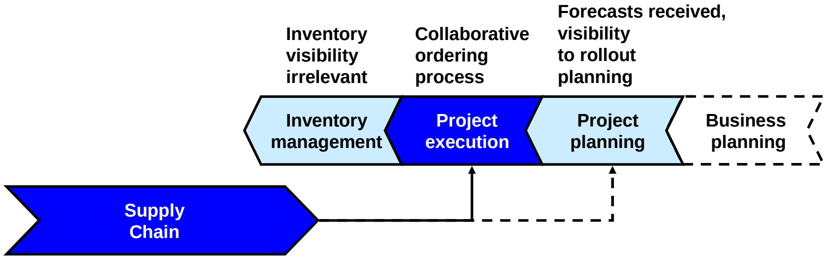

Figure 44: Demand visibility in Case Cinderella

The project rollout plans of the whole chain of actors were strongly operationally focused; the project teams of Operator, Nokia and the other project suppliers would plan for the next few months, and not much longer. As a result, no more than eight weeks of actual project planning information is used for global demand planning. In addition to a lack of interest for the longer term planning, the Nokia project execution organization does not have visibility to the customer capital expenditure plans. It is not known whether this holds true for the higher organizational levels.

This process for planning demand was at the time of research not documented, but it was recognized by the account team, the customer and supplier. Previously, the forecasts were scraped together from the regions with no official information, but recently efforts to formalize the process have been undertaken. Another important issue to be observed is that several feedback loops existed between the case company, the operator and the supplier. Feedback on demand information quality is a prerequisite for continuous development, but it also requires being able to measure the quality somewhat objectively, and so, that all parties agree what the measures are.

10 Cross-case analysis

According to Eisenhardt[268], the cross-case pattern search forces the investigators to look beyond initial impressions and see evidence through multiple lenses. One tactic to do this is to select categories or dimensions, and then look for within-group similarities coupled with inter-group differences. These dimensions can be suggested by the research problem, existing literature, empirical findings, or the researcher can simply choose some dimensions. My dimensions, and the structure for the comparison, come mainly from research questions and the empirical material.

I will start with comparing the planning context in the two cases and continue the discussion with the actual planning processes. The main empirical observations will be presented, and in order to maintain the train of thought, the practical and theoretical significance of the empirical observations will be highlighted in unison with the observations presented.

10.1 Case context

Table 10 presents the planning settings in the two cases. There were both similarities and differences between the two case environments, understanding which should be helpful in both internalizing the cases and determining the generalizability of the study. I have included those variables that I find having most explanatory force in terms of understanding the process differences or the success of planning. Many of the variables presented in the table are strongly interrelated.

For Nokia, both projects were so called telecom implementation projects meaning that NET was in a first-tier subcontracting position in the project delivery network. Both account teams were in a poor negotiating position relative to the customer mainly due to the competitive situation. The customers' strong negotiating position was emphasized even more as they did not commit to buying any specific volumes in either case. Thus, from Nokia's perspective, the operations they were running had both project-like and repetitive characteristics. Finally, the rollouts were in both cases in a mature phase, which should make them comparable in that sense.

Regarding the differences; one of the cases was researched in the UK and the other in the US. Whether this makes a difference in terms of capturing demand is hard to tell. The two cultures are quite similar, but at the same time the US is known as a hyper-competitive society which can be reflected in the attitudes toward collaborative planning and forecasting arrangements. Whatever the reason may be, the empirical evidence implies that Nokia was

[268] Eisenhardt 1989

much more intimate with the customer in the UK. The customer's internal situation and the maturity of its planning processes seemed to be a contributor of planning performance; the first case was an example of an operator struggling with change and putting little effort to planning, whereas the other operator had quite developed processes in a more static environment. Perhaps the biggest single discrepancy forging the demand planning landscape was the issue of inventory ownership; in the UK, the inventory was owned by Nokia and in the US, by the operator. As a result, services and equipment were planned in one package in the UK; on the contrary, in the US, the planning of services and equipment was separated. Finally, the size difference of these accounts was significant; large in the US and small in the UK.

Table 10: Comparison of planning context

Similarities		
Project mode	Telecom implementation	
Position in project network	First-tier subcontractor	
Customer volume commitment	No volume commitment. CATs are responding to orders rather than working against a project plan.	
Nokia sole supplier to customer	No	
Rollout maturity	Mature, min 3-4 years of rollout for customer	
Differences	**Case Tango**	**Case Cinderella**
Country	USA	UK
Customer relationship	Arm's length – Working relationship	Working relationship
Customer situation / planning processes	Turbulent / embryonic	Semi-static / developed
Inventory ownership	Customer	Nokia
What is planned?	Implementation services and equipment separately	Complete deliveries
Volumes relative to other case	Big	Small
Planning performance	Below average	Above average

Regarding the differences; one of the cases was researched in the UK and the other in the US. Whether this makes a difference in terms of capturing demand is hard to tell. The two cultures are quite similar, but at the same time the US is known as a hyper-competitive society which can be reflected in the attitudes toward collaborative planning and forecasting arrangements. Whatever the reason may be, the empirical evidence implies that Nokia was much more intimate with the customer in the UK. The customer's internal situation and the maturity of its planning processes seemed to be a contributor of planning performance; the first case was an example of an operator struggling with change and putting little effort to planning, whereas the other operator had quite developed processes in a more static environment. Perhaps the biggest single discrepancy forging the demand planning landscape was the issue of inventory ownership; in the UK, the inventory was owned by Nokia and in the US, by the operator. As a result, services and equipment were planned in one package in

the UK; on the contrary, in the US, the planning of services and equipment was separated. Finally, the size difference of these accounts was significant; large in the US and small in the UK.

Planning performance, the bottom line, refers to how successful the account team has been in planning demand measured by the company's own demand planning figures. One should be careful in drawing any assumptions of the relationship between the contextual factors listed in Table 10 and the planning performance. Evaluating such links was not the purpose of this study and the factors are presented here purely as background information for understanding the processes of capturing demand.

Observation: Despite the fact that only two cases were researched, it could be observed that the situations in the field can be highly diverse.

Research proposition: Although many contingencies could be discovered already in the two rather rich cases, a broader sample should be researched for statistical representativeness and benchmarking purposes.

10.2 Capturing demand in project delivery networks

Next, the main empirical observations and their practical and theoretical significance will be discussed. The discussion is structured around answering the empirical research questions.

Research question: In the project delivery network, where and in what form is information on future demand located? What is the quality of this information at source? To what information is there access?

The approach in the research was that the project delivery network as a whole would be considered a source of demand. It was discovered that the network viewpoint of capturing demand information was less significant than what was expected at the outset of the research. The customer was practically the only source of information in the long term and by far the most important source in the near term. The progress information provided by the other project stakeholders became more important in the near term, but the actual use of this information in demand planning was practically negligible. This observation seems to support the assumption made in the literary review that there usually is one coordinating party in any project delivery network.[269] Whoever manages the project as a whole in the delivery network, acts as a gatekeeper of demand information for all network stakeholders below the company in the project hierarchy. In the cases studied it was for the operator to choose whether demand information would be shared, and how. As this situation is quite self-evident, in terms of future academic research, it would be interesting to know whether cases exist, where companies really need to focus on several actors when collecting advance demand information, and under what situations this may occur.

[269] Hellgren et al. 1995, Nassimbeni 1998

In terms of practical significance, having a central actor in the network means that NET should focus on this key actor in further efforts to develop demand planning.

> **Observation:** In the two cases, the customer was practically the only source of demand information in the project delivery network.
>
> **Practical significance:** At NET, the customer and its planning processes should be the focus of further efforts aiming to improve demand planning instead of the broader project network.
>
> **Research proposition:** Do situations exist where demand information is significantly distributed in project networks?

The sources of information were quite expectedly various project plans, forecasts, meetings, continuous contact and rumors, and varied from organizational level to the next. The generic sources of demand information were well identified in the existing literature, including the project plan.[270] In both cases, the information generation was more frequent and on a more detailed level at the bottom of the project organization due to the extensive coordination needs. As was stated before, at this level it really was a team effort, and the triad Operator – Nokia – Service supplier basically all held the same information. The information exchange grew more formal when climbing the organization levels from market toward national, and simultaneously, the interaction frequency dropped.

Some of the information was in hard codified format in the form of plans and forecasts. Yet, much of the information used in planning is currently very tacit in nature, transferred in human interaction and stored in the heads of different individuals. Both types of information, tacit and explicit, were used in planning; if the hard numbers were inconsistent in the light of any other information the decision maker possessed, adjustments could be made. This observation should not surprise anyone, and is in line with what we know about the nature of information in general, and what demand planning and forecasting literature say about qualitative forecasting[271].

> **Observation:** Much of the information used in planning is tacit and informal in nature and the sources are diverse.

Concerning information quality at source, the two cases were as different as chalk and cheese; in case Cinderella, the customer planned quite well, in case Tango, for various reasons, the customer did not. Allegedly, there was access to the demand information sources in both cases, but in Tango, one really had to dig for the crumbs of information and still not be sure whether it is usable in the end. The impact of the customer's planning quality on the account team's ability to plan should be obvious.

In the supply chain collaboration literature, the implicit assumption has more or less been that demand information exists, and the challenge has been how to gain access to or utilize it. The literature that I reviewed does not directly tell what strategies can be implemented for

270 E.g. Lee et al. 1998; Seidmann et al. 1998; Simatupang et al. 2001; Collin 2003
271 E.g. Polanyi 1966; Nonaka et al. 1998; Crum et al. 2003

planning demand in a project where the customer cannot or will not plan its own operations, which is a clear gap to be researched further. I aim to partially address this gap in the literature with a conceptual model presented in chapter 11.2.

Observation: The planning performance of the central actor of a project delivery network, in these cases the project customer, determines to a large extent the planning performance of other project stakeholders. For instance, Operator in Case Tango was real-life evidence of being a wretched planner which forced the whole network into a reactive mode.

Observation: There is a limit to the demand information available for the account team to use.

Research proposition: What strategies can be implemented for planning demand in a situation when the customer cannot or will not plan its implementation properly?

Research proposition: How could demand planning processes be designed using the availability and quality of demand information as a starting point?

In general, it seemed that there is access to customer planning information as long as giving this information away does not require much effort from the customer. In the two cases, the customer's supply strategy seemed to be a major determinant of, not access to demand information *per se*, but the level of effort and commitment the customer was willing to put into collaboration. Yet, as the following quote shows, information exchange still eventually takes place in person-to-person interaction on all levels; good personal relationships are a crucial pre-requisite in terms of retrieving demand information. This notion is also supported by existing research.[272]

"Most of this [retrieving advance demand information] comes down to personal relationships."

– *Senior Project Manager (Case Cinderella)*

Observation: Allowing access to operational information did not seem to be a *matter of principle* for the customer in the two cases. Strong factors determining access were rather personal relationships and the customer's supply strategy among other factors determining the cost-benefit ratio[273] of collaboration as perceived by the customer.

Practical significance: As long as there is no commonly agreed process in place, it was reported, integrating people into the customer organization is a success factor for retrieving demand information. In such cases information needs to be taken in any format it may be available.

Research proposition: How can the cost-benefit ratio as perceived by different customers be improved most efficiently from NET's perspective?

272 E.g. Heikkilä 2000
273 The ratio between the costs and benefits of collaboration as perceived by the counterparty.

Any advance demand information NET received in both cases was non-binding for the customer. There were no consequences for the forecasted figures, which reportedly led also to a bias toward over-forecasting by the customer in one of the cases and to a lack of motivation to forecast.

Research question: What is the process of collecting and sharing demand information in the project delivery network? What is the flow and evolution of demand information from its origins to the final demand plans?

The processes for capturing demand are to an extent the products of their environments, which were quite different in these two cases. Trying to force the collaborative process from the UK case to the customer in the US would probably just have resulted in lost business due to relationship complications, not to mention the differences in supply chain configurations.

The process of planning demand was not documented at either account team at the time of research.

Observation: The charting of the process seemed to open eyes, increase awareness and elicit discussion.

Practical significance: Process charting exercises could be useful as a seed of development in the other account teams as well.

In both cases, the processes for collecting demand for the BTS products were quite similar. The short-term demand, two months of demand in the Tango case and three months in Cinderella, was collected bottom-up from the people also responsible for project planning. In the short-term, project planning and demand planning feed on the same information. The rest, up to 13 months of demand planning information, was collected and put together by the regional level people in the account team, mainly the Senior Project Manager responsible for the radio access network rollout, and the Account Manager. A notable difference in the two cases is the cycle time; in Case Cinderella the short-horizon planning has been separated from the long-term planning and carried out once a week. In case Tango, demand is planned on a monthly basis.

Observation: Demand planning and project rollout planning processes utilize the same information in the short term. The rollout planning information is a subset of what demand planning needs as input information.

Practical significance: Demand planning data for the short term should be derived from the project plans, and inputted only once.

Observation: In Case Cinderella the short-horizon planning has been separated from the long-term planning and carried out once a week. In case Tango, all demand is planned monthly.

By looking at the planning system formed by the three companies presented in Figure 41 and Figure 43, it looks like more information flows enter the company than exit in the form of forecasts to the supplier or feedback on customer planning. Neither does demand information possessed by the higher organizational levels flow downward, even though this kind of feedback information was in demand. The main reason for not being able to give feedback was the lack of tools to create the reports combined with traceability problems. In both cases, management adjustments were made to the plan in several steps of the process, which makes it impossible to follow the reasoning how the forecasts were created in the beginning.

Observation: In addition to the different organizations, the different organizational levels, market, regional, and national, have distinct "demand bodies of knowledge" Demand information moves bottom-up, but information on what happens on higher levels does not move back down.

Observation: The planning ability of the customer was seen improving after giving feedback on its planning performance in case Cinderella.

Research question: What are the collaborative arrangements related to demand visibility between network stakeholders?

Some degree of customer collaboration characterized both cases, which is understandable considering the complex and information-intensive transaction. Yet, in Case Cinderella, the situation in terms of collaboration was more mature. Figure 45 provides an overview of the major formal collaborative arrangements.

- *Information sharing* took place, both formally, and in informal interaction, in both cases. In the UK though, the processes for information collection from the customer, and for its processing and sharing were more formal compared to the US. Moreover, in the UK-case, the account team had full visibility to the customer project rollout plan.

- An example of *logistics synchronization* is the emergence of a collaborative ordering process in the UK account; this idea has though been difficult to push to the customer as no real benefits are realized from the buyer's perspective.

- Feedback on forecasts quality in Case Cinderella was seen as the beginning of *collective learning*.

- In the end though, none of these efforts worked too well as the customer was not motivated to play along, and *aligning incentives* seems to be a very difficult task. An example, part of the collaborative ordering process was, the UK account team trying to impose longer lead times for non-forecasted orders.

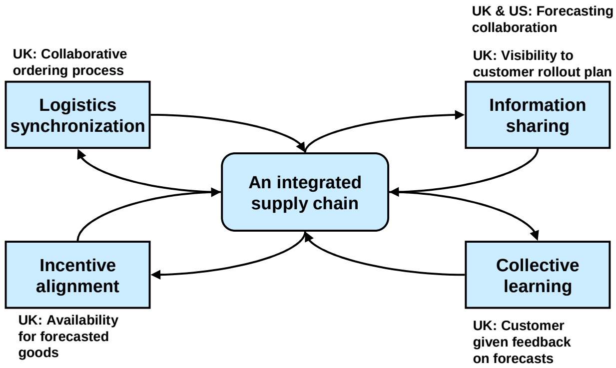

Figure 45: Overview of collaborative arrangements in the cases[274]

Generally speaking, the main argument of the supply chain management literature seems to apply in both cases; as companies become more efficient, the biggest gains are to be found outside the walls of the organization. For instance, the problem of separate forecasts was observable. Basically, the customer, NET and the service supplier all try separately to predict the same thing: how many base station deployments of a certain type will be carried out in the near future.

In my opinion, to improve information flows in projects, companies in coordinating roles in the project delivery network should look into ways of sharing the centralized information they possess with the rest of the network. With recent technology development, this is not a technical challenge. Rather, the complexity and uniqueness of projects make finding a common language between companies more difficult and discontinuity in projects makes a decent reason or excuse for not implementing improvements.

[274] Modified from Simatupang et al. 2001

11 Discussion and conclusions

In this chapter, I will discuss the significance of the results in a more integrative fashion than in the preceding chapter. What I do not intend to do is re-process the already discussed results and suggestions.

This chapter opens with reliability and validity analysis, after which a model constructed for summarizing the focal themes of the study will be introduced. The chapter will end with conclusions which summarize the research.

11.1 Reliability and validity analysis

The quality of the research is typically evaluated using two measures: reliability and validity. *Reliability* is the extent to which an experiment, test, or any measuring procedure yields the same result on repeated trials under similar conditions. It is thus a measure of repeatability of the research. *Validity*, on the other hand, is concerned with the study's success at measuring what the researchers set out to measure.[275]

11.1.1 On improving reliability and validity in case research

Yin[276] has presented a more elaborate frame of reference for assessing validity of case studies, including respective tactics to improve research quality. The frame, consisting of four tests, is presented in Table 11. I will use Yin’s frame as a basis for discussing the reliability and validity of my study.

Table 11: Case study tactics for four design tests[277]

Tests	Case study tactic
Construct validity	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report
Internal validity	Do pattern-matching Do explanation building Do time-series analysis
External validity	Use replication logic in multiple-case studies
Reliability	Use case study protocol Develop case study data base

[275] E.g. Kauranen et al. 1992, p.34
[276] Yin 1994, pp.33-34
[277] Yin 1994, pp.33-34, modified from

In Yin's work, *Construct validity* refers to establishing correct operational measures for the concepts studied. The issue of construct validity can be tackled by using multiple sources of evidence and establishing chains of evidence while collecting the data, so that the reader can understand how the results have been achieved. Also, construct validity can be increased through having the key informants review the case study reports. In my research, construct validity was protected by using several sources of evidence including observation, hard planning material and figures, interviews and workshops. The key informants also had the opportunity to comment the results, as have had the representatives of the NET supply organization. The chain of evidence - how data is collected, stored and analyzed - is presented in chapter 1.5.2. The fact that all interviews could not be taped and transcribed may have a biasing effect on the results.

Internal validity, according to Yin, is the extent to which the designers of a study have taken into account alternative explanations for any causal relationships they explore. Yet, internal validity is an applicable measure only for explanatory or causal studies, so its evaluation is omitted in this exploratory research.

External validity refers to the extent to which the results of a study are generalizable. According to Yin, case studies rely on analytical generalization rather than statistical generalization. This means that the investigator is striving to generalize a particular set of results to some broader theory. With respect to external validity, this research draws analytical generalizations mainly to project management, demand planning and supply chain management research. The value of this research is in explaining and exploring uncharted terrain, and there is no ambition, or possibility, to generalize the results across cases.

Reliability represents the repeatability of the study. Yin highlights the significance of proper documentation of the research in increasing the reliability. [278] This is something that I have tried to be quite thorough with. The research framework developed during the study can be quite easily re-applied by anyone.

When interpreting the results, one should keep in mind that the scope of the study has been narrowed down quite a lot. Only planning of base station products was within the scope of the research. If the planning process in the account team would be designed for the needs of base stations only, it would probably be sub-optimization from the perspective of the whole.

11.1.2 Potential sources of error in a field study

I believe that the greatest potential sources of error in this research come from the field. According to McKinnon[279], there are four general threats to validity and reliability in a field study: observer-caused effects, observer bias, data access limitations, and the complexities and limitations of the human mind.

[278] Yin 1994, p.36
[279] McKinnon 1998

Observer-caused effects may occur when the role attributed to the researcher by the participants is such that it causes them to alter their natural behavior. According to McKinnon, this can occur for instance if the researcher is seen as a "management spy". I personally believe observer-caused effects should not be a major source of error because of the open atmosphere prevalent in the research and the student-researcher role.

Observer bias means a "*tendency to observe the phenomenon in a manner that differs from the 'true' observation in some consistent fashion."* Bias of this type is typically associated with political and philosophical views, background experiences and such. In this research, a big source of potential error, not necessarily bias, is rather the lack of background experience; for instance, understanding the industry logic better would have probably yielded in higher-quality inferences.

McKinnon argues that two types of *data access limitations* can be experienced in the field. Firstly, the researcher is only on site for a limited period of time and cannot observe what happened before he arrives or he leaves. Moreover, the time period the researcher spends on the site may prove to be an uncharacteristic one, and the phenomenon researched is observed in an abnormal state. The second limitation is that imposed by the research hosts; it is possible that the access to certain documents, events or people is limited. For this research, the first limitation, that of time and role of abnormal conditions, is a larger potential source of error. For instance, both field studies were done in the summer, which is a quieter time in terms of business. All the material I thought of asking for, I received.

What McKinnon refers with *complexities and limitations of the human mind* is that the statements subjects make may not be able to be taken at face value. The subject may consciously seek to mislead or deceive the researcher, or be honest and accurate, but as we all are, be influenced by natural human tendencies and fallibilities. I have no reason to believe that this source of error would be of greater magnitude than in other similar research.

In summary, I feel that in terms of being able to describe the processes correctly, the results of the empirical research are quite valid. In terms of understanding the context, they are less valid.

11.2 Proposed framework

An interesting empirical observation was that the planning performance of the central actor in a project delivery network determines to a large extent the planning performance of other project stakeholders. As nothing could be found in the literature on what strategies can be implemented for planning demand in a situation when the customer cannot or will not plan its implementation properly, I decided to construct a model to answer this question. The model also accommodates the question of access: just because demand information is available to the buyer does not mean that the buyer is willing or capable to transfer it to the supplier. A managerial framework is proposed for:

- assessing the utilization potential of demand information in projects in different demand visibility scenarios, and
- identifying an appropriate high-level strategy for managing the contingencies taking the utilization potential of demand information as a starting point.

The utility of the model comes from being able to segment and manage different segments of projects. Taking demand information as a starting point, the model addresses the question whether to focus on supply chain responsiveness or demand chain improvements for a particular project. Thus, the model summarizes the focal themes of this study, demand visibility and demand-supply chain differentiation, into one model.

The model presented in Figure 46 categorizes demand situations based on two dimensions; the vertical axis depicts to what degree a project supplier has access to demand at a given moment in time, and the horizontal one to what degree advance demand information exists in the first place. When these two dimensions are combined, four possible scenarios emerge. The utilization potential of the information in the four scenarios is different as are the appropriate approaches to manage each scenario. The text in the model's quadrants describes the *utilization potential of the demand information captured by the supplier in the buyer-supplier relationship*, and the arrows below the matrix illustrate the appropriate high-level strategy for managing the demand supply chain in the different scenarios. Moreover, the two cases have been positioned in the matrix.

The first insight the model should provide is the conceptual separation of demand information availability, and the access to the available demand information. A no-brainer is that both availability and access are needed in order to benefit from the information. It is assumed, that improving the quality of the input information is more costly and tricky for the supplier than improving access to it.

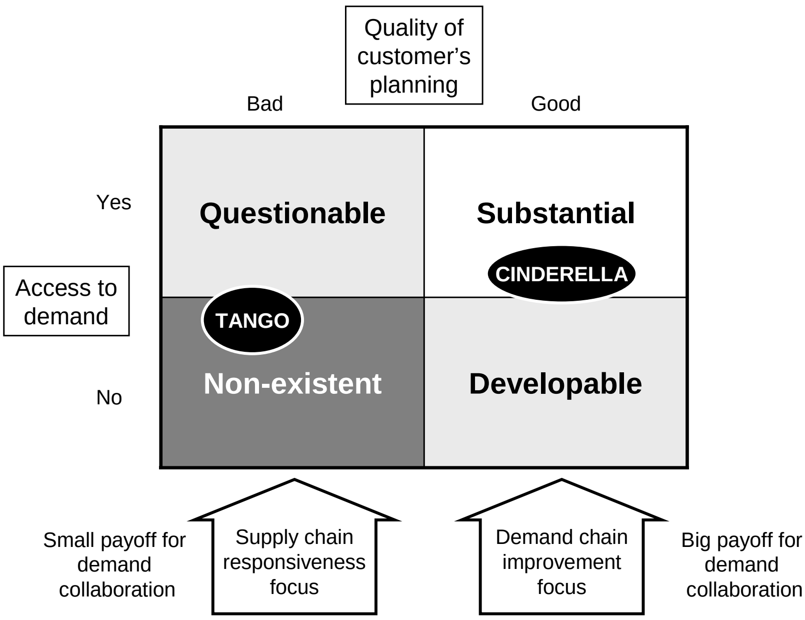

Figure 46: Strategies to cope with different demand access - availability scenarios

The four quadrants and the appropriate strategies are described in more detail below:

- ► It is reasonable to presume that the current potential for utilization is *Non-existent* if there is no access to bad-to-mediocre quality demand information. In cases like these, the resources that are invested in capturing demand are most likely wasted and a better option might be creating a more responsive supply chain. Educating the project customer how to plan is one option, but probably a long-shot. Yet, this kind of a situation is probably quite typical in the beginning of a project, so one should not make too drastic conclusions based on static assumptions alone.

- ► The potential is *Questionable*, when the situation is favorable in terms of access but the customer's planning processes produce demand information of questionable quality for one reason or another. Also in this situation, the expected benefits of demand collaboration are small due to the input quality of information, and the focus should in most cases be in developing supply chain responsiveness. Yet, as there currently is access to demand, an investment in demand collaboration may be justifiable if there is hope that the customer will learn how to plan in the course of time.

- ► The potential is *Developable* if there is plenty of demand information available to capture, but currently there is no access to that demand. In contrast to questionable, the quadrant has been termed developable as bigger payoffs can be expected faster from demand collaboration.

- ► The utilization potential is *Substantial* if access exists and there is good quality demand information available. The appropriate strategy is to maintain the position and to try to make the best use of the advance demand information for achieving operational efficiencies.

The model should be applied with caution as it is in many ways a heavy simplification of reality. Essentially, it presents a snapshot in time and does not consider individual customer requirements, such as lead time needs.

When applied to the model, it can be seen that the two cases are radically different in the horizontal dimension; the customer in Tango was a lousy planner. In terms of access, the cases were more similar. What the model would recommend in case Tango is to focus on developing a responsive supply chain and in the case of Cinderella, to focus on demand collaboration. To validate the model, more cases should be researched to see if the choice of dimensions is appropriate.

11.3 Conclusion

In dynamic businesses of high internal and external complexity, uncertainty, and abrupt shifts, it is important to have processes in place to maintain a proper balance between demand and supply. In such turbulent environments, the ability to capture end-user demand and to physically respond to that demand in a timely manner has become a matter of survival for companies. Against this background, it is of high practical importance to understand the potential, the challenges, and the actual processes of demand collection at the customer interface. The study addresses this need, probably among one of the first.

This work played a probing role in a newly founded two-year development program for simplifying demand planning at Nokia Networks. Being in the front-end of this long-term development effort, the purpose of the study was not to find a solution for a particular problem as such, but rather to explore and describe the situation at the customer interface. This multiple-case study was primarily exploratory, as neither the theory, nor the practical knowledge on the phenomenon at NET was sufficiently well developed to create and test hypotheses explicitly. Two cases were researched.

The concern of the theoretical part of this work was to answer the question: ”**How can advance demand information be captured from project delivery networks for demand supply planning?”** The empirical part of the research described how demand information *is* being captured from project delivery networks in two telecommunications infrastructure projects.

The main goal of this research was to reveal how advance demand information is captured in two telecommunications infrastructure implementation projects. A systematic framework for mapping and visualizing the process was developed for this purpose. The analysis framework has already at the time of writing the work been used to chart processes in additional customer account teams, and should be generally applicable to other semi-repetitive project delivery environments as well.

The two rich case descriptions created during the research process are undoubtedly the most significant practical, and theoretical, contribution of the research. As special attention was given to describing the case context, the reader is given the opportunity to draw his or her own conclusions in addition to those provided by the author. The practical utility of the descriptions comes from mediating an image of the situation down at the customer account team level to the NET global development organization. The descriptions can also be used for benchmarking purposes in other customer account teams. Based on the current state analysis, several propositions for development and further research were suggested.

The theoretical value of this research comes from combining ideas from supply chain management and project management and from taking a completely novel perspective on capturing demand information. In contrast to the numerous simulation studies on demand visibility, often alienated from reality, this research took a hands-in-the-dirt approach. In comparison with other empirical case studies on demand visibility, the broader network perspective and the emphasis on project demand was something new. As a result of combining theory with practice, a conceptual model was constructed to address the question how information access and availability can drive demand-supply chain design for a project.

This research resulted in a better understanding of what project networks are, and, of what demand is in project context. It was found that demand information in projects is in a concentrated form; at least in theory, component and service demand can be derived from a limited number of project plans and schedules that define the project end-product and its building process. Yet, project demand information is not usually stable due to high level of uncertainty and openness of design. Moreover, it was reasoned that a central coordinating actor is likely to exist in project networks in the delivery phase. Both the empirical findings and theory back up the notion that such an actor is a gatekeeper and a superior source of demand information.

Despite the fact that only two cases were researched, it could be observed that the situations in the field can be highly diverse. Thus, one answer to how advance demand information can be captured from project delivery networks seems to be: *It depends*. The contingency argument in projects is always strong due to projects' uniqueness in terms of the end product, local institutional settings, project network build-up, supply chain configuration, the customer-supplier relationship, and the competitive situation, to mention just a few empirically grounded examples.

Despite the differences in the cases, also patterns were identified. For instance, it seems that the overarching hurdle or enabler for any demand collaboration is that of incentive alignment between partners. The key to capturing advance demand information, according to both the literary review and empirical evidence, is to be able to identify and implement win-win configurations between supply chain members.

In the end, it must be kept in mind, that achieving demand visibility is not an end in itself. When facing unpredictable demand, companies need to evaluate the soundness of improving the demand part of the demand supply chain, where the major challenges are improving demand visibility and planning, or to strive for responsiveness on the supply side.

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24. Project Manager, Atlanta, 26.7.2005, USA.
25. Project Controller, 27.7.2005, USA.

Appendices

Appendix 1: Case Tango - meetings and communication

	Present	Frequency	Discussions and decisions
Project manager Meeting	**Nokia:** Project Manager **Operator:** Project Manager	Weekly, every Monday	This meeting is a project scheduling meeting, where the customer typically presents the work to be done for the following two weeks. The first week of is frozen and the second week a forecast. Usually the customer at this level does not have a good view what will be after these two weeks.
Channel meeting	**Nokia:** Market-level project staff **Operator:** Market-level project staff	Weekly, every Wednesday	Nokia is participating in an customer-hosted meeting where the results of customer-made blocking study published each week are discussed. Nokia does not typically actively take part in the discussion but listens to the results. Some indication on when and where new sites will be built can be retrieved maximum 30-40 days into the future.
New site build meeting	**Operator, Nokia, General contractor and fixed-line connection provider:** Implementation level managers from all companies	Weekly, every Thursday	In this meeting, the different project implementation stakeholders sit down and discuss the sites for the month to come. In a typical meeting, Operator presents issues related to zoning and leases, General contractor tells what is going on with construction and power. In this meeting, NET tries to nail down a date when the site is ready for Nokia. At the best, the information is trustworthy two to three weeks into the future. Generally, no other direct contact with General contractor exist.
Supplier meeting	**Nokia:** Project manager **Service supplier:** Project manager	Weekly, every Monday	Suppliers receive information on capacity needs on a weekly basis in rather non-formal form. They only get a one-to-two-week forecast of what will happen, but, basically they have the same information on future service demand as the Nokia. Also in these meetings, what has happened during previous weeks is discussed.
Program review meeting	**Nokia:** Core and RAN Project Managers, Senior Project Manager **Operator:** Respective people	Monthly	In this meeting, Regional level people discuss Market-level issues. This meeting deals mainly with operational topics, such as quality problems and progress tracking. It is always part of the agenda that stakeholders show their plans and discuss upcoming business and programs.
Executive review meeting	**Nokia:** Regional Vice President, Account Manager, Regional Ops, Sales **Operator:** Respective people	Quarterly	This is another meeting for region-level people to discuss market level issues. Similar issues are discussed as in the Program Review Meeting, except for that the people attending are more senior. Progress and forecasting is reviewed. Such meeting exists for each market.
Regional customer vice president meeting	-	Monthly	-
Ad-hoc meetings, event management, boardroom talk	**Nokia:** N/A **Operator:** N/A	N/A	The different types of ad-hoc meetings and conversations that account management participates in with the customer were seen as an important source of demand information. Often these meetings are organized because some particular event has occurred.
Regional management review	**Nokia:** A mix of the following roles are present: Regional Vice President, Account Director, Account Manager, Account Controller, Project Director, Care Director	Monthly	This is a regional internal meeting. The purpose of the meeting is to review the LE and volume plan within the region. In the meeting, the numbers in Nelle sheets prepared by the Account Controller are massaged if necessary based on management input. Changes are often made. This plan is further reviewed by the national / CBT level.
Regional / CBT LE review	**Nokia / Region:** Same people as in the Regional Management Review **Nokia / CBT:** Sales directors, CBT Controller, Area Controller,…	Monthly	This is a meeting between the national / CBT level and regional level. The regional LE is being reviewed by the CBT people. Changes in LE are often made.
Balancing meeting	**Nokia:** 5-6 Nokia people; CBT Controller, Sales directors, Area planning process owner, Logistics.	Monthly, although sometimes there are two meetings at the end of the month.	In this national-level meeting equipment needs derived from regional service forecasts are consolidated and balanced against any information (details unknown) received from the customer's national organization. The purpose of the meeting is to get the forecast balanced, so that the national level forecast is in sync with Operator national level planning. Nokia has zero visibility to customer inventory, but some forecast information is received from the customer; information is received for 6 months into the future and out of this 6 months 3 are quite reliable. The first 6 months of information is balanced and the rest is based on what the regions predict. The meetings take roughly 2 hours, and if adjustments are done, they are usually done downwards.

Appendix 2: Case Tango - plans and forecasts

	General description	Planning horizon	Planning cycle	Bucket	Created by	Perceived quality	Stored in
Market-level forecast	This is a Nokia-made market-level forecast on the amount of services, by service type, bought by the customer in the coming 3 months. The forecast states how many expansions and new builds will be produced each week and what are the related service requirements. Equipment is not planned. This forecast creates the basis for BTS demand planning. The market-level forecast has some overlap with Rollo, although the Project Manager needs to plan the services on a bit more detailed level in Nelle. (One of the PM's complaints is the duplication of effort required for both tools.)	Rolling 3 months	Monthly	Week	Project Manager / Nokia Market	The PM's can predict about 2 weeks into the future with reasonable accuracy. After month it is a wild guess. Quality of plan is mainly based on customer's planning ability.	Nelle-sheet
Volume rollout plan	Rollout planning is conducted in order to be able to plan and control the BTS rollout. Continuous rollout planning is carried out in Rollo on the Market level. The planning is done on volume level, no nominals. The plan is drawn using basically the same information as for the market-level forecast.	6 months baseline, forecasting done with varying ambition level	Depends	Week	Project Manager / Nokia Market	Rollout plan quality based on the same assumptions as the market-level forecast.	Rollo
Regional customer BTS forecast	The customer collects its BTS demand from its markets and combines this information to a regional forecast for Nokia. The purpose of this forecast is to help Nokia do its own forecasting. This forecast serves as one starting point for the AM's part of the BTS forecast (3-13 months).	3-8 months depending on market	Quarterly	Month	Operator / Regional level	The quality depends much on which market it comes from. Some customer markets put more energy into forecasting.	Excel-sheet
Regional BTS Forecast	This forecast includes demand for BTSs in the region. The level of detail is the same as in market level plans; site services per type and some extra detail. The aggregation for the first three months is done by the SPM and after the 3-month horizon, the forecast is drawn by the account manager.	Rolling 13 months	Monthly	Week	Together by the SPM and AM	Based on market level information and the adjustments the PM and AM may do.	Nelle-sheet
Regional Combined Plan	The combined plan is the first draft of the CAT LE. In this plan, the different demands from BTS, core, care and the Carolinas project are combined.	Rolling 13 months	Monthly	Week	CAT Controller	Depends also on other aspects than BTS forecasts	Nelle
Regional equipment forecast	Each region derives from its services planning the corresponding material requirements using dummy items. At the national level, summary reports of the forecasts for the balancing meeting are created. The forecast sheet breaks service demand into material needs based on the service forecast and and an estimation of the split between outdoor and indoor and the 850 and 1900 frequency areas. The sheet was taken into use after moving into EPL mode approximately 2 months ago.	Rolling 13 months	Monthly	Month	Nokia Regional	Unknown, as no feedback received	Excel-sheet
National level customer information	This box depicts information on Operator national level equipment needs that sales directors bring into the balancing meeting. The information is used in evaluating and adjusting the regional forecasts. Until now, the information and its collection has been quite informal in nature. The first official customer forecasting meeting was held in June and the first official Operator forecast will be received this in the first week of August. The customer gives information to about 6 months into the future, out of which 3 months is reliable.	?	Monthly	Month	?	?	?
Combined equipment forecast	A *report* that is created for national level balancing of the equipment volumes. The report shows the aggregated volumes from the regions; number of radios, cabinets and so forth. The total what is planned to be delivered. Created in EV.	13 months	Monthly	Month	Nokia National	Based on Nelle data	N/A
Services LE	CAT Services LE is the regional level 13 month latest estimate for implementation services demand. 1-3 months of the information is based on market- level forecasts and the rest on AM's information.	Rolling 13 months	Monthly	Week	Nokia Regional	Based on Nelle data	Nelle
Equipment LE	CBT equipment LE is the national level 13 month latest estimate for bulk equipment. 0-6 months of the information is based on balancing and after this on regional estimates.	Rolling 13 months	Monhtly	Week	Nokia National	Based on Nelle data	Nelle

Appendix 3: Case Cinderella - meetings and communication

	Present	Frequency	Discussions and decisions
Scheduling meeting aka. Weekly vendor meeting	**Nokia:** Project Managers **Customer:** Network deployment managers, sometimes rollout coordinators, transmission planning people. **Service supplier:** Respective supplier representative(s)	Weekly	In the scheduling meeting, the customer, Nokia and supplier together decide on the detailed tasks to be done during the following week and less detailed plans for later weeks. The planning is done on a nominal level. The site authorization take place here and the meeting is run by the customer.
Deployment review meeting	**Nokia:** RAN Project Manager, 2 Regional PMs, Account Logistics Manager **Customer:** Network deployment managers (a NDM looks after implementation in a market or zone.)	Monthly	The DRM is mainly a status meeting in which issues like progress, aborted activities, metrics fault analysis, aborts and other operational issues are presented to the customer. Nokia presents, and their view on what will happen will be commented and questions asked. In the review meeting only issues for the coming 3 months are discussed, so the focus is on more short-term issues than in Regional management meeting.
Supplier meeting	**Nokia:** Project Manager **Supplier:** Project Manager and others	Monthly	Similar to DRM with customers. In this meeting, Nokia gives feedback on performance, metrics and quality. Also, the customer long-term forecast that has been inputted into Rollo is communicated using Executive Viewer. If there are important changes, these will of course be released earlier.
Continuous contact	**Nokia, Customer, Supplier**	N/A	In addition to the formal meetings, continuous contact is kept to both customer and supplier to handle the ever changing short-term scheduling requirements. Actually, the market-level project engineers are co-located with the customer network deployment people.
Regional management meeting	**Nokia:** Project Director, Project Manager, Account Logistics Manager **Customer:** Implementation manager of total project and the 3 regional managers	Monthly	RMM is a problem solving meeting of a higher profile than the other meetings. It is the only meeting where the long-term forecast is discussed and in general the issues that are handled are more commercial than operational in nature. These can be future purchase orders, change requests and such. The minutes are handled by the customer. These people are the bosses of those who sit in the DRM meeting.
Weekly BTS short-horizon planning meeting	**Nokia:** Project Director or RAN Project Manager, Account Logistics Manager, Account Controller	Weekly, except cut-off week	Demand planning is done on volume and configuration level. In essence this plan includes exactly the same information as the Frank and Shaun spreadsheet; adjustments to the short horizon are seldom made. Planning is done only 8 weeks on configuration level of detail. After 8 weeks, a simple averaging is done based on history, and the planning level is only volumes. Some fiddling with numbers is needed to meet CBT targets, which was seen as a problem. Separate meetings like this exist for Core and RAN. Duration 1,5 hours with a goal of one hour.
Monthly CAT latest estimate (LE) meeting	**Nokia:** Account Director, Account Manager, Project Director, Project Manager, Accout Controller	Monthly	Not witnessed. Probably the same as in the BTS short-horizon planning meeting, but with more suits involved in the process. Duration approximately 2 hours.

Appendix 4: Case Cinderella - plans and forecasts

	General description	Planning horizon	Planning cycle	Bucket	Created by	Perceived quality	Stored in
Customer nominal rollout plan	The customer has to plan for the whole from site acquisition to integration. The customer rollout plan is used as one input for nominal level planning in the markets. The customer rollout plan is done on nominal level in contrast to volume level. Thus, each planned entity already has an earmarked site.	For BTS, the customer plans some 4 months in advance with rapidly deteriorating quality as the time horizon gets longer. The customer rollout organization is mostly concerned of getting the near term right (~8weeks).	Unknown	Unknown	Customer	OK in the short term. Oftentimes happens that the database is not updated by the customer.	NetOne, the customer rollout planning database. There is visibility to this tool.
Nominal short-term schedules	This is a pure project execution plan in which actual work tasks are planned on a very detailed level. For each coming week these plans are created in a customer-led scheduling meeting after which changes are updated freely. It is nominal, that is equipment is earmarked to certain site locations, it contains exact configurations, responsibilities and such.	Current + 1 week	Weekly, combined with continuous updates when project constraints found.	Day, even hour	Nokia project engineers in markets	OK, as created for the short-term.	Excel
Market-level nominal rollout plan	This plan is for longer term market-level rollout planning purposes. The plan is largely based on information coming from the customer rollout planning database. It is nominal in nature, but with less detail than the short-term schedule.	Varies based on visibility at the given moment. Active rollout planning is done for the coming 8 weeks.	Weekly	Week	Project Managers	Very good in the 1-4 week horizon, adequate in 5-8 week horizon, guess work after this.	Excel
Market-level volume rollout plan	For global demand planning purposes, a market-level forecast is created in the markets. The plan is derived from the market-level nominal rollout plan and the level of detail is the orderable configuration level.	Typically current + 8 weeks. The markets will not do more detailed forecasting because information is not available.	Weekly updates prior to demand planning meetings	Week	project managers (in markets)	Derived plan from nominal market-level rollout plan.	Excel, "Frank and Shaun spread-sheet"
Official customer forecast	The customer forecast is an official but non-binding medium term forecast from the customer. It has been taken into use in order to be able to communicate forecast needs in a more official way. It contains required hardware on configuration level for each market.	6 months. Current + 1 months fixed and after this variable.	Monthly	Month	Customer	OK. A historical fact until now has been that customer forecasts need to be scaled down by 25%.	Excel
Project rollout plan	Project rollout plan is a volumetric plan with volumes planned per site type per period.	Project baselines drawn 18 months out. Planned for 7-8 months.	Weekly	Week	Project-level / Project manager	Derived plan from from F&S spreadsheet.	Rollo
BTS Short horizon demand plan	The weekly demand plan as required by DO. Planning is done on volume and configuration level. In essence this plan includes exactly the same information as the Frank and Shaun spreadsheet, but with some adjustments if needed.	The practice is to plan current + 8 weeks on a detailed level and after this using historical averages (3 configurations for BTSs).	Weekly	Week	CAT controller with input from team	-	Nelle
Latest estimate	The monthly demand plan and latest estimate as required by the global organization.	Rolling 13 months.	Monthly	Month	CAT controller with input from team	-	Nelle

Appendix 5: Research introduction letter

RESEARCH BACKGROUND

The purpose of this document is to give the interviewees a brief introduction to the research exercise that will be carried out in late July 2005 by Mr. Ville Hirvonen with the help of Mr. Arthur Anonymous.

In NET, the CATs are responsible for forecasting / planning their demand based on 'best available information' for global Demand Supply Planning purposes. For Delivery Operations, it is visible what the projects have planned, but there is only a limited understanding of how planning information is retrieved, under what kind of conditions it is retrieved and what are the challenges in finding / using this information. This understanding is needed mainly for sharing best practices among projects and for improving the global Demand Supply Planning process based on knowledge rather than guesswork. This research is a first step on this path *Tango* is the second case to be researched after *Cinderella* in the UK.

RESEARCH GOAL AND SCOPE

The purpose of the research is to map and describe how rollout / demand planning is done in the Customer Account Team. Only the short / medium term planning of BTS rollouts are within the scope of the research. The main theme areas in the interviews are (exact questions will be customized for each interview):

- The planning context
    - Business environment
    - Project information: Project contract, project organization, products, volumes, logistics arrangements, history
    - Project network information: Customer, partners, other stakeholders

- Local rollout / demand planning processes (and link between those two), including the following dimensions:
    - The process: plans, planning activities (meetings), actors, roles and responsibilities, tools, and detail issues linked with planning such as aggregation, cycles, horizons, buckets and items.
    - Origins of planning /demand information, quality of information at source, flow and refinement of planning/demand information
    - Inter-company demand / project planning collaboration, demand / project plan visibility
    - Performance of the current processes, learnings and challenges

METHODOLOGY

The research will consist of interviews, observation of a demand planning meeting and analysis of planning material. At least the following roles will be interviewed: *Account Manager, Senior Project Manager, RAN Project Manager, Cost and Progress Manager, Account Controller, Account Logistics Manager.*

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