Master of Science Thesis
Department of Computer and Systems Sciences
Royal Institute of Technology, Stockholm, Sweden

Requirements for Contract Management-handling of network rollouts

- A feasibility study

Nicklas Ahlroth

This thesis corresponds to 20 weeks of full-time work.

Master of Science Thesis

Title:	Requirements for Contract Management handling of network rollouts
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In cooperation with:	ParaCell Solutions AB, Kista, Sweden
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Abstract

Defining your company´s supply chain and finding an integrated application that spans across this supply chain is a contemporary and overwhelming task. This application is found to over-bridge and integrate stakeholders and companies to facilitate quicker and more precise order fulfilment resulting in higher customer satisfaction. This thesis is written in collaboration with ParaCell Solutions AB situated in Kista, Sweden. ParaCell is a project management company that is searching for its own supply chain application in order to streamline the communication among the stakeholders in its projects. This need is the foundation of this master thesis project.

This report is the basis and starting point of a feasibility study of a complete integrated supply chain application for ParaCell. The report is focusing on the requirements of such an application and a current market analysis of applications that might be able to satisfy these requirements is presented. The roles and information flow that defines ParaCell´s supply chain will also be analysed.

The application ParaCell is searching for should, among other things, be fast, simple, accurate, in a dynamic way mirror the contract between the stakeholders and also present a clear overview over the entire project office. The market analysis in this report shows that there are applications that fulfil all ParaCell´s requirements but that these applications solely has a very wide range of features that covers functionality that lies well outside the scope of ParaCell´s supply chain application. Independently of the result of this market analysis the roles and the information flows that delimit the supply chain are fundamental characteristics of a future application. These aspects will be reviewed and presented in the In/Output section of this report.

Conclusively, in determining whether this application should be bought from the market or developed in-house, a first estimation of the effort required for an in-house development must be made. This analysis was then compared with the results of the market analysis, resulting in a recommendation that ParaCell ultimately have two options to choose between. The first option is to buy Antura Projects as a complete bundled package and customize it to ParaCell´s requirements. The second option is develop the application in-house using Input Soft AB. There are many reasons why this thesis results in a recommendation between two choices and why it cannot be decided in this report which option that is optimal for ParaCell – uncertainty of programming efficiency, highly differentiating market prices for complete bundled packages and non-specified software developing tools are just a few examples.

Examensarbete

Titel:	Requirements for Contract Management handling of network rollouts
Författare:	Nicklas Ahlroth
Fakultet:	Department of Computer and Systems Sciences Royal Institute of Technology
Handledare:	Björn Rosengren, fil.lic, Department of Computer and Systems Sciences
I samarbete med:	ParaCell Solutions AB, Kista, Sweden
Nyckelord:	Supply Chain, Supply Chain Management, Contract Management, Invoicing, Customer Satisfaction, Project Management, Input, Output, Agency Reporting, Budget Estimation, Function Point Analysis.

Sammanfattning

Att definiera ditt företags supply chain och hitta en integrerad applikation som omfattar denna supply chain är en överväldigande uppgift. Tanken med denna applikation är att den skall överbrygga och integrera intressenter och företag och underlätta och förbättra kommunikationen mellan dessa. Detta leder till en högre grad av fullbordade beställningar som levereras i tid och slutligen också högre kundnöjdhet. Detta exjobb har skrivits i samarbete med ParaCell Solutions AB i Kista. ParaCell är ett projektledningsföretag som letar efter sin egen supply chain i sin strävan efter att strömlinjeforma sin kommunikation mellan intressenterna i deras projekt. Detta behov utgör grunden för detta exjobb.

Denna rapport är startpunkten på en förstudie av en integrerad applikation för ParaCell Solutions. Rapporten fokuserar dels på kraven på en sådan applikation och dels på en marknadsanalys över applikationer som möjligtvis skulle kunna tillfredsställa dessa krav. Vilka roller och hur informationen bör flöda i denna applikation kommer också at analyseras.

Applikationen som ParaCell letar efter bör bl.a. vara snabb, enkel, korrekt uppdaterad, på ett dynamiskt sätt spegla kontraktet mellan intressenterna och också presentera en enkel översikt over den totala projektportföljen. Marknadsanalysen i denna rapport visar att det finns applikationer på marknaden som tillfredsställer ParaCells behov men att dessa enbart har en väldigt bred bas av funktionaliteter, med små möjligheter till köp av begränsade moduler, som ParaCell inte är intresserad av. Oberoende av resultatet i denna analys så är de roller och de informationsflöden som definierar ParaCells supply chain kritiska. Dessa aspekter kommer att granskas och presenteras i In/Output-kapitlet

Slutligen, för att bestämma om denna applikation bör köpas eller utvecklas så måste en första uppskattning över hur mycket det skulle kosta att utveckla denna produkt själv göras. Denna analys jämfördes sedan med marknadsanalysen, vilket resulterade i en rekommendation att ParaCell har två val. Det första valet är att applikationen köps av Antura för att sedan modifieras och anpassas efter ParaCells behov. Det andra valet är att ParaCell själva utvecklar produkten med hjälp av Input Soft AB. Det finns flera anledningar till varför denna rapport resulterar i en rekommendation mellan två val och att det inte kan bestämmas vilket av dessa val som är det optimala valet för ParaCell – osäkerhet i effektiviteten i programmeringen, varierade marknadspriser för kompletta applikationer och ospecificerade utvecklingsverktyg under programmeringen av applikationen är bara några av dem.

Preface

This thesis is the final element in the Civil Engineering program Media Technology at the Royal Institute of Technology in Stockholm, Sweden. The thesis is written at the Department of Computer and System Science at DSV in Kista, Stockholm and it comprises of 20 credits which is equivalent to 20 weeks of fulltime work. The project commenced in November 2007 and was presented at the IT-university in Kista in March 2008.

This report is written in collaboration with the telecom project management company ParaCell Solutions AB situated in Kista, Stockholm. It is a feasibility study helping ParaCell Solutions with contemporary problems using the canonical and accepted supply chain model as a foundation. This model will help to generalize the specific problems resulting in mappings, analyses and conclusions that hopefully are applicable also for other organisations. Some sections may seem organisation specific but what is important is the procedure used for finding answers and solutions to the problems presented throughout the report.

The information presented in this report is the pre-study and foundation of a specification for a software application that the people of ParaCell have to realise after this project is handed in. This application will in the end help ParaCell in achieving greater communication and retrieving more accurate and updated information about the activities that define ParaCell as an organisation. This report will help ParaCell to realise the importance of such application, how it should look and how it should be obtained. It is ultimately ParaCell´s choice to accept the recommendations stated and proceed with the realisation of this application or disregard them and solving the problems in alternative ways. Either way, I indeed wish them all good luck in the future.

Acknowledgement

I would like to take this opportunity to acknowledge all those who have supported me during this thesis project.

First of all, I would like to express my sincere gratitude to all employees at ParaCell Solutions AB for making my thesis project a special and interesting experience. Special appreciation is dedicated Rickard Anderberg and Per Assarsson that has been an exceptional support throughout this project.

Very special thanks to my supervisor Björn Rosengren, who has been a very valuable guide and mentor. I would also like to dedicate a thank you to Anders Robertsson at the Forum Library in Kista who has helped me with my literature study.

The reference group that I have had access to throughout my project has been a great support and motivation and Warren Moorgas, Anders Hellgren, Martin Björk and Frans Tivell deserve all gratitude. I would also like to mention Peter Larsson at Input Soft AB and Ulf Schubert at Mideye for helping me with input to the budget chapter.

Last but not least, the people helping me with completing my market analysis and guiding me through many applications deserve to be mentioned. Thank you to Magnus Håkansson and Erik Barrebo (IS-Tools), Geoff Bray (Andrew), Lex Barker (Andrew), Anders Norrman and Klas Englund (Primavera), Göran Husman (Sharepoint), Klas Glaumann (Projektplatsen.se), Johann Krafve (Projektspecialisten) and Mattias Andersson (Antura).

Stockholm, March 15th, 2008

Nicklas Ahlroth

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1. Introduction

This is a Master of Science Thesis Project within Media Technology at the Royal Institute of Technology in Stockholm, Sweden. The thesis project is completed within IT-Management, a minor given at the IT-University, DSV, in Kista. IT-Management consists of Systemtheory, Organisations and IT-Systems, IT-Platforms and IT-Management.

1.1. Background

The thesis project presented in this report is the result of an extensive investigation made for ParaCell Solutions AB, in this report referred to as ParaCell. ParaCell´s core business is to deliver project management services to telecom companies. ParaCell does also deliver consultant services to telecom suppliers and other telecom operating businesses. Geographically ParaCell focus their business on emerging markets, primarily Africa, Asia and South America. Emerging markets can be seen as developing foreign markets, involving greater volatility and higher risk than established markets [Soundinvesting, 2007]. Emerging markets is often a high profit market because of its above-average economic growth potential. Because of ParaCell´s extensive contact network in these emerging markets their vision is to become a leading project organisation within telecom and other fast developing sectors.

In projects carried out by ParaCell they take full responsibility for implementation and integration of mobile phone systems, such as radiobasestations, telecom switches and transmission equipment, on a mission from a local or regional customer. In these projects ParaCell´s work is to lead and coordinate and not to do the actual practical work. The value created for ParaCell´s customers is that ParaCell offers a complete interface that controls the suppliers and workers in the entire project. Instead of ParaCell´s customer contracting several different individual companies to complete a small part of the project the whole project can be outsourced to ParaCell who will take responsibility for the project and deliver it within budget and time frames. It is only the execution of the project, i.e. the project rollout that is outsourced to and handled by ParaCell. The sales process prior to the project rollout, that includes submitting offers and creating the first basic contract towards the main customer, is not handled by ParaCell. This basic contract, like any other contract, is treated in accordance with the company´s Contract Management. Contract Management is not only about offering a flexible and secure environment for contract creation but also for contract visibility, and contract control. Contract Management is suppose to give support for automated performance tracking, alerts, and reporting capabilities [Ariba Procuri, 2007]. This means that also within ParaCell the need for effective Contract Management, especially within network rollouts, is extremely important.

It is important to understand the total relationship between ParaCell and its surroundings. What are their customers and what are the normal stakeholders in their projects. When we know this we can identify our system in focus which will help us with our limitations throughout the project. ParaCell´s organisation basically looks and works like this: ParaCell´s customer, that in most cases is Ericsson AB, chooses to outsource a full, or parts of, a project to ParaCell. ParaCell´s customer is referred to as the main contractor. Before this outsourcing takes place the main contractor has already signed a contract with the end-customer. This first contract is nothing that ParaCell is interested in, but what is important is the second contract that is written between the main contractor and ParaCell. Here it is decided what ParaCell´s commitment against the main contractor is. So in this relationship the end-customer is customer to the main contractor and the main contractor is customer to ParaCell. This leads to the fact that the contract signed between the main contractor and the end-customer is outside the system of focus and the contract signed between the main contractor and ParaCell is inside the system of focus.

ParaCell then takes full responsibility to fulfil their part of the project. This includes finding resources, staffing the project etc. All the stakeholders connected to ParaCell, and employed by ParaCell, are important to ParaCell´s organisation and they will therefore be inside our system of focus. During the project execution there will be a direct contract between ParaCell and the end customer. This is to avoid using the main contractor as a middle hand. Although this communication channel is important for the execution of a project it has no contractual importance. There are no, or at least very few, milestones that are controlled by this channel and that are regulated in the contract. Since this is a contract management tool this communication will lie outside the system of focus. During the project execution there is also a substantial contact between the main contractor and the end customer. This contact is of course concerning every detail of the first basic contract and this is information that does not concern ParaCell. Any problem communicating through this channel concerning ParaCell, and their commitment to the main contractor, is of course forwarded through the channel between Ericsson and ParaCell. This means that the communication channel between the main contractor and the end customer lies outside our system of focus and the communication channel between the main contractor and ParaCell lies inside our system of focus. The situation can be explained according to Figure 1. The figure only shows the stakeholders in ParaCell´s environment that are interested in any direct information flow to manage an effective project rollout. As will be explained in Chapter 2 this thesis project is a pre study of finding an Integrated Supply Chain Application to manage the information flow between the stakeholders in the picture below. In addition to these there are of course many other people involved, everything from supplier of material to people handling shipping, that need to be informed about their assignments. These people lie outside the scope of this Integrated Supply Chain Application and they are therefore not presented in Figure 1. Also importantly, within each of the stakeholders presented in the figure there are many different roles that all have different requirements on what information they are interested in. These roles and requirements will be outlined in Chapter 4 (In/Out-put data).

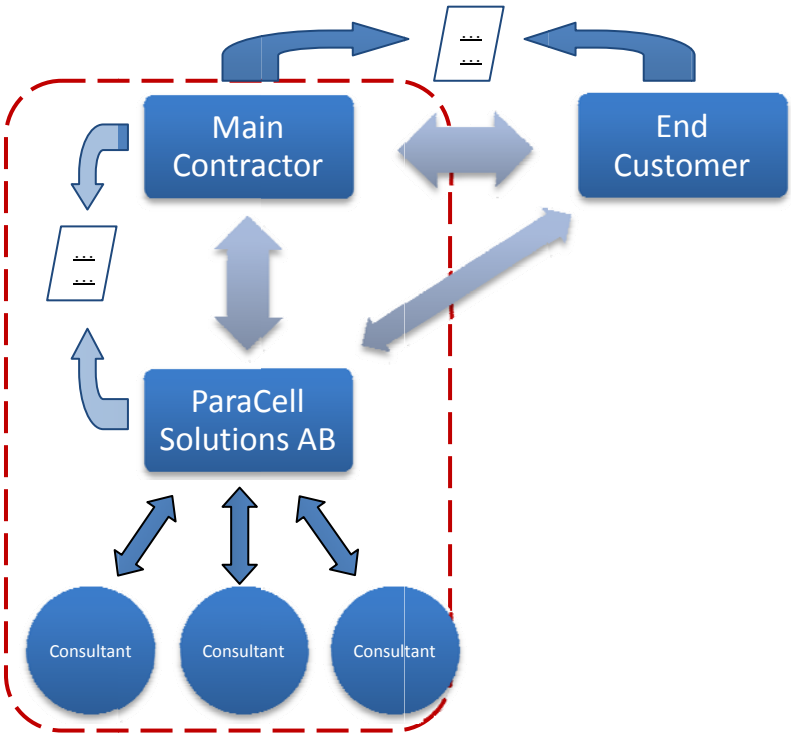

Figure 1: System in Focus

1.2. Problem Discussion

The projects carried out by ParaCell are often executed in countries that geographically are well separated from the different people involved in the project. A situation that often occurs is that the higher management of the company that ParaCell is doing the project for is situated in Stockholm whereas the regional coordination of the project is situated at one of many sites that the customer has regionally, which could be for example Africa, South America or the Middle East. In implementation projects there are also of course people involved locally that is doing the actual implementation of the necessary equipment. There is an imminent need for all these participants to have a way of following the progress of the project and have a common view over the status of the project. It is extremely important that all the people involved in the project have the same information and the same understanding about the projects current status and where it is going. In present time this is achieved by sending status reports and other documents between the participants by email. Because of the non-standardized format of these crucial documents it is very hard to maintain a homogeneous view about the status throughout the different parts of the project.

This also creates an uncertainty about where and when the different invoices can be sent. It is not unusual that a project manager sends an invoice to a supplier or a customer and that this supplier or customer either does not know why this invoice is received or simply do not agree that the work underlying this invoice is completed. Delayed invoicing is another problem that occurs when different people have different views about the status of the project. If the project manager does not have a tool where he can update himself on which deadlines and milestones that has been completed it can easily happen that this manager does not know that an invoice can be sent.

Primarily this problem leads to delayed payments which affects both ParaCell and its customers. But also, this leads to a low efficiency throughout the entire project. Because project management is ParaCell´s core business this low efficiency in its projects is affecting ParaCell as a whole. Ultimately this leads to less customer satisfaction and fewer project assignments. ParaCell is in the need of a system where the company´s business target states are realised through its IT-architecture. ParaCell´s business target state today is, among other things, to create a streamlined and efficient communication between the different participants in its projects.

This issue is closely linked to another well known, contemporary problem, namely to find your business´ supply chain. In today´s business world it is the customer that sets up terms and conditions and the companies that can best adjust to these terms are the companies that will survive. In this struggle of finding an adaptive, streamlines business that will offer exactly what the customer wants, when it wants it, Supply Chain Management (SCM) is the key. Supply Chain Management will help business to find out where the problem lies and how to fix it. The general Supply Chain model, as presented in Chapter 2 (Supply Chain), will work as a foundation of this thesis project. This general model will be tailored after ParaCell´s organisational structure and scrutinised as a method of finding the reasons to ParaCell´s problems.

1.2.1. Explicit Problem Discussion

The problem discussion can be subdivided into two main problems. The first problem is how ParaCell in the best possible way can solve the problem presented in 1.3? What IT-solution or IT-solutions will support ParaCell´s business goals in the most efficient way? After that the next step is to look into how ParaCell should act to realise and build this solution. What are the requirements for developing such a solution and how can it best be achieved?

There are a number of problem implications that need to be considered in order to find the answer to these questions. The natural start is to look at ParaCell´s *needs*. What is it exactly that ParaCell needs? To find the answer to that question I need to start by looking at ParaCell´s own organisation. How are the projects preformed and where do the different problems occur? It is also important to talk to the people having key positions in ParaCell´s projects. How they experience these problems and how would a perfect software solution look to them? These are important questions that can best be answered by ParaCell´s employees and suppliers that have key positions in projects handled by ParaCell. In addition to this, finding the voice of the customer early in the development cycle is crucial to project success, hence a crucial factor in this thesis project. As Karl Wiegers explained it: "A necessary prerequisite to designing software for use is to know what the users intend to do with it." [Wiegers, 2003] In this case it is therefore important to early identify the user of the software and include them in the development cycle. Some of these key positions are the Project Manager who will lead the project, the finance responsible who is responsible for making sure the project meets its budget and a commercially responsible who are responsible for the sales process and for securing the final payment [Assarsson, Anderberg, 2007]. During the project I will have access to, and contact with, a reference group consisting of people that all are working in one of these key positions. This reference group, and its purpose, will be presented in detail in section 1.4 (Methodology).

The next step is to look into the *current market* of software in this area. What kinds of IT-solutions are used today to handle these types of problems? Is that something that ParaCell can use or are the existing solutions tailored to each company´s specific needs? To do this one of ParaCell biggest and most important clients, Ericsson AB, will be examined closer. It is also important to look at ParaCell's own IT-architecture in order to find out if there is something that already exists and can be used. The reference group will also have a big impact on the results of this research. These two aspects will be researched comprehensively and be presented in the Chapter 3 (Market Analysis). The final step, which will constitute the second main part of the thesis, is to come up with a suggestion for a solution that ParaCell can use. The aspects taken into account in this thesis in finding this solution will be presented in chapter 1.5 (Goals).

From the general problem discussion the explicit problem is the contract signed between ParaCell and the main contractor. This contract plays a key role in the overall system in focus. What is decided in this contract is what decides how the rest of the relationships in this particular project will look. The whole system is centralised around this contract. Today ParaCell is missing tools and applications to, in a holistic perspective, follow all the different commitments that exist in the different contracts it is suppose to follow. This can create big problems, and huge fines, if contractual arrangements and milestones are not met. It is therefore important that any system developed to solve ParaCell´s problems does consider this contract. I would therefore like to pin point this contract, as shown in Figure 2 in this explicit problem discussion.

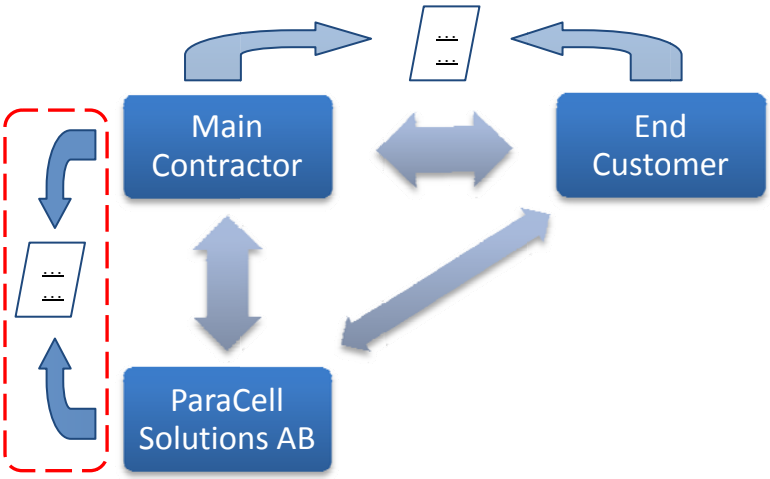

Figure 2: The contract as a key of the problem discussion

1.3. Purpose

The purpose of this thesis project is to study the general Supply Chain model, adjust it to ParaCell´s organisation, and use it to help ParaCell to identify the problems outlined in the problem discussion. Finding the problems of ParaCell´s supply chain will be the first step of creating a solution that will help them to increase their customer satisfaction and streamline their project process. This is clearly the main part of the thesis project but this research will also help ParaCell to look at possible solutions. In addition to this there are some secondary purposes that will motivate me during this project. I have taken courses in Industrial Project Management and Multi Project Management and I find the subject very interesting. It does not matter if you are studying how to run a single project or how to run a project portfolio containing fifty projects, the basics are the same. In a single project you need to know how prioritize, you need to know how to adapt to the situation and you need to know the art of advanced planning. When you are in charge of a bigger project portfolio the exact same qualities are important. What these courses do *not* teach you is how it is to work in a project, what problems that can occur and how to solve these problems. In a project there are a vast number of stakeholders that a Project Manager has to regard in order to succeed. These stakeholders, they can be everything from steering groups to finance departments to implementation managers, all have their own saying and opinions that the project manager has to handle. Except for getting knowledge about how the supply chain research can help a company, with this thesis project I get the chance to get insight into and knowledge about different problems that not only the project leaders encounter when working in projects, but also the problems that the people around him are facing.

1.4. Methodology

Different sections of this report require different methods to be solved. To address the problems described in the problem discussion the two main parts requires two different methods. The first part, the Market Analysis, will require a close contact with the users. These users exist both within ParaCell and among ParaCell´s customers and clients. In this part of the project the reference group will play an important role. The reference group that I will have access to during this project constitutes as follow:

- **Rickard Anderberg**, ParaCell Solutions AB
  Position: Sales Manager
  Role: Account Commercially Responsible / subcontractor

- **Per Assarsson**, ParaCell Solutions AB
  Position: Operations Manager
  Role: Contract Fulfilment Responsible or Project Manager / subcontractor

- **Warren Moorgas**, Ericsson
  Position: Project Manager/Operations Manager, Ericsson Celtel Account Western region (Sierra Leone, Burkina Faso, Niger, Chad), Ericsson
  Role: Contract Fulfilment Responsible or Project Manager

- **Anders Hellgren**, Ericsson
  Position: Finance controller Ericsson Celtel account (all countries)
  Role: Finance Controller

- **Martin Björk**, Ericsson
  Position: Head of Multi Country Account (MCA) Digicel Group
  Role: Management

- **Frans Tivell**, ZTE
  Position: Operations for ZTE Northern Europe, primarily Millicom account
  Role: Contract Fulfilment Responsible or Project Manager

In the initial part of the thesis project an interview will be performed with each and every one of these people. It is essential to define what the major problem is. How would a perfect system look to them? These people will also function as tutors or mentors as they will help me and guide me in the right direction throughout the project. This reference group is very important in order for the project to succeed and their input will be highly considered and taken into deep consideration.

To gather information about budget, competence etc. that is required, which will be the second part of the project, a more literary approach must be taken. Except for Internet, theoretical knowledge about software development can be obtained from many sources. The main literary sources will be Software Requirements (2nd edition) by Karl Eugene Wiegers [Wiegers, 2003] and Rapid Development by Steve McConnell [McConnell, 1996]. The electronic sources will mainly be found through the databases INSPEC, ACM and Web of Science. These databases contain millions of reviews that have a bigger contemporary value that any literature ever found.

1.4.1. Time plan

As already mentioned this thesis will roughly be divided into two parts. Each of these parts will represent about 50% of the total project time, which is 10 weeks of full-time work.

In the first part a complete market analysis will be performed. With assistance from the reference group and other contacts a complete survey about the current problem that this thesis will handle will be made. During this analysis all the different stakeholders that need access to this tool must be identified. It is important at this stage to map what kind of information each of these people require and should have access to during a normal project. Also, what kind of operational

systems are used today to deal with these problems? To find the answer to this problem a research that stretches beyond ParaCell and its customers must be completed.

With a solution to the first problem the next step will be to create a specification to how ParaCell should go about to solve the problem. How much will it cost? How long will it take? What competences are needed? What input and output data must the software be able to handle? These are important questions that will be considered in the second part. This part will also include the creation of a flowchart that defines the key processes and activities in a standard ParaCell project. This flowchart will be the instauration of a graphical Interface and will function as a cornerstone in the creation of it.

The final result of the thesis will first be presented for ParaCell in the beginning/middle of April 2008 and then presented for the examiner in a final seminar at the Department of Computer and Systems Sciences in the middle/end of April 2008.

1.5. Goals

The goals of this thesis project are multiple and they have all emerged from the problem discussion. The overall goal of this report is to come up with a system that can be used in ParaCell´s projects to create an overview of each project that is shared among the key participants and stakeholders. This system will help project leaders, account managers, technicians etc. to have the same understanding of the status of the project which will simplify invoicing, status reporting and other key events that take place in a project. Software development is a complicated business where many different aspects apart from software engineering must be taken into account. One of these aspects is marketing. In the book "*Great Software Debates*" Alan M. Davis explains this [Davis, 2004]:

> *Students of engineering learn engineering and are rarely exposed to finance or marketing. Students of marketing learn marketing and are rarely exposed to finance or engineering. Most of us become specialists in just one area. To complicate matters, few of us meet interdisciplinary people in the workforce, so there are few roles to mimic. Yet, software product planning is critical to the development success and absolutely requires knowledge of multiple disciplines.*

This is the reason why this thesis will not focus on the pure developing skills and requirements that are needed for a final development of a system tool. This report will focus on ParaCell and its competitors and customers, it will focus on the project-process and its problems and it will focus on the system´s Input and Output data. By presenting a deep analysis of each and every of the goals presented in this chapter the report will also present a solution to ParaCell´s initial problem. The goals are presented one by one in the same order as they will be treated in the report.

1.5.1. ParaCell´s Supply Chain

The general supply chain model will be used as a foundation for this thesis. The supply chain model very much describes the essence of ParaCell´s problems. Finding a solution that can help all the participants in ParaCell´s projects to follow the project progress is the same problem as finding an integrated supply chain solution that spans over ParaCell´s entire supply chain. The initial goal of this thesis is therefore to study the general supply chain model and from that define ParaCell´s own supply chain. This supply chain will be useful in mapping of roles and information flows later in the thesis.

1.5.2. Market Analysis

To start with ParaCell´s needs and the requirements that are put on a supply chain application that satisfy these needs will be analysed. After that an analysis of ParaCell´s own IT-architecture, i.e. what software that are used today to handle the project progress, will be presented. Following that research, the current market of Contract Management network rollout project tools will be the foundation of a market/competitor analysis. The software development market is an extremely fast growing market where time is of the essence. If you want your new software to be competitive you do not have time to create something that already exists. This fact makes this Market Analysis an essential and central part of this thesis project and it corresponds to the first part of the time plan presented in chapter 1.4.1 (Time plan). This chapter will conclude in a summarisation where each application tested is matched with the requirements outlined.

1.5.3. In/Out – put data

In order to build a system tool that is useful to the organisation and widely used throughout the projects it must be constructed so that it uses the correct input and produces the correct output data. Every stage of a project starts by an activity and is completed by an activity and it is essential that this system knows what the input and output is of each of these activities. It is imminent that the different roles and stakeholders in ParaCell´s project organisation are identified and involved in the early stage of the In/Out-put analysis. The reference group will help me with this. Then the information flow through ParaCell´s supply chain must be defined. In order to be able to perform this, a schematic model of the supply chain application will be constructed. When this is known it is possible to map what kind of information each role requires and what access that role would need to an application.

1.5.4. Agency Reporting

In addition to the project progress module that will contribute with the main part of this application there will be an agency reporting module. This module will keep track of all the consultants that are working for ParaCell around the world. It will answer questions about if the consultant´s time reports are handed in, if the consultants are paid, if the Main Contractor has been invoiced etc. The scope of this module and how this module should work is analysed in the Agency Reporting chapter. This module does basically follow the same processing logic and adds no further complications or attributes to the project progress module that work as a foundation for the Market Analysis and the In/Output chapter. The information presented in these chapters is also applicable on the agency reporting module and it is therefore handled and presented separately.

1.5.5. Budget

The initial basic question is: How much does it cost to develop this kind of a project tool? There are two main approaches to this question. Should the development take place In-house or should it be outsourced? From a purely financial perspective there is a big probability that the conclusion is that this development should be outsourced. Financially, outsourcing creates a certainty due to a bigger stint of fixed costs. You sign a contract with a fixed cost for a complete product and any problems that might occur along the way are not your own concern. Outsourcing is also used as a way of achieving higher quality of your services and products. There are also a number of negative factors that need to be considered here. The obvious one is loss of control. It is impossible to have the same control over the process when the development is outsourced. This can create problems when the company wants to make sure that the final product meets all the

requirements. Also, by letting someone outside the company developing a product this product can often only for the nearest future, be used as a competitive advantage for the company. Any breakthrough will generate competence that is now public knowledge which can be used by other companies for other purposes. The aim of this thesis is to find the optimal solution for ParaCell, both from a financial and operational perspective.

Another important issue in determining a budget is what competence that is required. There are many aspects that come into play when determining the competence for a development of any kind. The roles in a system development include everything from indirect or secondary users to developers and management teams. Overlooking the customers need and insufficient user involvement is a common cause for software development failure [Wiegers, 2003]. The users therefore play an important role in a system development. Obviously the users are not the only stakeholders. It is impossible to define all the different positions in a system project but what is important is to identify the key competences that are needed for this specific project.

This chapter will result in estimations about how long it is going to take, in man-months, to develop this software application. This estimation can then be used in further estimations about cost and size of the total project.

1.5.6. Goals Summarized

The goals presented are achieved chronologically in the order presented in Figure 3.

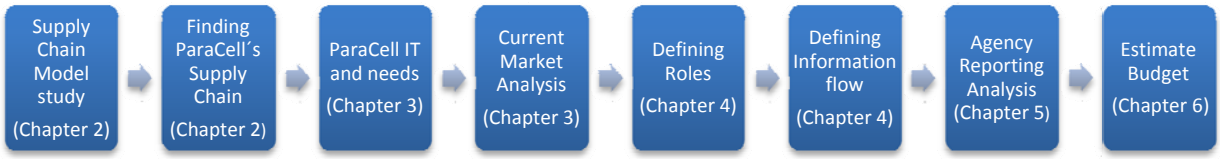

Figure 3: Goals of Thesis presented in a chronological order

1.6. Limitations

Developing new software to be used in a company´s core process, in this case in the project process, is an extensive and complicated process. There are many factors that are essential, a majority of them are treated in this report, and there are hundreds of more detailed issues that every participant needs to handle along the way. The system in focus presented in the problem discussion outlines where this thesis project draws the line in ParaCell´s environment. In addition to these limitations there are some aspects that this project will not look into. A complete project consists of a sales process, a project execution (or project rollout), and an evaluation. Both the sales process and the evaluation are outside the scope of this thesis project. The project rollout, with its feasibility study execution phase and completion stage, is what this thesis project will analyze.

During a project dozens of project reports are created. These reports are used for spreading information through the project and also to facilitate the final evaluation of the project. This is a feature that will make a project tool more comprehensive but it is not essential and will not be treated in this report. This thesis project will not look at the selection of database or programming language used for constructing the tools, two aspects that are closely linked together. The selection of programming language is very much depending on who is consolidated and it is not essential to any of the presented goals. Except for the suggestion of an Interface any graphical aspects will be outside the scope of this project.

2. Supply Chain

The business world as we know it has changed. Today it is the customer´s demand that control the supply and not the other way around. We have gone from a push market to a pull market. To start an e-business today takes ideas, money and technology. But when you got your e-business running it definitely takes supply chain management (SCM) to operate it and to meet your customer´s demands [Kalakota, Robinsson, 2001]. Today, there is an ever increasing pressure on the companies to speed up their responsiveness to meet the customer´s demands. Now it is about meeting the customer´s demands and not about reducing manufacturing costs or making the highest quality product. A successful SCM is based on satisfying your customer´s needs by effective processing and timely order fulfilment. Also for ParaCell, this issue is of essence. In order to keep your customers satisfied ParaCell need to deliver their project within the budget and on time. An important aspect in this is also the information flow. Just delivering the project on time may not be enough to keep the customers satisfied. The majority also demands to continuously be informed about the status of the project. This information flow is also important internally. In order to fulfil your assignments within the project´s time limit it is of outermost importance that all the stakeholders, i.e. project managers, key account managers, implementation managers etc, are updated about the progress. These demands are realised with an effective and coordinated supply chain strategy.

The ultimate goal of a traditional SCM is Interenterprise Integration [Kalakota, Robinsson, 2001]. This is true in most cases. In a traditional supply chain offering products emerging from raw material and passed through a chain of manufacturers and suppliers this is obvious. By integrating the different steps you improve manufacturing efficiency and distribution effectiveness. In offering a service like project management, integration is important for other reasons. In project management, the need for an effective information flow is put in the centre. System integration is crucial to secure the information flow between the different stakeholders of the project. If this integration is integration of internal and external systems or just of internal systems is unsaid at this stage. In the Market Analysis (chapter 3) this issue will be addressed. In this chapter the current market, which includes internal systems and systems used by the stakeholders close to ParaCell, will be examined. An important issue is of course if and how these systems can be used in ParaCell´s organisation.

2.1. Defining Supply Chain Management

Supply Chain Management can be seen as an over bridging process under which products and services are created, offered and delivered to the customer. Under this "umbrella process" lies purchasing, material management, warehousing etc. During the 1980s it was realised that the transportation manager could not work independently from its colleagues in purchasing, manufacturing etc and that there was an ever increasing demand for integration between these roles, and supply chain management started to grow. In the ideal world this would mean that all the different companies in the supply chain work together as one single company, with full visibility and accountability. SCM in its essence is the coordination of material, information and financial flow between all the different enterprises [Kalakota, Robinsson, 2001]. Higher demands, quicker, shorter and also more frequent order-to-ship times have become the cornerstones of SCM. There is a need for companies today to rethink their relationships with their suppliers, manufacturers and consumers. The classical view of supply chain management can be described as in Figure 4.

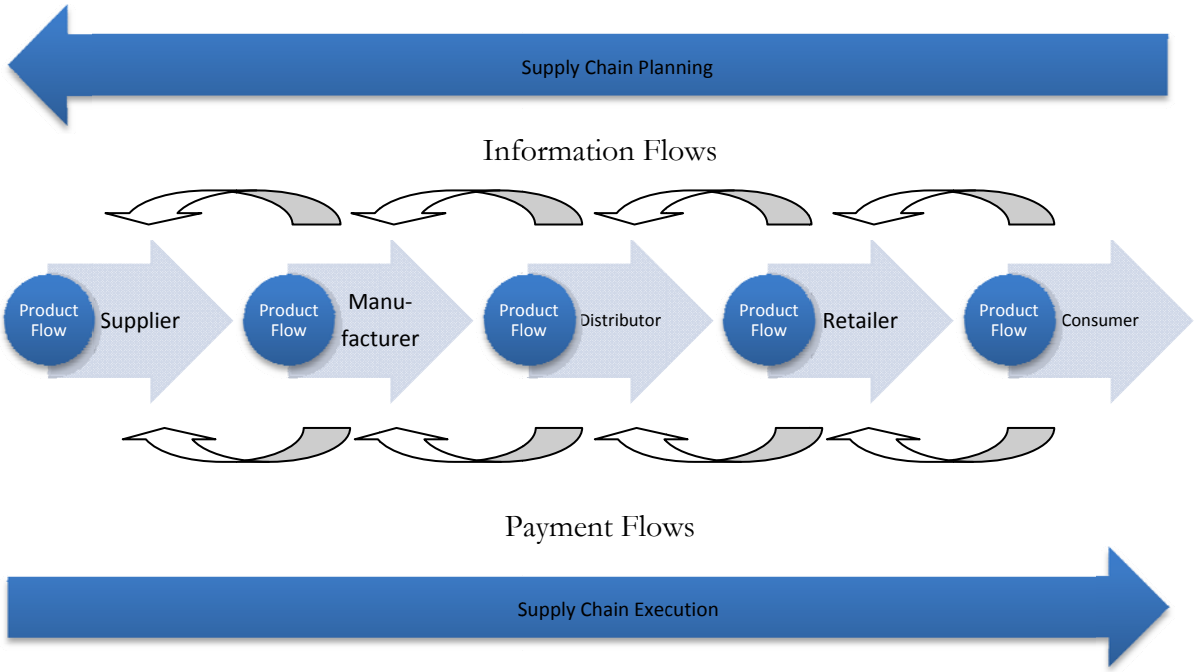

Figure 4: Classical view over Supply Chain

This supply chain also exists within ParaCell´s organisation but it looks somewhat different. In ParaCell´s organisation the whole chain of a product developing from raw material to a product on the shelf does not exist. What does exist is a process where a customer´s request is being processed with a project that will involve many different stakeholders. The supply chain planning and the supply chain execution, as the two main flows in the picture above, is more of a consecutive process where the planning mostly is conducted before the execution is even started. This is just a rough generalisation though as planning is an ever changing process that will follow the progress throughout the project. The picture above can be shaped and formed into ParaCell´s specific organisation by redefining the roles in the supply chain. We first have the customer (or consumer) that has a request that it would like to have fulfilled. This end-customer contacts a main contract holder (could be for example Ericsson AB) and a contract is signed. This main contract holder is seen as a retailer because it is the party that handles the communication with the end customer and the one that is mostly informed about its needs and requirements. This is where the main part of the planning in this supply chain is preformed. This main contract holder contacts a sub contractor (the distributor) to fulfil a part or the whole project. This subcontractor could be for instance ParaCell Solutions AB. In order to answer to the demands from the customer ParaCell needs to employ consultants (manufacturers) that lead the project and follow the instructions given by ParaCell. In the last step these consultants need to get help from all kinds of technicians (suppliers) that will do the practical work. The payment flow in this project flows according to the planning flow as in the general model. The customer pays the main contractor, who pays the subcontractor, who pays the consultants and the technicians. So far so good, the interesting part comes when we scrutinize the information flow. As a direct translation from the general model there is an information flow that flows in the same direction as the payment flow. The customer needs to inform the main contractor what he demands and that information needs to be passed on down the supply chain (the broken arrows in Figure 4). But as described in the problem description this thesis is more interested with the information flow that goes from the people doing the actual practical work on site up the chain through ParaCell, Ericsson and finally the customer. What ParaCell is in need of is a system that supports and enables the communication between all the different stakeholders in the project. In this thesis

project this is the main information flow (circled in red in Figure 5). The supply chain customized for ParaCell´s organisation is showed in Figure 5.

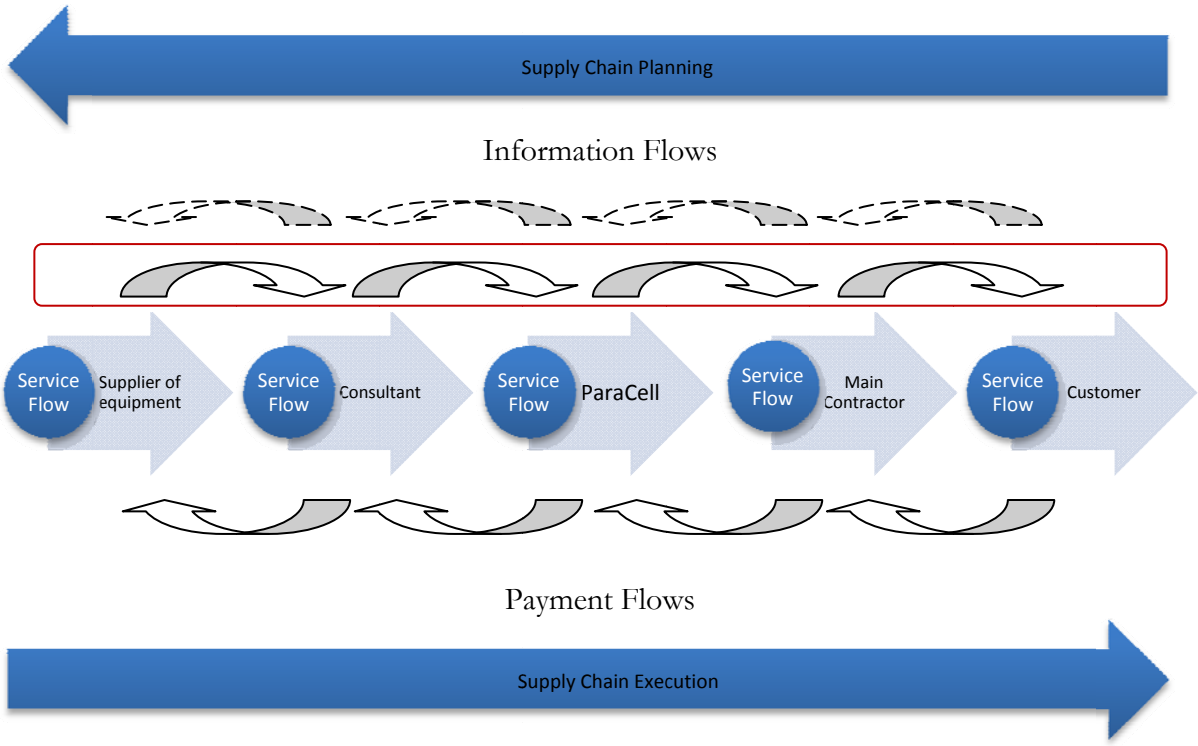

Figure 5: ParaCell´s Supply Chain

Just like in the general case a supply chain perspective is important in ParaCell´s case in order to minimize the cost of the order-to-delivery process. The difference is that the cost is not saved due to better handling of inventory goods or a more streamlined transport process but due to a more efficient communication throughout the project. To make this distinction even clearer I would like compare ParaCell´s case to a classic supply chain case. In order to get a bottle of Cool Mint mouthwash to the shelf in a store it takes more than the bottle, the contents and the truck to deliver it. The first step is to gather the eucalyptus crop from perhaps a farmer in Australia. After that the eucalyptus oil needs to be extracted and the product is shipped to the next manufacturer. Somewhere else in the world the alcohol that this mouthwash contains are being produced. This alcohol also needs to be shipped to same site as where the eucalyptus oil is at the minute. The two ingredients are then mixed and distributed to the final retailer where the customer can pick it off the shelf. In this process there are many small processes that need to be integrated and adjusted in order for the total process to work. The secondary part of this process is the information that flows through the supply chain. Everybody needs to know what to do and when to do it.

In ParaCell´s case we will focus on the supply chain in the project rollout because this is the scope of this project. More aspects come into play when for example the sales processes or the evaluation processes are included, but these are irrelevant in this case. The project rollout starts with the technician. The technician offers the service to install the equipment on site. When the consultant accepts and approves the installation of the equipment he/she can now fulfil his part of the deal and deliver it to ParaCell. ParaCell can now look into if their part of the deal is completed and they can deliver that service to the main contractor, for example Ericsson. In the final step Ericsson can inform the customer that the project has been completed and that the

equipment is installed and in operation. In this process we cannot follow a specific product through the supply chain but we have to look at the services provided. What is extremely important in this process is that all the information needed for each step of this process is communicated in the best possible way. The scope and aim of this thesis project is therefore to examine these processes and find how this communication is handled today, where the weaknesses lie and how the communication should be carried out.

2.2. Supply Chain Investments

There are many reasons why to invest into supply chain. Three basic reasons and why they are important to ParaCell are listed below [Kalakota, Robinsson, 2001].

- *Channel unpredictability.* To use new technology to enable your company to manage local, regional and global demands. This requires multiple distribution channels and coordination among them. In projects preformed by ParaCell all the participants are geographically spread out over the world and effective communication channels are vital. Without the proper communication the project stops and very quickly it is delayed.
- *Responsiveness over efficiency.* There is an ever increasing demand for more customized deliveries. No projects are identical and it is fundamental that ParaCell has the ability to adjust to the changes and be swift in the transmission between two projects. Also within one single project the prerequisites changes rapidly and the whole project organisation needs to change accordingly.
- *Companies´ willingness to accept lower margins to maintain and increase market share.* By redesigning the supply chain you can drive out unproductive work, eliminate delays and inflexibility. One of ParaCell´s biggest problem today is that the perceptions of the status of each projects varies between the stakeholders. Either the business controller does not know when an invoice can be sent out or the receiver of the invoice does not agree the underlying work has been performed. By having an effective communication between all parties many of these problems can be adjusted.

2.3. Supply Chain Requirements

It takes a lot of skills in many different levels in order to succeed with the development of a fully implemented supply chain. The reason for this is the high demands that are put on these kinds of systems. They need to be built quickly, they need to adapt well, they need to respond well and they need to incorporate business intelligence. Current trends show that companies today need better access to detailed information about supply chain execution in order to coordinate supply chain tasks [Kalakota, Robinsson, 2001]. Companies are now looking for supply chain execution applications to provide this visibility. Businesses that have maximized their internal efficiency are now working to achieve greater operational efficiencies in their relationship with their supply chain partners. It is exactly this that is happening at ParaCell. In order to achieve greater efficiency they are looking into the possibilities to increase the integration with their stakeholders.

2.3.1. Root Causes of Supply Chain Problems

Before creating this supply chain structure a proper diagnose about what the problem is must be performed. This will be done in the chapter ParaCell (3.1). If the problem is not understood there is hard to anything about it. In projects performed within ParaCell today a lot of decisions are based on out-of-date-data, inadequate information or because of poor decision making tools.

This is a typical Supply Chain issue. The next issue is the lack of integration across parties. Effective SCM requires an integrated interface than spans across the entire supply chain, in this case the entire project rollout process. ParaCell in need of an Integrated Supply Chain Application that spans across the stakeholders directly involved in ParaCell´s projects. These stakeholders were presented in Figure 1 (p. 2). They include, in addition to ParaCell´s own organisation, the main contractor, the consultants and the end-customer. As already mentioned there are many people involved outside these stakeholders, suppliers and manufacturers etc, but they will lie outside the span of this Integrated Supply Chain Application. An illustration of this is shown in Figure 6.

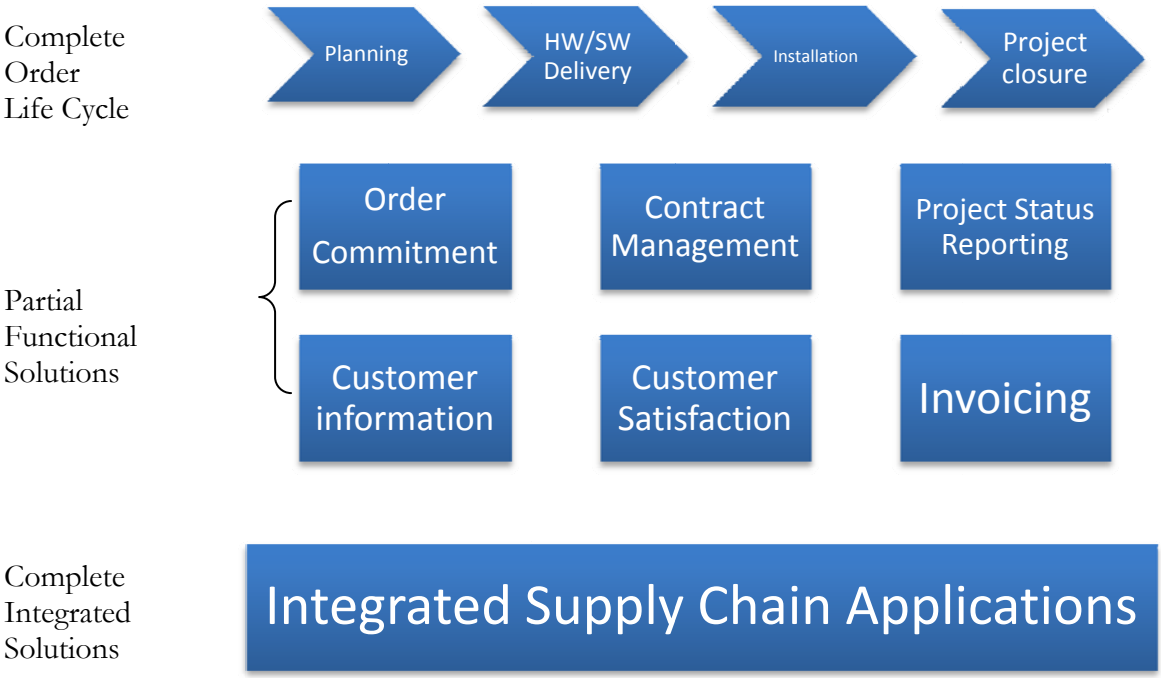

Figure 6: Scheme over an integrated Supply Chain Application

As explained earlier, Contract Management is an important centrepiece of this Supply Chain application. This means that the application must be flexible enough to mirror a contract with all its milestones and payment demands. The figure above also shows that Contract Management only is one of the aspects this application should consider. To find this application there are also other aspects and features that needs to be included and considered. The application must deal with invoicing, it must mediate customer information, it must increase customer satisfaction etc. ParaCell´s requirements, which will lead to the requirements on this application, will be analyzed in Chapter 3 (Market Analysis).

2.3.2. Fixing the Root Causes

The progress of the supply chain evolvement generally involves four stages [Kalakota, Robinsson, 2001].

1. *Enabling information sharing.* All the people involved in the supply chain process needs to have access to the same information. That does not mean that all the stakeholders need to see the *same* information but information *updated* at the same time.

2. *Create joint performance measurements systems and collaborative planning processes.* The challenges here are to develop an understanding about the costs and the benefits involved in supply chain integration.
3. *Realign work and collaborate fiercely.* In this process the borders between companies and assignments are blurred. Who does what is not as important anymore, the important thing is that it is being done.
4. *Redesign products and processes so that work becomes easier or more effective.* The major challenge is to include the entire supply chain into your own processes.

This thesis will be concentrating on the first step of this process. Enabling information sharing is an expansive task that needs a lot of preparations to succeed. The second step will also partly be treated. Estimation about development costs will help ParaCell in the initial steps of realising the results of this thesis project.

2.3.3. ParaCell and its Supply Chain

Companies must use their supply chain to anticipate demands and to act, and not react, to these demands. Marshall Fisher wrote in his article "What Is the Right Supply Chain for Your Product": "Before devising a supply chain, consider the nature of the demand for your products." We are once again back to the foundation of this thesis, to analyse ParaCell and to analyse ParaCell´s supply chain to figure out what the problem is, i.e. what are the faults and defects in its supply chain. Most profitable firms are offering the customers something that other firms do not have. Most companies, in an effort to differentiate themselves, focus their energy only on their services or products. What supply chain does is offering another way of differentiating the companies. The Integrated Supply Chain Application that ParaCell is searching for reaches far outside ParaCell´s own wall and spans over ParaCell, ParaCell´s customers and ParaCell´s consultants. This will be, in the end, a clear and comprehensible way for ParaCell to differentiate themselves.

To find the right supply chain applications for a company is an overwhelming and never ending task. It is not uncommon that companies fail in their attempts to implement a supply chain application and the main reason for that is that the planning, selection and implementation of supply chain management solutions is becoming more and more complex as the degree of technological change increases. At the same time, which further complicates the issue, the number of a company partners accelerates constantly. This again shows the importance of the Market Analysis performed during this project. The industry in this market has boomed and it can be hard for the managers to separate programs and suppliers as products of this hype from true capacity. First of all the analysis of the current market is important and it will in the best possible way prevent ParaCell management from inventing the wheel twice, but it is important that they are judicious and have a broad perspective in their judgements. In their judgements, and in their search for their own supply chain applications, there are some key issues that the managers of ParaCell should consider [Kalakota, Robinsson, 2001].

- *How do we define our supply chain problem?* What do we know about our supply chain, where is it broken and how do we fix it? In Chapter 3.1 (ParaCell) a flowchart over the project process will be shown and this will also have close connection to ParaCell´s own supply chain.
- *Do we start with a clean-slate approach or with an incremental-improvement approach?* Do we use what we have in our environment or do we start from scratch? The answers to these questions will be presented during the Market Analysis. If the current market analysis

results in a full program, or a partly functional program, then there might not be a need for a clean-slate approach.

- *Should we build or should we buy?* By making estimation about the budget and competences needed in this budget a scanning of this problem will be made.

Supply Chain Management is the key to understand what the customers want and to enable your business to offer exactly that. In order for ParaCell to succeed in finding a system that enables the communication throughout their projects they need to understand their own supply chain. When that understanding is present they can move on to the next step and start realising the result of that research.

3. Market Analysis

The purpose of this project is to perform a pre-study of an application that is actually *used*. In the evaluation process one of the main criteria will be if this thesis is referring to an application that ParaCell needs. In order to find that need this market analysis is fundamental. The road to that specification starts with an analysis about ParaCell. Here we have one main question; what is their problem?

3.1. ParaCell

To understand what the major problems in ParaCell´s organisation is we need to understand how ParaCell works in their projects. A standard telecom project can be described as the flowchart in Figure 7.

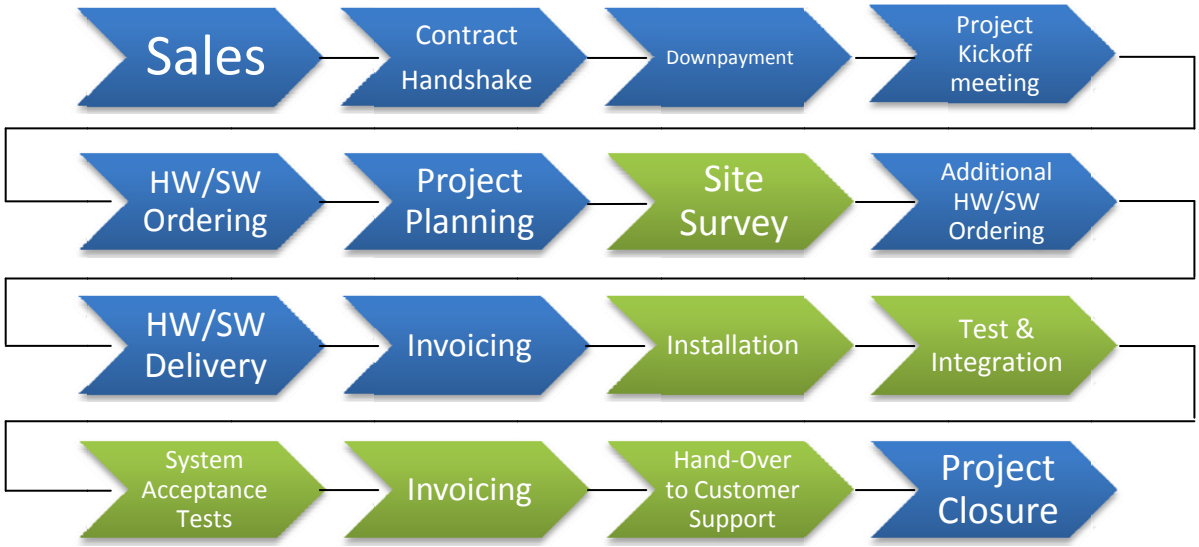

Figure 7: Flowchart over a telecom project

Envision a project that is built and started to install 150 telecom switches in Sierra Leone. This project starts with a sales process. This is where the customer expresses his/hers demands; how many stations they want, what are the stations suppose to do, requirements etc, and the project company presents its offer (prices, material, components etc.). Hopefully this process ends with a purchase order from the customer. This sales process is often controlled and managed by the Account Manager. When both parties have agreed a handshake is made and the project is handed over from the Account Manager to the Project Manager (PM). From now on all the way through the project until it is closed the PM is responsible. Normally the first down-payment is made at this stage to cover initial costs. The PM also starts off the project by having a kick off meeting where he invites all the different stakeholders in the project (often even the customers) to present the project and the people working with it. Very soon the first hardware and software ordering is made and the PM starts to plan all the details. The PM needs to find out exactly what needs to be done, when it has to be done and who is doing it. An activity that often occur parallel to the planning is the site survey. This is where you have local people in Sierra Leone that checks that the site where the equipment will be installed is prepared. During this survey you discover if any additional ordering has to be placed. Maybe there is a need for longer cables than you originally participated? At the same time as the equipment is sent the logistic manager also sends out an invoice to the customer to pay for the goods. When all the equipment has arrived in Sierra Leone it is time to install it. This is usually an activity that is supervised by the Implementation Manager. When everything is installed it is time to do the testing to prepare it for a final system acceptance

test. This is an activity where the customer approves that the PM has delivered the project and accomplished the tasks according to what was agreed in the contract. The customer checks that every single basestation is doing what it is suppose to. When the system is approved it is handed over to support, the final invoice is sent and the project is closed.

There are some key activities that require "on-site-competence". That is competence about how the country where the installation is about to take place work, it is competence about the people working there, about their visas, about their travel arrangements etc. These activities are marked as green activities in Figure 7. This is where ParaCell comes in because they have special competence about emerging markets such as Africa, South America and the Middle East. It is therefore cheaper for many companies that have projects in these regions to outsource these parts of the project. This results in that in projects that ParaCell commits itself to, the sales process, the kick off and the initial planning is already performed. In reality ParaCell is partly involved in planning because they will do many of the activities planned. They also need information about ordering and delivery of equipment so that they know when their consultants need to be in place and ready to work. These are activities that ParaCell needs to be informed about in order to do their job satisfactory but that they are not responsible for.

3.1.1. Resourcing

One of the problems within ParaCell today is the limited communication between ParaCell and the Main Contractor [Anderberg, 2007]. This causes many problems and one of them is *resourcing*. Resourcing is when ParaCell staff the project with Project Managers and consultants. They decide who is going to be in the project and when they should be on site. According to the contract written between ParaCell and the main contractor a date is set for when the installation should commence and people needs to be on site. In a case where the delivery of the hardware is delayed but ParaCell is not informed, which often happens, ParaCell sends down its consultants according to the contract but they cannot start to work until the equipment arrives. This will cost money. If ParaCell would be informed that the equipment is delayed they could hold back their consultants and save money.

3.1.2. Invoicing

Another problem that occurs because of the lack of communication and reporting opportunities is delayed *invoicing* [Anderberg, 2007]. Let's pinpoint a specific invoicing activity to statue an example of this problem. When the installation of the equipment is complete the PM contacts the Operations Manager (OM), or a higher level PM (often situated at the ParaCell main office) by phone and/or email. The PM reports that this stage of the project is complete and that an invoice can be sent. If the receiver of this message has the opportunity he or she notifies ParaCell Finance that the Main Contractor that outsourced the project to ParaCell can be invoiced. Finance then invoices the Main Contractor and then controls that the money arrives. There are a number of problems with this. Firstly, if the PM or OM that receives the first invoice message does not have the opportunity to forward the message to Finance it is easy to forget it and the process is delayed. Secondly, in this process the Main Contractor receives a contract without any previous notice. The Main Contractor has not been updated about the project progress and does not know, or does not simply agree, that the work underlying this invoice has been completed. If a disagreement occurs this further delays the process. If the Main Contractor is updated continuously about the progress he would be informed that the installation is complete and no surprises about the invoice would arise. Contract Management is extremely important in the invoicing process. In the contract it is specified when each payment should be issued and how much of the total amount that should be invoiced each time. Today it is hard to keep track of all

these deadlines and when invoicing can take place in every single project which lead to delayed invoicing and less profit for ParaCell.

3.1.3. Customer Satisfaction

ParaCell are in an imminent need of a system that will increase the *customer satisfaction*. This is a term closely linked to the Supply Chain Management discussed earlier. To keep your customer informed is to keep your customer satisfied. Or this thesis can be reversed by stating that it is hard to keep your customer satisfied if you do not have the means to keep him/her informed. This is what Supply Chain Management is about, giving your customer what it wants and exactly when it wants it. The invoicing problem above is one out of many examples. If the main contractor would be informed the invoice could be paid without questions saving time and money for the main contractor, the end-customer and ParaCell.

When a Main Contractor, this could be for instance Ericsson AB, outsources a project to ParaCell there are a lot of people, not only within the organisation below ParaCell with Project Managers and consultants, but also within Ericsson AB, that need to be informed about the progress. Also within Ericsson AB there are Operation Managers, Business Controllers, Account Managers etc. that are in need of the same information. These people have the responsibility to inform the end customer about the progress. Of course, from ParaCell´s point of view, the aim is to keep Ericsson AB happy, because they are ParaCell´s customer. But if Ericsson finds it easy to inform their customers they are happy with ParaCell´s routines which will lead to more assignments given to ParaCell. What ParaCell need is to stretch their view about who their customers are. The customer satisfaction originates in the End-customer and by keeping this End-customer satisfied, you keep Ericsson satisfied. As seen in chapter 2.3.2, enable information sharing through the entire supply chain, from the consultants doing the practical work to the end-customer ordering the work, is the first step of realising an efficient supply chain.

There are numerous examples of when this lack of information sharing is apparent. A common problem in projects is delays. It is also common that when delays occur the contractor finds it hard to explain for the customer where the problem emerged. If the correct information was shared throughout the entire project then everybody, including the customer, would be up to date about any delays. It does not matter, from a customer satisfaction point of view, who that is responsible for the delay. The important thing is that you can go back and track the reason. An honest and correct explanation for the delay will often keep the customer satisfied. Sometimes the customer has the responsibility to complete certain milestones in the project, it could be preparing the construction site for installation or clear the goods from customs for further transportation within the country where the project takes place. If the customer is not informed that all the goods are stuck in the customs and that they must be cleared from the customs for the consecutive work to commence, the customer is delaying the project itself. Even then the customer will be unsatisfied and in the end blame the delay on the contractor. It is easy to see that information sharing is not only important but necessary to keep your customer satisfied.

3.1.4. Application Requirements

In the search for ParaCell´s needs we need to go back to the integrated supply chain application discussed in Figure 6. This is the application ParaCell is looking for. We know that this application will help ParaCell to improve its information flow across the project rollout but we still don't know the requirements of this application. What does the Main Contractor, the customer and ParaCell themselves demand from this application? The application requirements have been derived from interviews with the reference group.

ParaCell themselves see this application as a *reporting tool* where each and every step along the project progress is reported by the person responsible. All the different stakeholders can then use this tool to log in and in a second see where the project is and if it is delayed or not. For example, when installation is complete the person responsible for that activity logs in reports the completion of the activity. The person responsible for the next activity is notified in best possible way that this activity is completed and that the next one can begin. According to Per Assarsson there is no need for a tool helping them with finding the right people for the projects or planning the projects. There is a need for an application that keeps ParaCell and all the stakeholders up to date about the project progress. Another thing that this application should be able to process is *documentation handling* to some extent. In projects there are many different kinds of documents that needs to be sent between the stakeholders and this often happens when something is complete and the next phase is about to commence. Since the application ParaCell needs mainly operates at these milestones it would be good if the application could handle this aspect as well. When the project planning phase is complete and the Project Manager uses the application to report this he also needs to distribute the Project Specification, The Work Breakdown Structure (WBS), the Resource Plan, the Time Plan, the budget, the risk analysis and an established Invoicing Plan to the stakeholders that need this information. It would be simple and time efficient if the Project Manager could use the application to distribute these documents at the same time as he reports the completion of the planning phase. It is important though that the application is *not* merely function as a document bank used for storing documents, but should function as a reporting tool, simplifying crucial processes like invoicing and project closure.

Three requirements on this application that has been mentioned by several reference group members but emphasized especially by Warren Moorgas are *fast, simple* and *accurate*. By fast means that it should be fast to load and fast to use. Since many of the users of this application are operating on remote locations, often with poor Internet connections, speed is of essence. The term simple means that it must be simple to use. The application needs to be so intuitive that no training or user manuals are needed to understand how to operate it. With the term accurate it is implied that the tool is continuously updated and trusted among the projects stakeholders. The information presented needs to be accurate and correct or the stakeholders will turn somewhere else for information. If the application does not fulfil these three requirements it will not be used [Moorgas, 2007]. One mean that can be used to reach these requirements is to create multiple *login interfaces*. The majority of the tools existing today allow you to see a lot of information about the project but it is hard to limit what each stakeholder can see. This result in that everybody can see everything that has been uploaded to the tool. This is not to present the information in a simple way. By creating different interfaces for the Project Manager, the customer and the Key Account Manager, each stakeholder will see the information he/she is interested in. Another mean of achieving these requirements is to have a good *overview* of the entire project office. This will help the user to fast and accurately locate and examine where the problem is and what that is wrong. Exactly how this overview should look graphically is irrelevant at this stage.

Another problem that exists among ParaCell´s customer is the *uploading and downloading times* to the local LAN. Within Ericsson for instance all the documents needed for each project is located on a LAN connected to the server placed in Sweden [Moorgas, 2007]. The uploading and downloading times to this server is very long if you are connected from Africa. This is solved by emailing today. If a large document that is stored on the LAN is needed in Africa a call is made to someone in Sweden, that person downloads the document and emails it to the correct person in Africa. Another requirement would therefore be that the application takes care of, and shorten, these loading times. All the applications investigated in the market analysis and that has short and effective loading times have been web based applications. This does not necessarily mean that an

application has to be web based in order to facilitate short loading times. An application that is web based also fulfils another important requirement. That is that the application is *easy to access*.

According to Frans Tivell, project manager at ZTE, an application dealing with ParaCell´s problems needs to have three characteristics. The first one is that it should be *built around the contract* between the main contractor and the subcontractor and keep track of all the crucial milestones presented in it. As seen earlier Contract Management is one of the key aspects in this integrated supply chain application. The second one is that you must be able to divide the application into clusters. A big percentage of all telecom projects are performed in clusters where each cluster is run like a separate project in the project. Suppose ParaCell shall install 100 switches and in the terms and condition it states that when each 20 switches are completed the customer can be invoiced 20% of the total amount. Then the application must be able to handle this and have the flexibility to be constructed after the terms of each project. Generally, because of the flexible and variable nature of telecom projects, the application must be *flexible*. It must be flexible in the way that the administrator of the application can adjust it and change it according to every project´s specific needs.

An important requirement of this application is that every reporting checkpoint needs to have a *reference*. If you have nothing to compare with the tool is useless [Tivell, 2007]. If the PM logs in and sees that the installation is complete and that the implementation manager has logged in and reported that in the tool he/she shall also at the same time see when this installation was originally due so that he can see if it was completed before or after the time limit. Every reporting made in this application must therefore be compared with a reference date and the difference between these dates should be present to the right people. This leads to the next requirement – that everything that is made in the application is *logged by user and time*. This enables the users to go back and see what that has been done, at what time and by whom.

A requirement expressed by ParaCell´s own personnel is that there should be an opportunity to *integrate* this application with other systems and applications in the future. If there is an opportunity to integrate the application with for instance the financial system then time-consuming tasks like logging information and manually sending out each invoice could be handled by this application. So when ParaCell´s PM reports in the application that the project is closed the application knows that an invoice can be sent to the main contractor and it collects the information from the financial system and automatically sends out the invoice.

3.1.5. Requirement Compilation

To conclude, ParaCell is in need of a system that will improve the information flow between ParaCell and all its stakeholders during the performance of its project rollouts. This includes every stakeholder from the local consultants to the Main Contractor and the End-customer. It is obvious that an improved information flow will help ParaCell to deal with the problems and requirements described above. An improved information flow will change and affect ParaCell´s organisation in three fundamental ways. Firstly, ParaCell will improve their resource allocation process. By having the correct and updated information about when each of the consultants should be on site ParaCell will save money. Secondly, the invoicing process will be faster and more accurate. By synchronized information sharing the correct invoice will be sent out on time and the customer will know that an invoice is arriving shortly. Thirdly, and maybe most importantly, an improved information flow will increase customer satisfaction which will lead to more project assignment.

To achieve all this ParaCell needs to find an application that will ease the information flow through its entire supply chain, ParaCell needs to find the integrated supply chain application. This application needs to have certain characteristics in order to be used, characteristics that are compiled in the table below. The list is divided into characteristics that the application must have, characteristics that it need to have and finally characteristics that it is nice if it has. Each application will be scrutinized according to this list. This will create an easy overview over which applications that fulfil ParaCell´s demands and which that do not.

"MUST HAVE":

1. It must function as a reporting application that is used for the stakeholders to inform others what milestones that have been completed and when.
2. It must be fast.
3. It must be simple.
4. It must be accurate.
5. It must be easy to access.
6. It must have the ability to be constructed around the contract (Contract Management).
7. It must have different login profiles so that each stakeholder gets presented to only the information that stakeholder is interested in.
8. It must have time logging about who does what and when.
9. It must be dynamic and flexible.

"NEED TO HAVE":

10. It should have short up- and downloading times.
11. It should have a good overview over the entire project office so that you can fast locate a problem.
12. It should be comparable. Every input-information must be compared to some original data so that it is possible to see if that information is on time or delayed.
13. It is good if the application can handle attachments of documents.

"NICE TO HAVE":

14. It would be nice if the application is prepared for future integration with other systems.

As emphasised by Martin Björk it is important that a future application has Top Management support. If the application does not have Top Management support it will not be implemented as a long term project progress reporting application. This is important for the application to be used but nothing that can be tested on any today existing application. This requirement has naturally not been taken into consideration in the following current market analysis. Also, these requirements are not measured by any definite numbers. There are no definite criteria that decide if the uploading times are short, if the application is easy to access etc. Each requirement will subjectively be tested to each application. The outcome of the market analysis does not depend on definite requirement testing and a subjective decision making is considered enough for this analysis.

3.2. Current Market

The next step is to look into the *current market* of software in this area. What kinds of applications are used today to handle these types of problems? Is there any application that fulfils the requirements presented in Chapter 3.1? This chapter will present the outcome of a scanning that results in a recommendation to ParaCell. Before any final decision can be made about what application that suits ParaCell best there are some important questions that first need to be answered. How much does it cost to develop this application In-house? How long does it take to develop it In-house? These are questions that lie outside the scope of this thesis. However, the

result of the market analysis will be important in making a final decision about if ParaCell´s supply chain application should be developed In-house or bought from a supplier. Before this market analysis is performed it is important to look at ParaCell's own IT-architecture in order to find out if there is something that already exists and can be used.

3.2.1. ParaCell and IT

ParaCell has a somewhat simple IT inventory. Generally telephone and email are the means that are used for communicating throughout the projects. To keep everybody updated about the project rollout progress status reports are sent between the stakeholders. These status reports are normally Excel documents that are updated manually. This is the same problem as Ericsson AB is experiencing at the moment. All the data needed for one project is stored in one single, often very big, Excel document - when all the equipment was delivered, when it should have been delivered, when invoices were sent out, when they should have been sent out, when the customer paid etc. There are two main problems with this approach of dealing with important information. Firstly, it is extremely tedious to update these documents. Secondly, it is easy to make mistakes. Picture a document with 50 columns and 40 rows and you are suppose to fill in one date in the right cell. This is done several times every day and mistakes are made.

ParaCell also uses MS Project and MS PowerPoint to prepare and present offers to their customers, which normally is a main contractor such as Ericsson AB. They use MS Project to create Gantt charts and other visually clear pictures to show their commitments to the customer. They use these charts to present a visible timeline over when they are planning to do certain parts of the project and how many consultants they are using. This tool is very hard to update during the project rollout so the tool is merely used for promoting ParaCell to the customer in order to get purchase orders [Assarsson, 2007]. During the rollout the Excel documents are used to keep all the stakeholders updated.

ParaCell´s IT-infrastructure is built on a SQL database. ParaCell has a CV database, called CVbase, which they use to staff their projects. The database contains CV:s of consultants so when they are to find resources for their projects they use this database to find the right people. This database will not, in any way, make sure that the right people will be on site *at the right time*. This is entirely up to the planning of the project. The database is only for *finding* the right people.

All the financial business of ParaCell is handled by Hoogia 2007.11. This system is handling everything from invoicing towards customers to payments to employees and consultants. This system is only focused on the financial component of ParaCell and has nothing to do with the projects and their progress *per se*.

None of these tools are today employed to explicitly deal with the integration of ParaCell´s supply chain. They are built and used to help the staff to handle single steps in the entire process. CVbase is a toll for finding the right people for the right assignment but it will not help them after that and Hoogia is used to handle the financial. Excel is the only tool that is used for project progress updating. It is clear that ParaCell need an application that will ease the communication between all parties and reduce the risk of making unnecessary mistakes. It is also obvious that ParaCell in present time is not in possession of such an application. By scanning the market to find a project integrated application that could meet the criteria presented earlier a more meticulous review has been made in the following applications:

- Projektplatsen.se
- IS-Tools

- Windows Sharepoint Services
- Antura
- Primavera
- Andrew Omnix
- Projektspecialisten

The conclusions of each review of these applications are presented in the following sub chapters. For more details, please refer to Appendix B.

The following systems have been reviewed but for reasons discovered early in the reviewing process they have not been presented in detail in this report. The downsides and the reasons for not presenting them in this report are presented in Appendix C.

- Microsoft Project
- Microsoft Project Server
- Microsoft Office Sharepoint Server

Pricing information is interesting for a final decision about what application to choose. However, no consideration has been taken to pricing information for these applications. This is an aspect that lies outside the scope of this project. All the applications investigated in this chapter are in theory server type independent. Most of them even run on the free Oracle server (Oracle Database XE). This aspect has therefore been left out in the application requirements aspects.

3.2.2. Projektplatsen.se

Projekplatsen.se [Projektplatsen.se] is a web based project management tool that primarily is used by the project manger to manage staff and procedures in his/hers projects. The application is used to create Gantt charts and to add and administrate relationships between milestones in these charts. It is also easy to list all the members of the project team and their assignments. The intention of this application is however not to link project progress information with financial information derived from the contract. The lack of Contract Management flexibility makes it hard to present each user with only the information this particular user is interested in. The application does not reach the higher management level well above the project manager. Also, when you apply Projektplatsen.se, what you see is what you get. There is no possibility whatsoever to integrate the application with any other system in the future. Based on the review of Projektplatsen.se it is not recommended that this application is considered as a potential tool for integrating ParaCell´s supply chain.

3.2.3. IS-Tools

IS-tools is, out of ParaCell´s perspective, a very interesting application. IS-Tool offers a product called IS Builder [IS-Tools, 2007]. IS Builder is a Java-based platform that runs on Microsoft and Linux/Unix OS and that has the capability to be connected to a big variety of modules. The foundation is an adaptive system that is used for configuring information systems solutions. IS-Tools has already delivered applications to other companies that are operating in Africa and other emerging markets, for instance Ericsson AB [Håkansson and Barrebo, 2008]. It can be useful for ParaCell to hire a company that are familiar with the businesses, Internet access possibilities and information needs that exist in these countries. IS-Tools does not explicitly work with Contract Management but they offer a tool that is flexible enough to administrate and mirror payment terms stated in any contract. Except for this aspect IS Builder is capable of matching each of the

requirements that ParaCell have. It is therefore recommended that IS-Tools is considered as a supplier of ParaCell´s supply chain application when a final decision is to be made.

3.2.4. Windows Sharepoint Services

Microsoft is one the world´s largest supplier of software products with over 75,000 employees worldwide [Microsoft, 2008]. Microsoft offers a variety of products that can handle everything from a single project to a complete project office. Out of Microsoft´s products Sharepoint Services is the one most adapted to what is needed for this thesis. MS Sharepoint Services is, in its original form, a somewhat simple tool that can be adjusted after every user´s needs. Sharepoint Services are distributed in different packages from different companies. You buy a fixed "toolbox" from a distributor and after that you employ programmers that configure the tool to your specific needs. One interesting distributor of Sharepoint Services is BrightWork that delivers two types of "toolboxes", BrightWork Reporter and BrightWork PMPoint [BrightWork, 2008]. BrightWork PMPoint is the more advances version offering a work and project management environment that includes tailored project management templates, specially created SharePoint lists (for example, Risks and Milestones) and a host of features (including BrightWork Reporter). This means that BrightWork Reporter is only a module in the bigger framework called BrightWork PMPoint.

This tool can be modified fully according to the company´s specific needs but if the basic tool that you start with is too far from the final product there is a small chance that this solution turns out to be profitable. In these cases too much changes needs to be made to meet the criterion which will be both costly and time consuming. There is another big aspect that needs to be considered before choosing Windows Sharepoint Services. It is often seen that these simple toolboxes are employed and then as time goes more and more sophisticated features needs to be added. This often leads to a lot of expensive consultant hours to build these features for this tool. In the end you will have a complicated tool with no external support and high costs for maintenance. Choosing Sharepoint Services without having a clear future plan about what the tool should handle could be the start of painting yourself into a corner where you have to choose between paying exponential increasing consultant hours or completely change application [Andersson, 2008][Norrman, 2008][Englund, 2008]. The toolbox BrightWork Reporter is to far from a complete desired solution that fulfils ParaCell´s needs. Therefore it is not recommended that ParaCell uses Microsoft Sharepoint Services for a foundation of its integrated supply chain application.

3.2.5. Antura

Antura Projects is another application on the market for handling and managing your project organisation. With the Antura tool it is possible to configure it so that it fulfils basically all ParaCell´s demands [Antura, 2007]. The downside with Antura Projects is that it is bought as a complete package. With Antura Projects you get a complete framework for your project organisation. Included in the package are features like support for your own project model, tools for project planning, resourcing, project office handling, time reporting, document storing and project steering (Earned Value Management) [Andersson, 2008]. Antura Projects is delivered as one bundled version only and it is not possible to purchase modules of it [Andersson, 2008]. According to Mattias Andersson at Antura this application is a business system that is meant to affect the whole organisation. Activities like project planning and resource planning must be performed with this application in order for it to function as intended. However, Antura Project is very flexible and you can do almost anything with it. Except for not explicitly working with Contract Management, with this application it is possible to do everything that ParaCell is

demanding from its supply chain application. Even though Antura Project is bought as a complete bundled package it can still handle all the requirements that ParaCell has at this point and can therefore not be ruled out as a possible final application at this stage.

3.2.6. Primavera

Primavera Systems, Inc. is one of the world´s leading project and portfolio management software Company [Primavera, 2007] [Andersson, 2008]. They deliver many different kinds of solutions to manage projects, portfolios and programs. To buy and implement Primavera in Sweden you turn to a Swedish retailer that will help you to adjust it to your specific needs. AEC AB is such a retailer that has helped ParaCell to find out if Primavera is a suitable application for its organisation [AEC, 2008]. Primavera is a basic application with a number of modules connected to it. Each business have the opportunity to buy only the module they are interested in and in that way configure the application to its needs. Primavera has modules for manage projects of different types (Primavera P6), to identify, select and prioritize between projects (Primavera ProSight), to ensure that the right person is assigned to the right projects (Primavera Evolve) etc. The downside is that these modules offered are the fixed solutions that Primavera can deliver. If something outside these modules is required the opportunities are limited [Norrman and Englund, 2008]. What ParaCell would be interested in is a slimmed version of Primavera P6. This module includes tools for planning and scheduling, Cost Management, Time Sheets, Reporting and Analytics etc. What would be interesting is a combination of the Reporting and Analytics feature (used for project members to report their assignments), Cost Management (used to achieve insight by evaluating cost against schedule performance) and Project Management (will give the project members anywhere, anytime access to the projects they are assigned to work on).

Primavera offers one of the most comprehensive applications in the world. With it the user can do almost anything and it does meet ParaCell´s requirements. Nevertheless, Primavera´s solution is fixed to the modules delivered and limited in the possibility to configure it to specific needs, can become an issue in the future. Just as in the Sharepoint Services case, choosing Primavera is a risk if not a complete future plan for the application is set. The reason for that is that any specific need that ParaCell might want to fulfil with this application in the future might not be possible to realize with the modules that Primavera offers. Primavera are today capable of configure and deliver an application that ParaCell would be interested in but unless the scope of use of ParaCell´s supply chain application is entirely set, it is suggested that Primavera is excluded as a thinkable option at this stage.

3.2.7. Omnix

The Omnix platform, delivered by Andrew [Andrew Omnix, 2007], is one of the most concealing applications on the market. It is extremely flexible and the tests run on this application show that it will be able to fulfil the demands that ParaCell have on its application. But for this application there is one big issue that has been put aside up until now – the price. Omnix is a very expensive application but since this thesis is not considering price, before any further investigation has been made about the budget and costs of other alternatives, Omnix cannot be excluded from a future consideration.

3.2.8. Projektspecialisten

All the tools that seem to be able to fulfil ParaCell´s requirements so far are tools that are very expansive in its nature. In addition to the functionalities that is desired you get features that are not of any interest to ParaCell today. Projektspecialisten is a company that delivers a tool that is

very simple in its functionality and deals with problems as clear overviews and intuitive usage [Krafve, 2008]. With regards to the problems in finding a simple tool that matches the criteria for an integrated application this seems like relevant key features. This application does meet many of the requirements in the list and it initially seems like a well suited application. However, it is a tool that is built on an Excel based foundation and it is not a web based tool but an application that lies on an optional server. Every time you need access to the tool you connect to that server and download a client that you update towards the server when your work is done. This compilation does not realize the "easy to access" requirement and it could lead to longer uploading and downloading times for the users. Because the nature of ParaCell´s projects, with stakeholders often working on very remote locations, this can be a big problem. The fact that it is not web based and the limited opportunities to create flexible profiles with different log in views makes this tool to simple and to limited for ParaCell´s requirements and it is suggested that this tool will not be taken into consideration in the future.

3.3. Conclusion

Following project rollout progress is a well known problem in today's project organisations. There are a lot of new applications that enters the market and they all have their own characteristics. There are a few characteristics that are prioritized in the search for an application that will help ParaCell to integrate its supply chain. These characteristics are that the application should work as a reporting tool that is simple, fast, dynamic, flexible and accurate. This leads to the requirements that the application is updated continuously and that it is possible to create different log in profiles so that every stakeholder is presented to only the information that stakeholder is interested in. It is also important that the application mirrors the contract in an efficient way and that every reporting is time logged so that you can see the history. In addition to this there are a couple of characteristics that are desirable but not necessary. Among these are concerning the upload and downloading times, and of course the shorter the better. The application should also present a clear and lucid overview over the entire project office and at the same time present comparable information so that it is easy to see what was completed in comparison to what should have been completed. It is also good if the application has top management support in the end and also the possibility to be integrated with other applications in the future.

Before you start programming and building an application, or buying an application, with the requirements that we now have, some important pre study phases needs to be performed. Before we look at what specific input and output data this application requires and what roles that should have access to it (Chapter 4), we first we needed to search the current market for possible solutions that fulfil ParaCell´s demands. In this chapter some applications that, at least at a starting point, could be an application that fulfils ParaCell´s demands has been reviewed. Each of the requirements presented in Chapter 3.1.5 (Requirement Compilation) has been tested on these applications. The results has been summarised in Table 1.

Attributes/Applications	Projektplasen.se	IS-Tools	Projekt-specialisten	Sharepoint Services (Bright Work)	Primavera	Omnix	Antura
1. Reporting tool	X	X	X		X	X	X
2. Simple		X	X		X	X	X
3. Fast		X	X		X	X	X
4. Accurate		X	X		X	X	X
5. Easy to access	X	X		X	X	X	X
6. Contract Management		X					
7. Multiple login		X		X	X	X	X
8. Time logging	X	X	X	X	X	X	X
9. Dynamic / Flexible		X			X	X	X
10. Short loading times	X	X		X	X	X	X
11. Clear overview			X			X	X
12. Comparable data	X	X	X	X	X	X	X
13. Documentation handling	X	X	X	X	X	X	X
14. Integrating possibilities		X		X	X(limited)	X	X

Table 1: Applications and their characteristics

During the market analysis it has been realised that the application that ParaCell is looking for is very narrow and deep in scope. It is narrow in the way that it only needs to fulfil a few basic requirements compiled in Chapter 3.1.5. At the same time the requirements are deep because the demands for a dynamic application that has the functionality to create multiple log in profiles are high. Few applications allow the administrator to fully configure each log in profile to set different access rights and to choose exactly what information each profile should have access to. These simple but specific requirements has led to a market analysis that reviewed some of the biggest and most complicated applications on the market, such as Primavera and Antura, but also some very simple applications, such as Projektspecialisten. It has been realised that simple tools cannot fulfil all the requirements held by ParaCell but the more advanced tools are offering features that will not be used. Some tools that seem to lie in the middle, such as IS-Tools and Sharepoint Services have been reviewed. They do offer what ParaCell is looking for they are also offering a lot features that lie well outside ParaCell´s requirements. No applications that offer exactly what ParaCell are looking for, without too many features in addition to that, has been found. For further analysis about existing applications it is recommended to visit the Erik Philipson web page (http://www.philipson.biz/) where an extensive list of CRM software application is compiled (http://www.philipson.biz/projekt-system_leverantor.htm).

The Market Analysis is an important part of this thesis project but it will never fully cover the entire market. Even if the perfect application already exists today there is always an additional value in owning and developing your own product, which Frans Tivell perspicaciously accentuated. If your customers and suppliers like the application you offer and believe that your own supply chain is as integrated as they need they will come back with more assignments. Owning your in-house developed application will create a competitive advantage that well over bridges the cost for the development. There is also a big possibility that an in-house developed application is the most flexible one. You can totally decide how open it will be and how easy it is going to be in the future to integrate the application with other applications.

It is impossible to decide at this stage if any of the applications reviewed in this chapter should be used as a final complete integrated supply chain application for ParaCell´s organisation. Before this can be decided there are some important aspects that must be scrutinized first. In order to

choose if an application should be bought or developed in-house, estimation about cost and time of an in-house development must be compared to the option of buying an application. These aspects will be analysed in Chapter 5 (Budget). Therefore this chapter can only recommend what applications that should be taken into consideration when choosing how this application should best be obtained. Because of this the market analysis may seem redundant. The market analysis though has laid an important foundation in understanding what it is that ParaCell needs and how other companies have handled this problem. This chapter is an assurance, or at least as close as you can get to an assurance, that what ParaCell is looking for is unique. It has presented many ideas and tips about the upcoming work in mapping roles, information flows and user accesses to a future application for ParaCell as presented in Chapter 4.

4. In/Out-put data

As realised in chapter 2, what ParaCell needs is an application that supports and enables the communication between all the different stakeholders in the project. This communication consists of an information flow that goes in the opposite direction as the payment flow derived from ParaCell´s supply chain model. What is important is the way and means the consultants have to inform the PM about the progress of the project and how the PM notifies his management about the same. We know the requirements of such application and we also know that there are some applications in the market today that can fulfil these requirements. It is too soon to decide if any of these are suitable but regardless if one of these applications is bought or not it is important to define the information flow that this application should be able to handle. If the requirement list presented in the requirement compilation chapter is reviewed again the application *must* be fast and simple. In order to be fast and simple every stakeholders that have access to the application must only be presented to the information that they need to see. If every stakeholder had access to all the information available it would be impossible to keep the application simple. This naturally leads to the requirement that the application must have multiple login profiles. To make this possible there are still two important aspects that needs to be investigated. Firstly, what *roles* will need to have access to this application? We have previously seen that ParaCell, the consultants, the Main Contractor and the End-customer are the stakeholders that we are interested in. These are the stakeholders that will use the application regularly to enable the information flow, from consultant to end-customer, as described in Figure 5 in Chapter 2. But within each of these stakeholders there are different roles that have different needs of project information. All these roles need to be identified in section 4.1. Secondly, we are interested in what *information* each of these roles are interested in (section 4.2)? The third and last aspect is about security and accesses. Which roles need to have writable access and which roles need to have a read-only-access? The information in section 4.2 naturally leads to the decision about what access each role should have (described in section 4.3).

4.1. Defining Roles within ParaCell´s Supply Chain

Since a project is an extremely flexible process it is hard, if not impossible, to cover all the thinkable roles that could be involved in a project. The analysis presented below will cover all the roles that are involved in the *vast majority* of the projects performed by ParaCell. The roles in this chapter have been derived from a thorough analysis of ParaCell´s project organisation and the complete list of roles has been confirmed and analysed in compliance with the members of the reference group.

4.1.1. Top Management

When ParaCell signs a contract with the Main Contractor it is ParaCell´s responsibility to deliver the project within the budget. During the projects there are a lot of people within the Main Contractor organisation that are interested in the progress of the project and they are all gathered within the Top Management role. Every single person within this role is not employed in every single project but the complicity and size of the project determines the extent of the number of persons involved. The titles below are people operating within Top Management.

Market Unit Manager
This person is head of a market unit. According to strategic importance and monetary impact the business is often divided into units. What is strategically important in this sense is not explicitly defined in any document and it seldom has a monetary relevance [Hellgren, 2008]. This is simply

evaluated from case to case. An example of a market unit could be South Africa or North Africa. The title may vary but there is often one of the very top management that would like to have an overview over the active projects in his organisation. As Martin Björk mentioned, it is important that top management at the main contractor has access to the application and supports it in order for it to be used. The Market Unit Manager will be the highest form of management that will have access to the application.

Key Account Manager
The Key Account Manager (KAM) is normally responsible for a bigger organisation with a couple of Operation Managers underneath that in its turn has a couple of Project Managers underneath. The KAM has a lower rank than the Market Unit Manager. The term Key Account Manager is an Ericsson AB term but it defines a role that exists within the majority of project organisations. They have a financial responsibility and they are normally responsible for the sales process. When the project rollout starts the main responsibility is handed over from the KAM to the Project Manager in an activity called Contract Handshake. The Key Account Manager is continuously constructing forecasts about net sales, margins, how much money that is in the pipeline and how much money that is expected to enter the pipeline in a near future.

Operations Manager
The Operation Manager (OM) has a bigger responsibility than the Project Manager but is beneath the KAM. The OM is normally responsible for a bigger region, such as a country or a part of the world, containing several project or project offices. In smaller projects there is no need for an OM and a PM and in these cases the OM function as a Project Manager. The Operations Manager is involved in the entire project process (including sales and evaluation) as the Project Manager is only involved in the project rollout. In projects where there is an OM and a PM the PM is more focused on the practical details of the project and the OM is more responsible for financial aspects and updating the customer [Moorgas, 2007]. The OM normally spends a lot of time every week preparing for customer updating meetings.

Business Controller
The business controller (BC) is person reporting to the KAM. The BC is normally more involved in the projects than the KAM. It is the BC that really makes sure that all the money that is contracted to invoice actually also is invoiced in the end. The business controller has closer contact with the stakeholders in the project than the KAM and if there is any information the BC lack he/she contacts the stakeholders directly. The BC is a purely supervising role with no reporting responsibility [Hellgren, 2007].

Project Controller
The Project Controller (PC) has a similar task as the (BC) but they are even more operationally involved. The PC has insight into a bigger span of tasks and activities than the BC, i.e. he/she is involved in planning, shipping, installing, testing etc. The role is still a monitoring role and they have very little reporting responsibility in a normal project.

4.1.2. Project Management and Finance

Reporting directly to the Main Contractor are the people within the Project Management and Finance role. These people are basically interested in everything there is to know about the progress. They are responsible for delivering the project to the Main Contractor within time and budget frames. Within the Project Management and Finance role the following persons exist.

Project Manager
The Project Manger (PM) is the spider in the web that has the responsibility to deliver the project within budget and timeframes given by the Main Contractor. The PM is generally responsible for the project rollout and not the sales or evaluation process. He/she should be updated on strategic decisions on a high level as well as practical progress and problems happening on a very detailed level [Tivell, 2007]. The PM can be located locally, where the project is being carried out, or in the ParaCell main office in Sweden. In service project that have a more commercial nature a Service Delivery Manager (SDM) could be involved. This person functions as a PM but have more knowledge about how to deliver services to reach maximum customer satisfaction. In big projects a PM and a SDM can work parallel.

Customer Project Manager
In bigger projects there might be too much to keep track of for one person and in these cases several different PM:s are used. Each PM then has the responsibility for one or several project activities. In these projects there still needs to be one person responsible for the whole project and also a person who can be an interface towards the customer, in joint collaboration with the OM. This person is normally called a Customer Project Manager (CPM). Because the CPM is responsible for updating the customer this person is, just as the normal Project Manager, deeply involved in the project progress. Any detail important to the Project Manager is also important to the CPM.

Finance
The finance department at the ParaCell office in Sweden is responsible for invoicing the Main Contractor when invoicing can be made. Finance is also responsible for controlling that the invoices that are sent also are paid and that the money is received. Today Finance has no Contract Management tool for synchronizing the invoicing milestones in the contract with what is actually invoiced in real time. If a project is delayed Finance will not automatically discover this by delayed invoicing. This is a central role that is very dependent on a reporting tool that in a holistic way mirror the contract and the invoicing milestones that lie within it.

4.1.3. End-Customer Management

End-customer is the unified name for the organisation that originally demands the service or the product. Today it is the End-customer´s requirements that control the supply of the product. As already stated in this report an integrated supply chain application is important because it enables suppliers and project organisations, such as ParaCell, to offer the end-customer the correct service or product at the right time. Within the End-customer organisation there is often a management team that are interested in the project, often out of a financial perspective [Björk, 2007]. This management team has the responsibility to make sure that the project is done according to their demands and that the project management team is following the budget and other terms and conditions. The project progress often brings changes in what the customer wants and in how the project should be completed. In these processes the End-customer management team have an important role. An integrated application would help the End-customer to keep itself updated about the project progress and it would facilitate a faster communication with the project management when changes and problems occur.

4.1.4. Sub Project Management

The engineers and other type of supervisors and sub managers that report directly to the Project Manager belong to the Sub Project Management role. These people are normally responsible for a specific activity such as delivery, installation, implementation, testing, building etc. Smaller

projects do not employ sub project managers and the PM is responsible for all these activities. All the people within the Sub Project Management role are consultants contracted by ParaCell.

Implementation Manager
The implementation Manager (IM) is a consultant located locally. This person is mainly responsible for the installation and testing activities. This person reports directly to the PM when his assignments are completed. The title Implementation Manager is a title used within Ericsson AB so the person responsible for these activities is not necessarily called IM. A person with special knowledge about installation and testing procedures is conversely employed in bigger telecom projects.

Supply Manager
The Supply Manager (SM) is also a title derived from the Ericsson organisation. This role is normally a person responsible for shipping and invoicing the equipment needed for installation on site. This person is deeply involved in planning and HW/SW ordering so that he/she knows what to deliver and when. In the start of the project this person works closely with the Project Manager. When the SM has shipped the equipment and sent out the invoice for that material this person has little insight into what happens in the project [Björk, 2007]. In some cases they have reporting back that the equipment has been shipped or even that the equipment has arrived. This person can also be called Customer Logistics Manager (CLM).

Civil Work Manager
The Civil Work Manager (CW) is a person who is responsible for the practical work on site. This is activities when steel constructions, foundations etc. are built as preparation for the technical equipment to be installed. These people are always located on site and the CW manager reports directly to the PM when his assignments have been completed.

4.1.5. Administrator

When a project starts, ParaCell´s supply chain application needs to be configured according to the project and the contract specifying the project. All the different roles participating in the project and all the activities must be added together with the relationships between those. The administrator, who is the "owner" of the application, will be the person administrating this. As an administrator you can have two different titles. All the people within the Administrator role are people employed by ParaCell and located at the main office in Sweden.

Project Manger
In some projects the Project Manager is operating from the ParaCell office in Kista. In that case the PM and the administrator will be the same person. All the consultants on site are reporting to the PM in Sweden and the PM has the responsibility to keep the Main Contractor updated. The PM keeps track of milestones and deadlines and shall acknowledge when a project is delayed.

Administrator
In all projects, irrespective of if the PM is located locally or in the ParaCell office, there will be a person located in the ParaCell office that build the application and add all the activities that the project desires. If the PM role is laid on a consultant the administrator and the PM will be different persons, with the PM working on locally on site and the administrator working at the ParaCell main office in Sweden.

4.1.6. Project Teams

Reporting directly to the Sub Project Managers are the Project teams. These are the people doing all the practical work. They are preparing all the sites, they are building all the stands for the equipment, they are installing the equipment etc. There are no titles worth mentioning within the Project Team role but the teams are an important cogwheel in the project machinery.

4.1.7. Others

In addition the people filling the roles above there are hundreds and maybe thousands of people that indirectly are involved in the projects. There are people buying and constructing the material and equipment necessary, shipping the items, handling the communication with the authorities, there are law people making sure that no laws are violated and so on. There are an infinite number of tasks and roles on this list. All these people are of course necessary for the project to be completed on time and within budget. However, they lie outside the scope of a supply chain Application for ParaCell.

The different roles identified in this paragraph are the following:

- Top Management
- Project Management
- End-Customer Management
- Sub Project Management
- Administrator
- Project Teams
- Others

As seen in this chapter, within each and every of these roles there are many different people with different assignment responsibilities. All these roles therefore have different requirements in what information they need to see in order to complete their assignments. Each role´s specific information need are analysed in the next sub chapter.

4.2. Information Flow

Before it is decided what role that should have access to the application and what information each role should have access to, it is important to first decide what information that will flow through the application on the whole. As already mentioned, regardless if ParaCell´s supply chain application is developed in-house or if the development is outsourced, it is important to establish what information that will flow through the application and how the application will handle and present this information. When this is known it is possible to determine what information that should be accessible to each of the roles defined in the previous chapter.

Outlining exactly and fully what information that flow through a project is an impossible and meaningless task. Every project has its unique composition of information that the application needs to be able to handle. Once again the need for an application that is flexible and dynamic emerges. Whatever information that flow in a project needs to be possible to process in the application and for that reason there is no need to list all thinkable information in this thesis. What is important is to outline how different input will be processed and what output that will be generated. In order to do that a generalised model of how ParaCell´s application can look must be constructed. This may seem as a detailed level of presentation for this report but creating a general model is the best way of visualise the information flow. As stated in Chapter 1.5.3 the goals of this thesis is not only to define what roles that should have access to this tool but also what *kind of information* these roles should have access to. To map this need the construction of a

generalised model is inescapable. The following paragraph will clarify a simple model of how ParaCell´s supply chain application could work in order to solve the problems presented in Chapter 3. Figure 8 is a very basic overview of how the application could look and it is used to explain how an application could be handling input and then present output. Importantly, this figure is merely a schematic presentation and has no correlation to a potential interface or specific functionality.

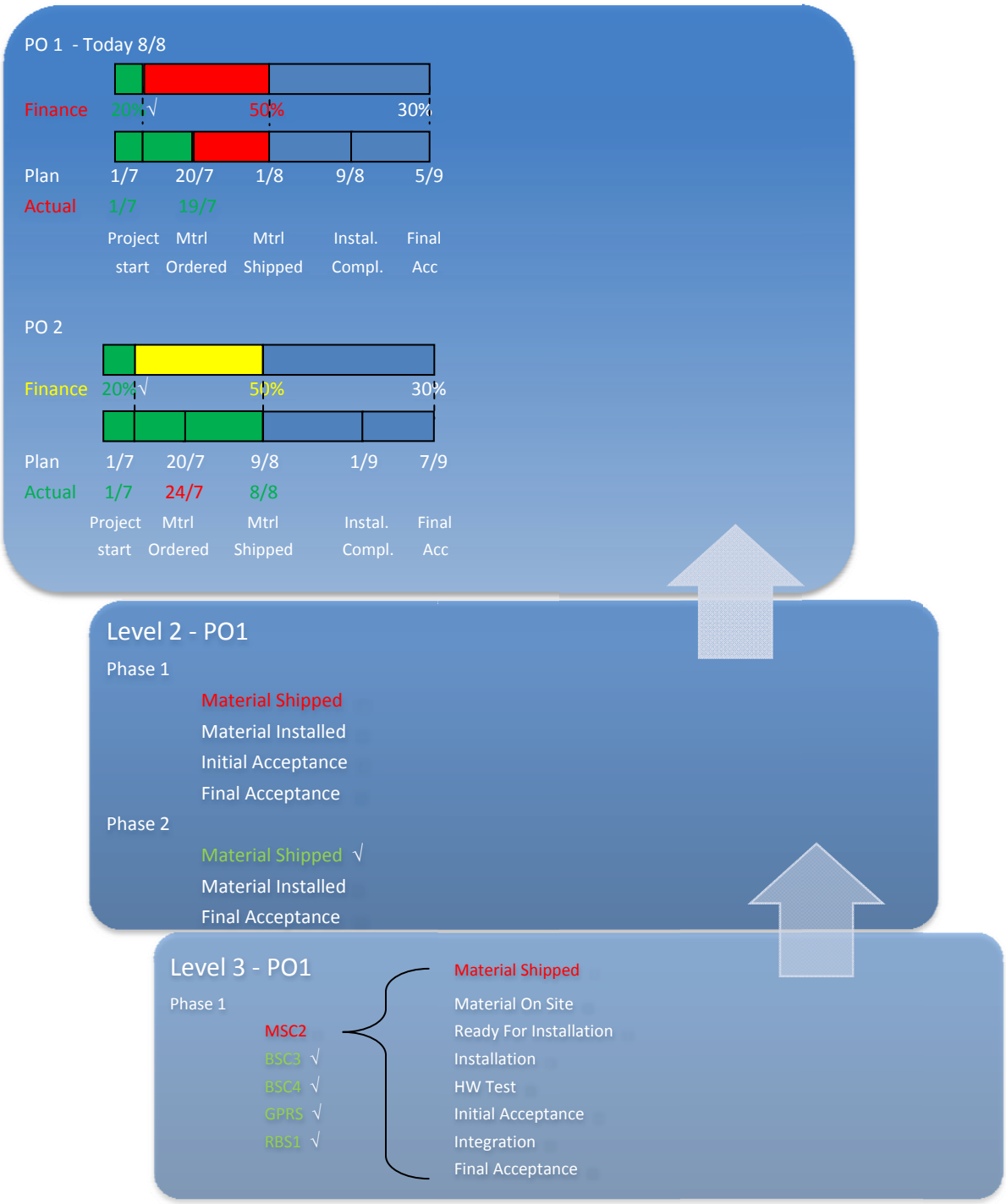

Figure 8: Schematic model of ParaCell´s integrated supply chain application

Imagine an application that is divided into three levels (Level 1, Level 2 and Level 3). These levels will span across the entire supply chain with Level 3 covering the project teams and the consultants up to Level 1 covering the Main Contractor and the End-customer. Depending on

the access rights the user sees only the highest level that user has access to when logging in. The levels will be divided into what *type* of information they display. On the first level each project active will be shown out of two perspectives – one financial and one project oriented. Each perspective is shown with timelines presenting an overview over the status of the invoicing process and the project progress. To follow the project progress you are interested in dates. You are interested in *when* is each milestone supposed to be completed according to the project plan (see the row named "Plan" in the figure) and *when* it was really completed (see the row named "Actual" in the figure). In telecom projects some important project progress milestones are also connected to a financial trigger points in the contract. However, there are only a few of the project progress activities that trigger an invoice when they are completed. These activities are normally initially a downpayment to get started, when the material has been shipped and when you have received a final acceptance from the customer. Milestones like Site ready for installation (Site RFI) or installation completed are important milestones to keep track of but they do not normally have a commercial value as such. From a financial perspective you are interested in how much that can be invoiced and how big a percentage that is of the total payment for that project. That is why percentages are presented in the financial timeline. In Figure 8 it is easy to see that PO1 is delayed, both with the invoicing process, i.e. some invoice has not been sent out as pre-defined in the contract, and with the project progress, i.e. some projects activities are not completed as pre-defined in the contract.

The project progress timeline in Level 1 is the key in this application. Firstly, all the information added to the application will be aggregated up and presented in the "Actual" row in this timeline. This row present all the actual dates when the milestones in the project were completed. How this is done will be shown later in this chapter. Secondly, the date that is presented in the "Actual" row is compared with the date in the "Plan" row to see if the milestone was reported on time or not. Thirdly, the milestones in the project progress timeline that are connected to trigger points in the financial timeline will update the status in that financial timeline automatically. If a milestone is reported as complete before the planned date the box in the project progress timeline for that milestone becomes green. If a date for a milestone in the project timeline is passed and the milestone is not marked as completed the box in the project timeline for that milestone will become red (see "Material Shipped" in PO1 in the figure). *If* that milestone is then linked to an invoicing activity in the financial timeline, that box will also automatically become red (again see "Material Shipped" in PO1 in the figure). One red date or percentage will generate a red "Project" or "Finance" in the left margin as in Figure 8. This will make it extremely easy to follow both perspectives closely.

Another thing that is important to recognise is if the Main Contractor invoice really has been sent out. The idea with this application is partly to follow the project progress and from that have a good overview over if an invoice can be sent. Secondly, it is important to easily see if the invoice really has been sent out. This is solved with colour codes. As already explained, red boxes mean delayed and green boxes mean on time, both concerning project progress and invoicing activity. When a milestone is completed on time *and* has a linkage to a financial trigger point, the box for that invoice should turn yellow (as in "Material Shipped" in PO2 in Figure 8). In figure 8 the "Material Shipped" in PO2 was marked as completed on the 8th of August, one day ahead of planned completion date. The box in the financial timeline turns yellow, telling the user that an invoice on 50% of the total order amount can be sent out. When the milestone date for "Material Shipped" is passed (9/8 in the figure), and the box for invoice sent has not been checked, this field will automatically turn red showing that the invoicing activity in the project is late. When the invoice has been sent the box next to the percentage is checked and the field turns green. In the end two green timelines will show that the project is completed and that all the invoices has been sent out. Also, when a milestone is reported as completed *before* the planned milestone date both

the box in the project timeline and the date under the timeline for that milestone will turn green (see "Material Ordered" – PO1 in the figure). If a project milestone is marked as completed *after* the planned date, both the date and the box for that milestone will turn red. When the project gets back on track and the next milestone is reported on time (as "Material Shipped" in PO2) the boxes in the project timeline switches from red to green showing that the project is back on track. However, the date for the delayed milestone however, will stay red (24/7 in PO2 is still red). This will enable a historical lookup, letting the user know when the project has been delayed and when it has been on time.

All the financial milestones on Level 1 must be linked to the real amounts that the contract states and be accessible to the user that has access to this level. This will make it easy for the KAM, the BC and the PC to use the application to make complete predictions to their management. They can see how many of the projects that are on time and how much money that are being invoiced for this period. The user that logs in to the application sees that both projects progresses are late but that PO1 is more crucial at this point. The user sees that all the material has not been shipped in PO1 (1/8 is red), which has led to a late invoice (50% is red), and he/she clicks on the red date to display Level 2.

Level 2 displays an aggregated view of milestones that are strategically important to this project. These are milestones that the PM and the sub project managers are extra interested in. What is considered to be strategically important milestones varies from project to project and it is decided from case to case by the administrator. On Level 2 the user in this case sees that PO1 is divided into two phases. In order for the "Material Shipped" status for PO1 on Level 1 to become green the "Material Shipped" boxes beneath both Phase 1 and Phase 2 must be checked, i.e. all the material in PO1 must have been shipped before "Material Shipped" becomes green on Level 1. When both these boxes on Level 2 are checked Level 1 will automatically be updated (the figure turns green) and it is easy to see that all the hardware material for PO1 is delivered. When Level 2 is displayed the user sees that all the material in Phase 2 has been shipped (green status) but that the "Material Shipped" box for Phase 1 is still unchecked (red status). The user clicks on the red line and Level 3 is displayed.

On the third level all the activities in the project should be displayed. All the reporting made in the application will be done on this level. This basic information will automatically be aggregated up to Level 2 and then to Level 1. On Level 3 in this case each phase is divided into several more detailed activities. Phase 1 here consists of the completion of Multi Switching Centre 2 (MSC2), Base Station Controller 3 and 4 (BSC 3 and BSC 4), the GPRS station and Radio Base Station 1 (RBS1). The user now sees that all the activities for MSC2 has not been completed according to the contract (red status) and clicks on the red line. The sub activities that presented in the list on Level 3 are displayed and it is clear that all the material for MSC2 has not been delivered. This list of sub activities can be displayed for every activity under Phase 1.

So how does this aggregating functionality work? If the "Material Shipped" box had been checked on Level 3 – Phase 1 – MSC2 all the activities under Phase 1 would have had status green, i.e. all the material for that phase has been shipped. This would have automatically generated a green status for "Material Shipped" under Phase 1 at Level 2. Since all "Material Shipped" boxes on Level 2 are checked the date "1/8" would automatically turn green, the box in the project timeline would automatically turn green, and the status on the financial timeline would be updated automatically (turn yellow showing that an invoice can be sent out). It is easy now to see that an invoice can be sent! This is just a very simplified model of what information that could be included and how this information is processed. The level of details, i.e. how many

levels there are and how many activities each level contains, may vary significantly from this model.

4.2.1. Additional features

In addition to this model there are some basic features that should be included. These functionalities are presented in the following list.

- All the milestones that are displayed should be linked to the contractual date. This is the date when this specific activity should be completed according to the contract. All the reporting made in the application is time stamped and compared to the contractual date. In that way the application will know if the activity is late or on time. The possibility to add dates about semi completion should also exist. It could be that an activity takes 14 days to complete and that the line should be marked for instance yellow if 10 days has passed and nothing has been reported. This of course demands that you can report in the application that a certain percentage of an activity has been completed.

- The possibility to set rules that one activity cannot commence before the previous one has been completed must exist. Often the administrator are going to need to set the rule that the Installation cannot start before the Site Survey is completed or that the Testing cannot start before the Implementation is completed.

- Generally there will be no reporting made on level 1 and 2. All the information added to the application on Level 3 will be aggregated to Level 1 and 2. However, there is some information that Top Management and Finance needs to add that and this is best done on a higher level. Two examples of such activities are RFI (Ready For Installation) and Invoices confirmations. It is often the Main Contractor or even the End-Customer that has the responsibility to prepare the site where equipment is to be installed. It is important that the Main Contractor uses the application to report that this milestone is complete. If this is done then it is easier for ParaCell to show that the project is late just because the customer was late with his commitments, if that is the case. Since Top Management and Finance is using the application to keep themselves updates about the invoicing process it is logical that they also use the system to report what is being done in this process. This is information flowing on a higher level and it is therefore important that the application is configured to handle this.

- All the activities displayed on Level 2 and 3 should also be linked to contact information about the responsible person. So if you locate where the problem is it should also be easy to locate who that should be contacted to solve it. In this way the application will cover the entire need to locate and solve project progress and invoice related problems.

- The application must be configured to handle documentation. Each project and each activity within every project is compiled and summarized in different kinds of documents. When the project is handed over from Sales to Execution you attach a Contract Handshake Checklist, a kick off meeting planning and a project group specification. When the Delivery process is handed over to the Installation, Goods delivery notices are attached and when the Installation is handed over to Testing the Final Installation Report and the Red Marking Report (shows any deviations to the original plan) is attached. It is important that these documents can be found next to the activity, or phase, that the document describes.

- This application is not only an instrument of following progress and financial status. The expectation is also that this application will be used to drive the project progress and make it more efficient. This can be achieved with a simple auxiliary mean - a built in emailing function. This emailing function will automatically send out an email when an activity is reported as complete, notifying the responsible person for the subsequent activity.

These are important features for the application to solve the problems outlined earlier in this report. It would definitely be a reporting application that is fast and simple to use. It would be easy to keep it updated and accurate, it would facilitate different views for different users, it would be easy to locate the problem and it would be easy to follow contractual terms and conditions. There are of course many additional features that would solve problems but that are not crucial at this stage.

In order to build this application, the administrator needs to be presented to an input screen, where all the necessary information needed to build the model presented in Figure 8 is added. So for each new project this input screen will help the administrator to build the application. How this input screen could look is presented in Appendix D.

4.3. Information Needs and Accesses

When it is known what type of information that will flow through the application and how this information will be processed it is possible to determine what information need each and every of the roles defined have and what kind of access they need. There are four access classes and each defined role will be given one of these classes:

1) Full Access – You have the authority to do whatever changes that is required. That includes adding users, setting and changing access restrictions.
2) Read and Write Access – You have the authority to read and write in this category
3) Read-only Access – You have the authority to read but not write in the category
4) No Access – You do not have the authority to read or write in the category.

It must also be decided which levels (as level in Figure 8) each role should have access to. Again, this decides what *type* of information each role would have access to and not what specific information each role should have access to. That is an analysis that is too detailed for the scope of this thesis. The result will be that when a new user is added to the application it is possible to choose which role/roles that user belongs to. The user will be given access to the application according to the access class and level pre-set for that role. The person that adds the entry therefore needs to know what people that might be interested in the information. The following sub chapter will clarify what information each role is interested in and what access class and level that role should have access to. Since the persons within every role have different information needs each person will be handled individually. Nevertheless, generally each role demands only one common access class and access level, so these aspects will be treated role by role.

4.3.1. Top Management

Key Account Manager

When the project rollout starts, and ParaCell gets involved in the process, the KAM is interested in two main aspects. The KAM wants to be informed about the commercial trigger points that are generating invoices. The KAM has the responsibility to construct reports and predictions about how much money that has been invoiced the last months, how much that is going to be

invoiced in the coming months etc. To make accurate predictions information about these trigger points are important. The KAM is also interested in information about the size and progress of each project that are in the pipeline and about projects that are on the way of entering the pipeline. It is the responsibility of the KAM to keep the customer satisfied and to do that he needs to be updated about the project progress. If a problem occurs the KAM needs to be able to fast trace where the problem is so that he or she can contact the right person and also inform the customer more specifically what the problem is. Information about project progress and invoicing activity is exactly the information that is presented at Level 1. Problem tracing and more detailed information about project progress can be found on Level 2 and 3. The KAM is not responsible for any specific activity or process in the projects and therefore this person does not have any reporting responsibility towards the rest of the project team. The KAM merely has a supervising function.

Business Controller
The Business Controller only gets involved in the project when there is a problem. The BC does not have the close communication with the End-customer and is more involved in the projects than the KAM. If deadlines are missed, invoices are delayed or payments are not received the BC contacts the PM to locate what the problem is. The BC is interested in the margins in the projects, what orders that are coming in and what orders that already are in the pipeline. This is basically the same information the KAM is interested in, that is Level 1 information. The BC needs this information to make forecasts to higher management. In order for these forecasts to be as accurate as possible there is an imminent need for the BC to be informed about project progress. Today the BC gets this information from a SAP report generator. The reports extracted from that generator only give an indication about that something is wrong. The BC can see that a project is approaching the end and that nothing has been invoiced and therefore something *should* be wrong. There is no explicit information in these reports that reveals that the project is not invoiced as it should. The invoicing process at the Main Contractor *should* work in the way that when a milestone has been completed and an invoice can be sent out the PM should know that. The PM contacts the correct person (could be the Supply Manager, SM) and that person sends out the invoice. Today it is often the BC or the PC, that discovers that there is something wrong and contacts the Supply Manager. The SM contacts the PM to ask if the milestone is complete, the PM acknowledge, and the SM sends out the invoice. The Business Controllers that are working with ParaCell´s projects today has no tool of following the project progress. If the BC had an application where he/she could follow the project progress, the BC could easily see that a project is delayed and why the project is delayed. This would mean that there would be no need for the BC to contact the PM or the SM to locate the problem as done today. The application would help the PM to see directly when a milestone that results in an invoice has been completed and there would be no delays. If a delay should occur anyway there would also be no need for the BC to contact the PM to enlighten that person about the problem as the PM has access to the same information. It is clear that a project progress reporting application would help both the BC and the PM in their work. Also, for the BC to be able to locate the problem he/she needs access to all the levels of detailed information. The BC has no responsibility to report anything in projects. This person only has, just like the KAM, a supervising role.

Project Controller
The Project Controller is exclusively interested in the same information as the BC. Even though the PC is more operationally involved, information like shipping and delivery is interested to both the BC and the PC. Because the PC is more operationally involved this person will probably be operating more on Level 2 and 3 in the application. The PC should also have access to Level 1 information since this information could be important to get an overview over several projects and a tool to locate problem areas fast. Just like the BC the PC is a supervising role only.

Operations Manager
The Operation Manager is more operationally responsible for the projects in progress than the BC and PC. They have a responsibility for the entire project process, including sales and evaluation. This responsibility is in difference to the PM who normally is responsible for only the project execution. In smaller projects there is no PM but only an OM who will handle the PM role during the rollout. Depending on the responsibility of the OM this person is interested in different information. If the OM functions as a PM he/she would of course be interested in the same information, and have the same access rights, as the PM (see chapter 4.3.2). In bigger projects, when there is one OM *and* one PM, the need for information access changes. In that case the OM is interested in almost everything that the PM is interested in. The OM wants to know everything about deliveries, resources, planning, consultants on site, invoicing etc. The difference would be that the OM would be interested in Level 1 information to a higher degree than the PM. Today, Operation Managers working in ParaCell´s environment often retrieve the information they need from an Excel spreadsheet, located on a LAN. Every project stakeholder logs in to this LAN and reports what has been done and when. There is one spreadsheet for every country that the OM is responsible for and it is very hard and very tedious to keep these spreadsheets updated and accurate [Moorgas, 2007]. The OM spends a lot of hours every week going through these spreadsheets, calling the Project Managers and preparing for the End-customer meetings. With a reporting application that spans over the entire supply chain, both the OM and the End-customer could easily see the project progress and the meetings would be shorter and easier to prepare.

Top Management Access
Top Management are only interested in following the project and none of the people within this role have the need to use this application for any reporting. This role will therefore only need a *Read-Only access*. Since high level information is of interest to all the people within Top Management this role will have access to *all levels*.

4.3.2. Project Management and Finance
Project Manager
The Project Manager basically needs all the operational data and information available in the project, Level 1, 2 and 3 because it is the PM:s responsibility to deliver the project to the customer within budget and time frames. The PM needs to know everything about who is doing what and when, everything about shipment status, installation status, when the site surveys are being prepared, when they are done, project planning, implementation, the status of testing etc. It is impossible to get all that information from one single application but for ParaCell´s supply chain application it is necessary that the PM have access to all the information presented on Level 1, 2 and 3. Because it is the PM:s responsibility to complete the project according to the contract it is unreasonably to assume that this person do not need access to high level financial information.

Customer Project Manager
The Customer Project Manager basically needs the same type of information as the PM. More specifically when it comes to the information flowing through the application, Level 1 and 2 information is of essence. Since the CPM is responsible for keeping the customer updated it is important that this person knows what it takes to fulfil the contract and also what is happening on a more detailed level.

Finance
Today the PM or the Administrator will discover that a project is invoiced late by looking at the contract and talking to the PM or consultant working on site to get an update about the project progress. With a supply chain application the Finance department can use the application to see which projects that are delayed. This will make it easier for the Finance department to discover where there is a problem and when it occurred. The application will also help Finance in the invoicing process. Today the invoicing process leads to late invoicing and confusion about the invoices that are sent. When a milestone is complete and an invoice can be sent out the PM contacts the personnel at the ParaCell office to inform about it. If this is not done it is up to the ParaCell personnel to discover that this project should be invoiced but nothing has happened. A process they have no application to assist them with today. When it is agreed that an invoice can be sent ParaCell contacts the Main Contractor. When they have agreed that the job is complete the ParaCell Finance Department sends out the invoice. Since the Main Contractor has no means to keep themselves updated about the project progress it often happen that they simply do not agree that the job is done because they get their information from elsewhere. If ParaCell and the Main Contractor were using the same application to follow the project progress they would have the same comprehension about its status. If so, when Finance sees that a milestone is complete it will directly send out the invoice and report this via the application. The Main Contractor would see that the milestone is complete, that the invoice has been sent and is arriving shortly. This would lead to a faster and more streamlined invoicing process. Just as to Top Management, Level 1 information would help Finance in its daily work. Only by having access to Level 1 Finance can have an overview over the entire project office and in seconds locate projects that have not met the financial requirements. This level of information is of primary concern to the Finance department but having access to more detailed levels will help to locate the problem faster. Thus Finance can have a better dialogue with the PM in a possible discussion about the problem.

Project Management and Finance Access

Project Management and Finance is in the centre of the organisation and they are very dependent on a well functioning information flow. The Project Managers will use the application to follow the project progress but also to report significant events. The finance department will use the application to follow up both the project progress and the invoicing process. They will also use the application to report to the Main Contractor (or whoever the invoices are sent to) that an invoice has been sent out and will arrive shortly. The Project Management and Finance will therefore both need a *Read & Write Access*. The Project Management and the Finance also need access to *all levels* in order to do their jobs effectively.

4.3.3. End-Customer Management

Within the end-customer organisation there are many different persons that need access to information about the project progress. The top management of the end-customer organisation has the same aim as the top management at the Main Contractor. They simply want to make sure that the projects are going well and generate the profits that are initially estimated. Any changes made in these estimations are in interest to end-customer management. A dialogue does exist directly between ParaCell and the end customer during the project, mainly to speed up the communication process by not using the Main Contractor as a middle hand. However, in ParaCell´s projects the customer is not responsible for any activities and does therefore not have any reporting responsibility for activity completion. This means that the end-customer organisation only needs a *Read-Only Access*. The numbers and figures presented on Level 1are often derived from the contract between the end-customer and the Main Contractor so these figures are no secret to these people. The *Level 1* information is perfect for the end-customer since it will give them a financial and practical overview of the project progress.

4.3.4. Sub Project Management

The sub project management team are operating on such a detailed level that they are only interested in the information concerning the activities that they are responsible for. They should not have access to any financial or strategic important information presented on Level 1.

Implementation Manager
The Implementation Manager is responsible for the installation process and the test & implementation process which normally also includes the System Acceptance Test process. This means that this person will be interested in all information about installation progress, implementation progress and testing progress. The IM will use the application to report assignment completion and also as a tool to keep oneself updated about the status of the activities that this person is responsible for.

Supply Manager
The SM needs to be informed about ordering status of the project and if everything that is ordered also is shipped from Sweden. Today the SM gets the main part of his project progress status via phone or email. With an integrated supply chain application the SM could use the application to be updated about when the ordering process is completed and the equipment is ready to be shipped and also to report when everything is shipped.

Civil Work Manager
It is often the Main Contractor, or even the End-customer, that is responsible for preparing the site, hence the Main Contractor that is responsible for contracting a Civil Work Managers. Civil Work teams though are people that normally are hired by ParaCell and that operates within ParaCell´s supply chain, since they handle the local activities. Therefore it is important that an application also cover the communication of Civil Work personnel.

Sub Project Management Access

Sub Project Management will use the application to report what has been done and to keep themselves updated about what needs to be done next. This means that they will need a *Read & Write Access*. The sub project managers do need an aggregated view about project progress but the contractual figures and numbers that is printed in the contract between the main Contractor and ParaCell is nothing the sub contract mangers should have access to. Therefore this role should have access to *Level 2 and Level 3* only.

4.3.5. Administrator

Project Manger
If ParaCell is handling the PM role themselves, as supposed to hiring a consultant, then this person will also be the administrator of the application. As an administrator the PM will have access to thinkable information flowing through the application. There is no information distributed that this person does not have access to.

Administrator
Also when the PM is consulted by ParaCell and operating locally the administrator, and owner of the application, will be a person operating at the ParaCell office in Sweden. Just like the administrating Project Manager there is no information that this person cannot see.

Administrator Access

The administrator is the person configuring the application at project start. This person therefore needs the authority to add roles and users and also to set and change the access classes and level accesses for every user and role added. The administrator needs *full access*. This naturally also means that this person will have access to *all levels*.

4.3.6. Project Team

The project teams are all the people doing the most practical work and they are located locally where the equipments or services are being delivered and installed. These people are normally just interested in exactly what they need to do and when. They are not responsible for any group of activities and they will therefore not need to use the application to inform themselves about project progress of any other part of the project than their own. It is up to the PM, or in bigger projects the Sub PM, to inform the teams about their assignments and to control that these tasks are being performed. The project teams have a need to know what is going on in the project and if the project is delayed or in any other way have an adjusted schedule. There is a possibility to give the Project Teams a writable access and that they too would use the application to report completion of their assignments. However, if too many project members are given writing access to the application then there is a risk that the team supervisors would devote more time to argue with people to use the application than they originally would spend on keeping themselves updated. It is important that the users see the purpose of the application and use it unconstrainedly or it will not be used at all. This risk is eliminated by giving the teams a *Read-Only Access*. This also means that the teams will only need access to *Level 3* information.

4.3.7. Others

All the people outside the roles that are already described are interesting for the project but not for this thesis. They do not have any, for this application, relevant reporting responsibility and they are not in need of any information presented through the application. It is easy to believe that it is good to inform as many people as possible about the project progress. The risk is that you lose control over who that has access to critical information and who that has insight into the project. It is important to avoid that and it is up to the PM or the Sub PM to draw the line of where the project teams ends and the all the "others" begin. Users that you want to add to the application, maybe their contact information are important, but that should not have any insight into the project, can be places under the role "Others".

Others Access

The people falling within this role are important for the project to succeed. They do also have to communicate with the project members but this communication will be outside the scope of this application. For the purpose of this thesis this role is considered to lie outside ParaCell´s supply chain and will therefore not be included in the application integrating this supply chain. To set the boundaries for the project and keep control over the information distribution *No Access* will be given to these people.

4.4. Conclusion

The In/Out put mapping made in this chapter is very important to make to understand how the application should work, what information it should be able to handle, what people that should have access to it and what kind of access these people need. The interviews with the reference group have given me a lot of input to the analysis made for this chapter. In the work of finding ParaCell´s supply chain application the information presented in this chapter is central, regardless of what how this application is obtained.

The first step of the In/Out put analysis was to map the roles that are included in ParaCell´s supply chain. The roles have been defined after what access needs they have and not after where they work or what they do. The application will have to be divided into several levels where each level will present different levels of detailed information. Level 1 will present an aggregated view of the financial and most important project progress milestones. Level 2 will present a list of the most important project progress milestones that have been summarized from the third level. Level 3 is where the majority of the data is added and this level will present all the detailed information of all activities that are of interest. All users will have access to all levels underneath the highest level that role have access to, i.e. if Top Management have access to Level 1 it also automatically has access to Level 2 and Level 3. The administrator will need to have the possibility to decide which level of access each role should have. The roles and what level of access they will need are presented in Figure 9.

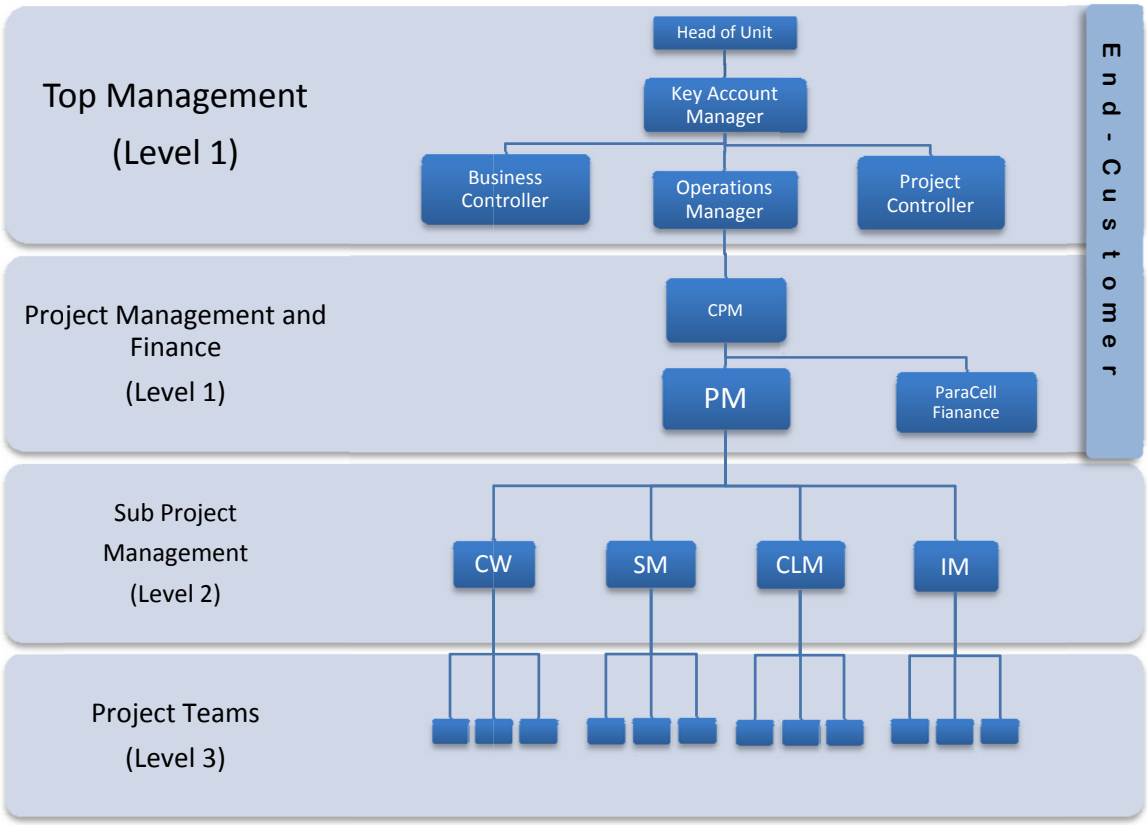

Figure 9: Stakeholders and roles in ParaCell´s projects

In addition to level each role is also given an access class. This decides what the role can do with the information it is presented to. Both the Top Management and the Project Management and Finance have access to all levels. They can therefore see all the information that is added to the application. Top Management though only has a Read-Only access which means that if a user has

been assigned to the this role it can only read the information added and not do any changes. Project Management and Finance will also have access to all information but the users that have been assigned to this role can add, change and delete information in the application. Each role and the access class given to that role are summarized in Table 2.

Roles/Access Classes	No access	Read only access	Read and write access	Admin access
Top Management		X		
Project Management and Finance			X	
End-Customer Management		X		
Sub Project Management			X	
Administrator				X
Project Team		X		
Others	X			

Table 2: Roles and access classes

Variations in these accesses can of course occur which will enable the functionality that a specific access will be able to administrate if necessary. Maybe you want to add a document that you want Top Management and PM to have access to but you do not want the PM to have writing access to that document. If the document is added without any changes are made then Top Management would have a Read-Only Access to that document and the PM would have a Read and Write Access. A good feature would be that if it is required then the person added an entry can explicitly set the access right as wished.

The information flowing through the application is very different depending on kind of project it is. Generally it is *milestone completion* that the supply chain application should handle. The application should assist the stakeholders in the process where one milestone is complete and the next should commence so that it is easy to follow the *project progress*. This is reported in the application and the application informs the next person that the next activity can start. This information should be aggregated into a simple overview and also connected to *financial invoicing information* that mirror the payment terms in the contract. The information outlined in Figure 8 is an example of information that is important to keep track of in the majority of telecom projects. Milestones like Material Shipped, Material On Site, Site Ready for Installation (RFI), Installation Complete, HW Test Complete, Initial Acceptance, Integration Complete and Final Acceptance is normally the information that the stakeholders in ParaCell´s projects are interested in.

5. Agency Reporting

In addition to the project progress functionality combined with the financial overview that is already described in this report there is an extra functionality which has been excluded from this report up to this point. The reason for that is that this new functionality will help the ParaCell personnel to keep track of a total different part of their organisation than the project progress reporting. This new "module" will help ParaCell to keep track of their consultant business. The project business is well separated from the consultant business but the functionality of the application helping ParaCell to keep track of their consultants resembles the functionality of the project updating module. Therefore, the module already defined can easily be used as a foundation to the agency reporting module defined in this chapter. Basically, when a user, that has access to both modules logs in, that user will be able to choose if he or she wants to display the project module or the agency module. Therefore, this new module will not, at least to a greater extent, change the functionality or complexity of the original application and it is therefore presented exclusively in this chapter. This chapter will define the scope of use of this new module, which people that will have access to it and how the information will flow.

5.1. Scope of Use

ParaCell does not only help the Main Contractor to fulfil activities in projects but they also help them to find the right competence to fulfil certain activities. The Main Contractor gives ParaCell a budget for one or more consultants that they need for their project and a specification about the knowledge requirements for these assignments. ParaCell today uses two management companies for finding these people and managing pay roll handling. These companies handle all the contacts with the consultants and ParaCell pay them a management fee for this service. Each month the consultant submit their time sheets to the management companies and that information is passed on to ParaCell. ParaCell then pay the consultant´s salaries and the management fee to the management companies. When that is done an invoice is sent to the Main Contractor and the money for the consultants is received. The problem that ParaCell is having today is that it is difficult to keep track of all the consultants, if their time sheets have been received, if the management companies have been paid and if the invoices to the Main Contractor are sent. They need an application where they have all their consultants summed up and where they can see the status of payments and invoicing activities to quickly locate delays. The users will use the application to see how for how long each consultant are hired, how high the salary is, how much the management fee is for that consultant, if the consultant has received its salary for all the received time sheets, if the Main Contractor has been invoiced correctly etc. How this should be presented is defined in chapter 5.3 (Agency Reporting Module Information Flow).

5.2. Role definition

Generally it is the people within the ParaCell organisation that will have a need to use this module. The people within the Main Contractor or the End-customer organisation have no interest of knowing any information about ParaCell´s consulting business. None of the roles within these organisations will therefore have access to this module. Also, the consultants themselves have no interest of access to this module. They normally send in their time sheets to the management companies so they would not use this application to submit those. If they would like to send their time sheets straight to ParaCell then this is done via email. In that case the receiver at the ParaCell office will add the sheet to the application. If the time sheet is sent to the management companies they must forward these documents to ParaCell so that ParaCell knows

how much this particular consultant has worked and how much that should be paid out. This submission of time sheets, made by the management companies, can be made directly in the application. This will require that the person in the management company organisation that is responsible for the consultants delivered to ParaCell will have access to add documents. To sum up there only people that will have access to this module are the personnel at the ParaCell office and the people in the management company organisations responsible for the consultants delivered to ParaCell. No other people will have access to this module.

5.3. Agency Reporting Module Information Flow

To map the information flow so that the application delivers all the necessary information a model needs to be built. This model will resemble the model built for the project progress module but it will be simpler in its performance. The purpose of the application and what information this module should display is defined in chapter 4.4.1. (Scope of Use). In more detail, the relevant information the agency reporting module should display is:

Important:

- What is the name and number of the Purchase Order for this consultant?
- What is the name, role and in what country does the consultant operate?
- Has ParaCell received the time sheet for a particular month and consultant?
- How much should ParaCell pay to the consultant?
- Has the consultant been paid, and in that case when?
- Is the Main Contractor invoiced?
- When does the contract starts and when the contract ends?

Less important:

- In what currency does the consultant prefers his salary?
- What management company this consultant is tied to.
- How many travel arrangements are supposed to be paid for that consultant?
- Are all the travel arrangements paid?
- What is the Main Contractor budget?
- How was that time sheet received?

The model handling these information requirements will in its essence look like in Figure 10. Just like in Figure 8, this model has no specific relevance to any functionality or interface.

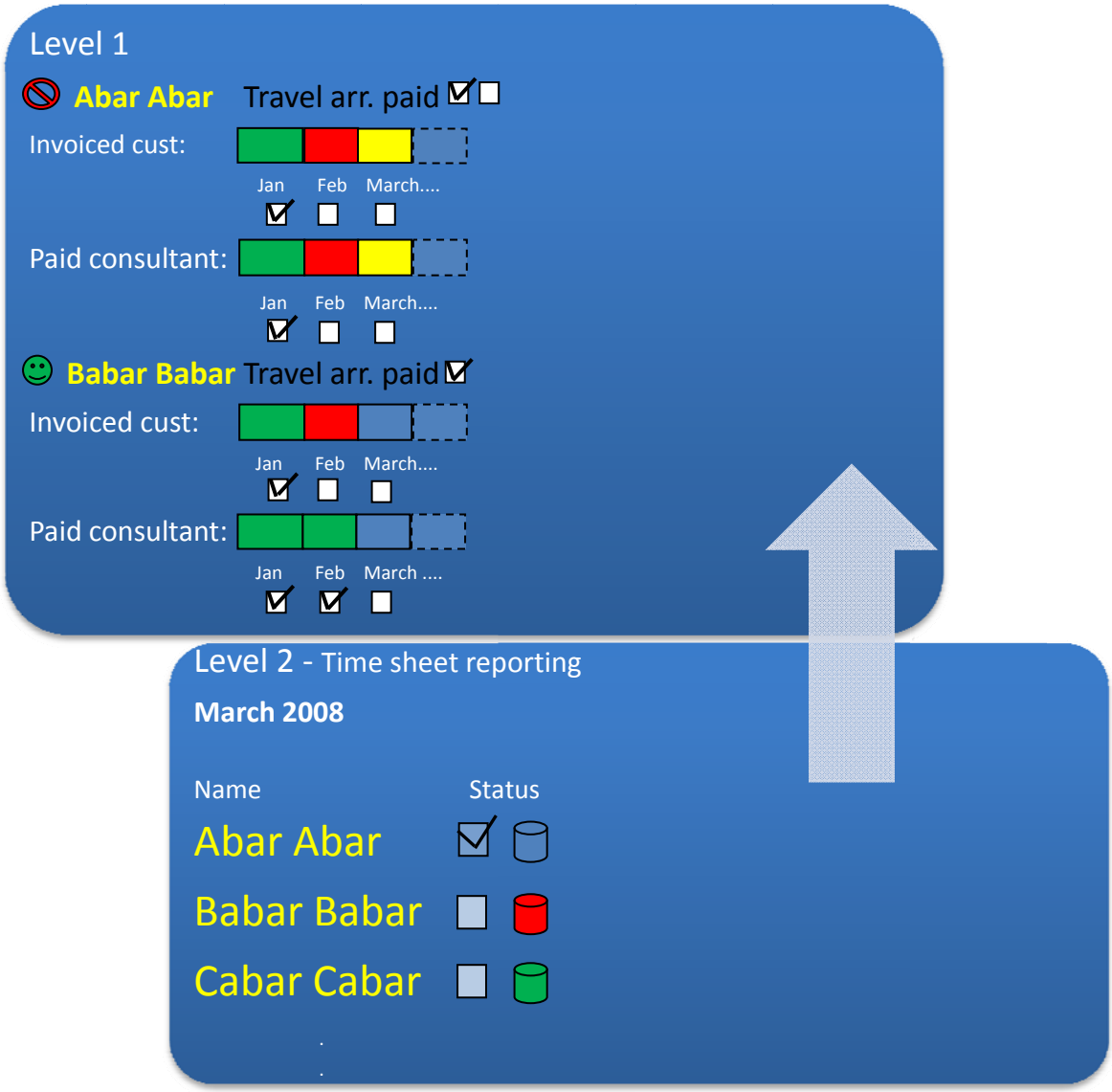

Figure 10: Agency reporting model

Just as in the project progress model input are added on lower levels. In this case the input is the time sheets handed in by the consultants. These time sheets will normally be handed in once every month for every consultant. Therefore, the timelines presented on level 1 will show the status of every consultant monthly. The submission of the time sheets can happen in two ways. Either the consultant sends it to the management company and then it is forwarded to ParaCell or it sent straight to ParaCell via email. The idea is that the management company should have access to the application and if they receive the time sheet they log in and submits it. The database icon turns green (as for Cabar Cabar in Figure 10). If the time sheet is sent to ParaCell they log in, add the document and the box next to the name is automatically checked (as for Abar Abar in Figure 10). In that way it is possible to go back and see how the time sheet was added to the application in the first place. In both cases, when the time sheet is added it is logged and the time stamp is shown, like in the figure. When the time sheet is added for a month on level 2, the two fields in the corresponding month on level 1 turns yellow. The yellow colour indicates that a time sheet is received and that no payments or invoices are sent for that consultant and that month. Before the time sheet is submitted the fields for that month is blue, indicating that no triggers has been added for that month. If certain predefined time passes after the time sheet is submitted the yellow fields turn red. When the consultant is paid the check box for that time line

and the correct month is checked. This will generate a green colour in that field. The green colour indicates that that month is complete for that consultant.

It is seen that the colour codes and the way they emerges is very similar in the agency reporting module and in the project progress module. When a milestone date is passed you get a red box. When a milestone is triggered (as "milestone completed" in the project module and "time sheet received" in the agency reporting module) you get a yellow box showing that an invoice can be sent. When the invoice is sent the user checks that box and the box in the timeline changes from yellow to green. In addition to this information the user should also see the consultant´s title, how much he or she is paid, how much the management fee is etc. This information is shown in information boxes, just as information about each project in the project progress view is shown in boxes. For each consultant it is stated in the contract how many travels that ParaCell needs to pay for (it can happen that the consultant are operating in larger areas and needs to travel) and how many travels the consultant pay for. This is shown as simple check boxes next to the consultant name as shown in Figure 10.

For each new consultant, the administrator adding this consultant needs to be presented to an input screen. This is where the administrator add all the information it has on the consultant. The application then uses this information to build the functionality and links that was presented above (refer to the input screen for the project module in Appendix D). How this input screen could look is presented in Appendix E.

The model in Figure 9 is a model showing only how the information concerning the consultant business should be handled. In reality this information is merged with the project progress information that is presented on level 1. Since the colour codes for both the modules mean the same thing, this will make it even easier for the administrators to keep track of the entire business. As we now have an overall picture about what information that this application should handle then we need to define how all this information should be sorted. As seen in Appendix D and Appendix E, for each project and for each new consultant, the Contracting entity is added. This entry will tell the application to which of ParaCell companies the project or the consultant belong. So when for instance the administrator (this user is used in this example because the administrator has access to all information in the application) logs in he or she first has to choose entity. When that is done the user will see all Purchase Orders and all consultants tied to that entity. This will help the user to get an overview over the entire entity, both for the project and for the consultant businesses. The logging in scheme will look like in Figure 11.

Choose Contracting Entity.

Sweden South Africa Malaysia

South Africa:

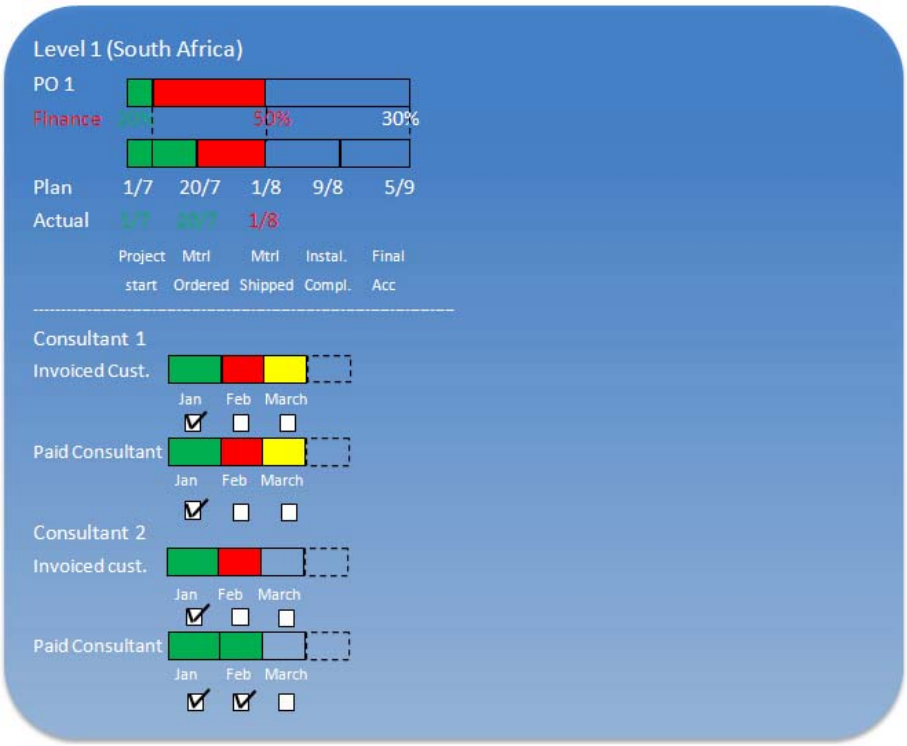

Figure 11: Logging in scheme for ParaCell´s Supply Chain Application

5.4. Conclusion

The agency reporting module of this application will not affect the project progress module that was described earlier in this report. The role definition, the information flow analysis and the access right mapping presented in chapter 4 are still applicable. The agency reporting module, although it is still displayed together with the project progress timelines on level 1, is still a somewhat stand alone functionality. It will display the users with information of a total different aspect of the company. Still, the In/Output processing logic is very much the same, as seen in this chapter, so there is no question about if the consulting business of ParaCell can be treated with this application. As seen of the two input screens presented in Appendix E and Appendix F the input information is very much the same. Also the presentation of the information is equivalent. Input is added on lower levels and presented in graphical timelines on higher levels. The main difference here is that in the project progress module there are more dependencies between activities and that the important milestones are decided from project to project. In the agency module there is one milestone every month for every consultant. That milestone is the submission of the time sheet that will trigger aggregation of information to higher levels.

The agency reporting module will keep track of how the time sheet was submitted, when it was submitted, if the consultant is paid on time and if the correct invoice to the Main Contractor was sent out correctly. In addition to this information, smaller details like the consultant´s salaries and other fees will be available in this module.

With this chapter we now have a complete picture of what exactly it is that ParaCell wants. They want an application where they can, in an easy way, update themselves both about the project progress process, well connected to the payment terms stated in the contract, and about the consultant business. This has laid the groundwork for the concluding budget chapter. This chapter will consider all the information presented in this report and use mathematical models to estimate a complete budget for the construction of ParaCell´s Integrated Supply Chain Application.

6. Budget

In order to decide if ParaCell´s Supply Chain Application should be developed in-house or bought from a supplier the budget of an in-house development must be estimated. To decide a budget is in this thesis directly translated into deciding the actual cost of such development. The term "cost" is in literature often translated into the term "effort" [Asundi, 2005]. This term include the "cost" for the competence required, the "cost" for time spent on the project (in man-months and calendar months) etc. These are aspects that have to be taken into consideration when estimating the budget that is needed for a software development. Because of this "effort" will be used to describe and illustrate cost in this chapter. Estimating software is a process of gradual refinement [McConnell, 1996]. In the estimation you start with a fuzzy picture about what you want to build and how much effort it takes to get there. As the picture about what you want to build is fuzzy the estimations of the effort required will initially be fuzzy too. This means that the result presented in this chapter is a starting point and it will be an object of constant refinement throughout the project. Nevertheless, the result of initial effort estimations should not be undervalued as it presents an important guideline of what to expect. If the estimation is far too low, planning inefficiencies will drive up the actual cost of the project. If the estimation is far too high, according to Parkinson's Law (that work expands to fill available time) will also drive up the cost of the project.

This chapter will first estimate the effort and cost of building this application from scratch. This will be done in chapter 6.2. This sub chapter will result in two final options. After the complexity of such estimation has been made (chapter 6.3) the results of the estimation process has been compared to the options of buying an already existing application. Information from the Market Analysis has resulted in three more final options in how ParaCell in the best way should realise this application (chapter 6.4). These five options are then analysed and a final recommendation will be the result of this chapter.

6.1. Estimation Process

As will be seen later in this chapter effort estimation is extremely complex and difficult to perform. From reasons that are specific to ParaCell´s organisation this process will be even more difficult. But how do you make this effort estimation? Three basic steps constitute the basic procedure [McConnell, 1996]:

1. *Estimate the size of the product.* It is a common mistake to jump into estimating the schedule. The schedule is highly dependent on the size of the project so this is the starting point in effective effort estimation.
2. *Estimate the number of man months required.* This is normally done by using the size as an input and comparing that to historical data from previous projects. Unfortunately this cannot be done in ParaCell´s organisation due to no software development history. Luckily there are additional methods replacing the history based models.
3. *Estimate the schedule.* After estimating size and man months the step of expressing this as a complete schedule is nearly trivial. The schedule is expressed in calendar months and this result will be the basic of the final effort estimation.

Wrapped around this methodology is a general step that will help the estimator to hedge it´s estimation.

4. Provide estimates in ranges and periodically refine the ranges to provide increasing precision as the project progresses (see Chapter 5.3).

The methods and models used to do effort estimation can be categorized into the following types [Asundi, 2005]:

1. *Analogy Costing.* The resource estimates are developed based upon experience from similar systems previously developed.
2. *Delphi Costing.* The estimation is based upon teams of expert doing estimations under similar assumptions and the agreeing upon a consensus estimate. Importantly, these experts are not only experts in software development estimations in general but to software development in a specific developing environment. In order to make accurate estimations factors like developing tools, programming language, effectiveness (how many lines of codes the programmers that are active in the project are producing per month) etc are important. These are factors that are specific to an environment or even company.
3. *Parametric Costing Model.* Estimations are made using prediction models which mathematically relate the effort and the duration to parameters influencing them.

As no historical data is available, the effort estimation will focus on the parametric costing models and Delphi costing. Today, a great quantity of estimating models is flooding the market. Examples of such models are COCOMO; SLIM, Function Points, and ESTERLING. These methods differ in what input they require and what output the produce. Some methods require special expertise in estimating and deciding the input for the model, e.g. SLIM [Panlilio-Yap, 1992]. Other methods, like the COCOMO model require certain extremely specific input information, e.g. Source Lines Of Code (SLOC), which can be difficult to estimate [Miyazaki, Mori, 1985]. On the other end some models produce effort (e.g. COCOMO) and some models produce actual cost (e.g. ESTERLING) [Arifoglu, 1993]. Many of these models stems back in the fact that you need some historic data or expert influence to complete a somewhat accurate estimation. Importantly, all these models are adjuncts to, and not substitute for, a detailed estimate by task by the project management. The results of the parametric costing estimation are presented in chapter 5.2 (Function Point Analysis).

6.2. Function Point Analysis

To estimate the effort of developing an Integrated Supply Chain Application for ParaCell the parametric costing estimation has to be used. Since ParaCell has no previous experience in software development and no access to experts assisting with the estimation, using this method is, at this stage, the only way of performing the cost estimation.

The development of this application is still in a very early stage. Because of this, a model that is meant to be used for an estimation made in such an early stage is required. Function Points Estimation is such a model. The output of this model is the number of man-months that needs to be devoted to this project to complete it. This number can then be used to estimate a final budget (see chapter 5.4). This model is easier to determine from a requirements specification (as the one presented in Chapter 3) than for example SLOC. There are many different ways of counting function points. The one used in this report is closest to the "1984 IBM Method" which is the basis of IBM´s and the International Function Point User Group´s (IFPUG´s) current practice [McConnell, 1996]. This model is the most widely used and tested model used for estimating size and complexity of a software development project [Symons, 2003] and therefore a good start of estimating this particular project.

When using the function point model you get the total number of function points for a particular application by estimating the complexity of a number of basic items. These items are inputs, outputs, inquires, logical internal files and external interface files. The result of the estimation of these items will result in an "unadjusted function-point total". This number must be multiplied with the "influence multiplier" to get the "adjusted function-point total". This number is then run through the Jones First-Order Estimation Practice to get the total number of man-months for the entire project. In order to use Jones First-Order Estimation Practice the project must be classified according to three categories (software systems, business systems or shrink-wrap software). Depending on how many programmers and how much these costs, the budget is easily derived from the basic schedule. Figure 12 shows the steps.

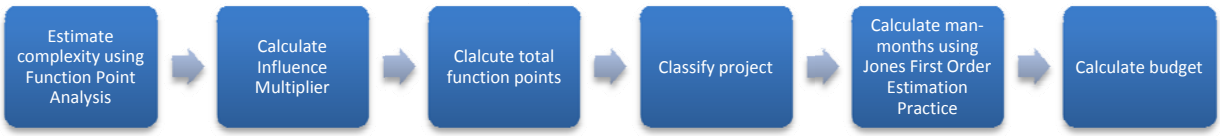

Figure 12: Steps of calculating software development budget.

6.2.1. Function Point Calculation

The first step of calculating the total number of man-months it will take to develop this application is to estimate the complexity using the items below.

Inputs: Screens, forms dialog boxes, controls, or entries through which a user adds, changes or deletes an application´s data. This includes inputs that have unique format or processing logic.

Outputs: Screens, reports, graphs, or messages that the application generates. Just as for the inputs these are outputs that have unique format or processing logic.

Inquires: Input/Output combinations in which an input results in an immediate, simple output. Generally the line between Inquires and outputs is blurry. However, quires retrieve data directly from a database and provide only rudimentary formatting, whereas outputs can process, combine or summarize complex data and be highly formatted.

Logical internal files: Major logical groups of end-user data or control information that are completely controlled by the application. A logical file might consist of a single flat file or a single table in a relational database.

External interface files: Files controlled by other applications with which the application being counted interacts. This includes each major logical group of data or control information that enters or leaves the application.

These items have been tested on ParaCell´s application and the results are as follow:

Input:

Inputs are screens, forms, dialog boxes, controls, or entries through which a user adds, changes or deletes an application´s data. This includes inputs that have unique format or processing logic.

Screens. Each user will be presented to the screen that is important to that specific user as in the requirements presented earlier. The number of screens that are prepared for input is therefore very much dependent on the number of users on this level. This application is very much screen

orientated and this aspect will counter as the major part of the complexity. Also, the majority of screens that this application should be able to handle is also screens that are built to handle some kind of input so this input category is interesting in particular. All the input added to the application must be logged by user and time which will contribute to the complexity. However, that functionality does not use a unique processing logic and can therefore not be considered as a standalone input type. It will therefore not be explicitly treated as an input aspect when determining the complexity of the input in this paragraph.

When a user within the ParaCell organisation logs in he or she can choose between three views, one for each contracting entity. This selection is an input that will only display one of three screens and is therefore a low complexity input. The information presented in these three views are aggregated and processed in the same way and there is no need to analyse these separately. We will start by analysing the project progress module complexity first. After that the agency handling complexity will be estimated separately. Even though these two modules are presented in the same level 1 overview the complexity can be treated separately. So, below is the project progress functionality and complexity analysed and estimated.

Level 1: If a user that has access to level 1 desires he/she must be able to look at the next level. There are no users that have access to the first level that does not have access to the second or third level (if these exist). This is seen in the description of the functional model in Chapter 4. The input added on level 1 decides what that should be displayed on level 2. Clicking on a date in the project progress timeline or a percentage in the financial timeline will display the more detailed items for that PO, independently of what date or percentage the user clicks on. Obviously the information displayed on level 2 is dependent on the PO clicked on when using level 1. This will conclusively be considered as medium complex inputs since different inputs results in different outputs.

The user with the access must also be able to add, change and delete information in the dialogue boxes and the information that is linked to each PO. This is a low complex input that is merely displayed to the other users having access to that level.

Level 2: Some input must also be added on the second level. Just as on the first level the user that has access to this level should also have the opportunity to display the next level for more detailed information. This is done by clicking on the text that the user is interested in and wants more information about. This input follows the same processing logic as the input added on the first level, which is a medium complex input.

Just as on level 1, the users having the access should also be able to change the information available on this level. This is low complex inputs.

Level 3: The initial screen displayed when looking at level 3 list the items that this particular user is interested in. The number of screens will be dependent on the number of users requiring different information, which is maximum 4 is ParaCell´s case. If the user wants to display more detailed information about an item, the user just clicks on the item he/she is interested in. This input will only display the activities linked to that item. The complexity of these four screens will only generate the presentation of more detailed activities linked to that item and the complexity of these inputs are therefore considered to be medium.

Each of these more detailed activities presented on level 3 are linked to checkboxes for reporting the completion of these activities. The top management and finance will only have a read-only access and no input screens are displayed to these users. Project Management and Sub Project

Management though have read & write access and use these screen to report milestone completion. When a box is checked in any of these screens this will lead to a check if this will generate any status change in levels above. This will increase the complexity of these inputs from medium to high.

Just as on level 1 and 2, the users having the access should also be able to change the information available on this level. This is low complex inputs.

Summary: Initially the presentation screen enables the user to choose between three options. This input screen is a low complex input screen. On level 1 the input type that is explicitly added by a user, and that will display a lower level, will basically follow the same basic processing logic and is therefore considered as 1 low complex input. On level 2 only 1 input with low complexity exists. On level 3 there are two types of inputs. One input type with medium complexity and one input type with high complexity. On each level there must be the opportunity to change basic information that is displayed to the users which will contribute with three more low complex inputs.

Building the application. Before each project starts the application need to be configured to mirror the milestones and payment terms that apply for that project. This configuration will be done by the administrator located in ParaCell Main Office. The interface in these set-up screens needs to be simple but does not require the same graphical and intuitive interface as the screens presented while the application is running. The reason for that is that there will be a limited number of users that will be operating as administrator. This enables the possibility to educate these users in how the application is configured. However, since all links between future entries must be configured and all the profile settings needs to be done in this configuring interface it generally means that the application configuration input is considered as highly complex.

First of all, adding entries, e.g. activities linked to a specific base station or multi switch (earlier called items) will be considered to be a high complex input. These inputs are also divided into two different inputs. Firstly, the activity is added and it is decided who is responsible and who that has the access to use the application to change the status of that activity. Secondly, this activity must be linked to an item. Adding an item follows the same logic. Each item must be linked to a phase (if the projects is divided into phases) or similar. This will therefore not be considered as a unique input.

Also, every user added to the system must also be linked to a role. This input will decide what access class the user will have and what levels the user will have access to (see chapter 4.4). Therefore, adding a user results in two inputs, both highly complex.

Summary: Configuring the application will contribute with some high complex inputs. Because of the applications dynamic nature these high complex inputs are necessary. Altogether, application configuring contributes with four high complex inputs.

Logging entries: All the data added must be logged by user and date. This is a unique input processing logic that is considered to be medium complex. It is static information but that still needs to be processed, by checking user and date, each time a change is made.

Summary: Logging entries is a unique input processing logic that is considered to be medium complex.

Dialogue boxes: Each project, each milestone date and each percentage on the commercial timeline on level 1 needs to have some basic information boxes tied to them. These boxes will facilitate the need for quickly finding important related information for each project. If we go back to the basic needs for the Top Management role we find that it is important that the OM, the KAM, PC and the BC knows how much money that is in the pipeline and how much money that is being invoiced and when. In the commercial timeline the user that has access to level one can see that PO1 is delayed and that 50% of the total income for that project is delayed. It is also important that this person can see how much money this is. This will be shown by information boxes linked to every milestone. Also on lower levels dialogue boxes must exist to clarify the entries. These boxes will be created by the administrator when building the application and it is simple, low complex, inputs that are not treated in any specific ways when the application is running.

Summary: The dialogue boxes all follow the same processing logic and consist of a low complex input by the administrator.

User information: All the activities on the third level will be linked to the person responsible for that activity. Name and the best way of contacting that person will be available. This will make it simple for the users to quickly find out who to contact if a project is late. Just as with dialogue boxes this is low complex inputs for the administrator that is not processed in any way while the application is running.

Summary: The user information is low complex input that all follow the same basic processing logic.

Output:

Outputs are screens, reports, graphs, or messages that the application generates. Just as for the inputs these are outputs that have unique format or processing logic.

Screens: Each level will have the opportunity to display a large number of output screens. The vast number of different output screens proves the dynamism of the application. The number of different screens will be determined by the number of users that requires different kinds of information and also by the size of the project. A bigger project requires more roles that will use the system that have their own requirements on information. It requires more levels, more items on level 3 and therefore more activity lists. This is closely related to the number of output screens.

As explained above, when a user logs in it can choose between viewing one out of three countries. This screen is displayed to users within ParaCell since its customer should have no insight into ParaCell´s different contracting entities. The presentation of this screen is therefore user dependent and has a medium complexity level.

Level 1: Each user that has access to level 1 should only be presented to the PO:s that this user is interested in. The admin should see all purchase orders, the Top Management should only see the orders that this main contractor has outsources and the End-customer should only see the PO:s that concern that organisation. The number of screens will therefore be dependent on the number of users that require different screens. Generally, in ParaCell´s case, there are four different such users relevant in this report. The Top-Management requires one specific screen, the admin requires one screen, the End-customer requires one screen and the PM could require one special screen. However, all these outputs follow the same processing logic and can therefore be seen as one output screen. Since the output screens are dependent on detailed information

added on lower levels and also that both a project progress view is presented linked to a financial view the output presented are considered to be high. Also, the output screens on level 1 are graphical which further increases the complexity.

Level 2: All the users that have access to level 1 will also have access to level 2. Independently of what link that is clicked on level 1 the same information belonging to that PO will be presented on level 2. The most important milestones for each project phase are summarized on level 2. This means that the number of output screens displayed on level 2 will be dependent on the number of projects that are active as there will be one screen per project. However, all the output screens presented on level 2 follow the same processing logic and can therefore be summarized into one output screen. The information is determined on what data that is added on lower levels and as with level 1 output screens the complexity is considered to be high.

Level 3: Different output screens will be presented to the IM, the SM, the PM and the CW. The PM will be able to see all the information available on this level (and so will also the admin so this will be treated as one screen) and the SM, IM and CW will only see information that these roles are interested in. When logging in the users that have access to this level will see the list of phases and items that this particular user is interested in. This is the MSD, BSC3, BSC4, GPRS and RBS1 list in the function model. Although the screens will look different depending on users they use the same logic to be constructed and this basic view is therefore one output screen. The information of every output screen depends on the information added to the activities for each item. The complexity of this output screen is therefore considered to be high.

When the user clicks on an item on level 3 the activities for that item are displayed. This list is dependent on what user that is clicking on the item since each user should only see the activities that this user is interested in. Therefore this output screen is considered to be high.

Summary: When logging in it is decided what screen the user should be displayed to. This is a medium complex output screen. Level 1 must be able to present one high complex output screen. Level 2 must be able to present 1 high complex output screen. On level 3, two different screens are available. Both are user specific and therefore considered high in complexity.

Reports and graphs: The automatic creation of reports or graphs is clearly something that contributes to a program´s complexity. This application will initially have no functionality for such creations. The application will merely present the user to documents and information added by another user.

Messages: Since this application should store date and user information for all changes it will also display this information to the users. These messages are medium complex outputs.

Also, all the milestones that are added do also have a presumed completion date. When that date has passed the users must be notified that the project is late. This will be done at all levels but these messages are created using the same processing logic and they are therefore summarized as one medium complex output.

Summary: The messages category contributes with two medium complex output screens.

Inquires:

This is Input/Output combinations in which an input results in an immediate, simple output. Generally the line between Inquires and outputs is blurry. However, quires retrieve data directly from a database and provide only rudimentary formatting, whereas outputs can process, combine or summarize complex data and be highly formatted.

A lot of information added on level 3 is aggregated up to level 1. The output from level 2 is considered to be input on level 1. Since this is input that generates an automatic output it is considered to be an inquire. Each input from level 2 will be connected to the project progress milestones in the timeline for the correct project. This input will decide if the entry is delayed or on time. There could be several trigger points that have to be completed in order for level 2 to produce an input to level 1. This can be compared to the functional model where "Material Shipped" in both Phase 1 and 2 must be completed before the application should generate that this milestone in the project progress timeline on level 1 should be marked completed. This is therefore considered to be high complexes inquires. In the next step this project progress timeline is connected to a commercial timeline and if the dates and percentages should be red and if the "Project" and "Finance" texts should change colour. Since each input to the project progress timeline is straight forward compared with the commercial timeline this is a medium complex inquire.

On level 2 the same principals apply. Output from level 3 will function as input for level 2. If level 3 automatically reports that all the material for phase 2 is shipped, as in the functionality model scenario, level 2 mark this line as green and checks if the rest of the material for that PO is shipped. In that case it sends an input to level 1 that this milestone is complete. Otherwise it waits for more input from level 3. This is a unique form of inquire processing that is considered to be high complex.

On level 3 we have several inquires. Firstly, the input from the user telling the application that, e.g. the material is shipped for BSC3 this will create an output that this station should be marked green. This is a simple input that generates a simple output and the complexity is therefore considered to be low. Secondly, the input that the material is shipped for BSC3 is compared to the material shipped for the rest of the items in that phase. If all the material is shipped for all the items in that phase, level 3 generates an output to level 2 that all the material for that phase is delivered. If there are items in that phase that still has not had the material delivered level 3 waits for more input before the output can be created. This is a high complex inquire.

Summary: On the first level we have 1 high complex inquire and 1 medium complex inquire. Level 2 consist of one high complex inquire and level 3 process two types of inquires, one medium complex and one high complex.

Logical Internal files:

Logical internal files are major logical groups of end-user data or control information that are completely controlled by the application. A logical file might consist of a single flat file or a single table in a relational database. ParaCell´s application must be able to handle documentation and all the documents added to the application are completely controlled by the application and will therefore be included in this category. Documents of several different formats must be permitted. The files added will not have any relationship with any complicated data processing in the application itself so no logical files will be considered of having a high complexity. There are a number of documents that needs to be added, edited and deleted on the different levels. However, none of the documents added will have a very specific format or would need any specific handling. All the documents that this application needs to be able to handle are pdf files,

word documents, excel sheets or similar. Therefore the application must be able to handle one type of low complexity files.

External Interface files:

External interface files are files that are controlled by other applications with which the application being counted interacts. This includes each major logical group of data or control information that enters or leaves the application. Since this application will not be interacting with any other software, at least initially, no such files exist.

Agency handling:

This application should be able to handle two major aspects – keeping track of financial and project progress related issues in the project organisation. The other aspect, as described in chapter 4.4, should be able to keep track of the consultancy business. To simplify the complexity estimation process made in this chapter, the agency handling has been treated separately. The reason for that is that the functionality in this part of the application resembles the functionality in the project overview part of the application. In reality, there are no inputs, outputs, inquires or document handling in this consultant overview that follow a specific processing logic. The agency handling will therefore not affect the overall complexity to a great extent. However, there will be some complexity changes because of this functionality.

This extra agency functionality is supposed to be handling time reports added by the consultants or the staff at the ParaCell office. This is not a new input since the project module already estimated above is suppose to be handle documents as well. What is new is that the application must be able to start counting days from when the time report was added to the application and flag when a predefined number of days have passed. The procedure of how this is done and presented is explained in the In/Output chapter. This counting of days and flagging when the limit has passed is a high complexity output. An extra special processing logic is also added with this agency functionality on level 1. When a box for a month is checked on level 1 the colour for the corresponding timeline in the graphical interface should turn green. This is another low complexity input. Finally, both the timelines at level 1 should automatically change colour to show the status of that consultant. When the time report is attached on level 2 the field on the timeline at level 1 should turn yellow. This is a low complexity input. The same goes if the time report is attached by a ParaCell employee. Then the box for that consultant and that month is checked and the corresponding field on level 1 turns yellow. This is though the same processing logic as when the time report is attached by the consultant, so this will not contribute to any extra complexity. Just as in the project progress module there the possibility to add information fields about each consultant must exist. This will follow the same procedure as when the information fields are added to the project progress module so this will not contribute to any extra complexity. The input screen for adding a consultant will basically contain the same fields and lists as the input screen for adding a new project, presumably less complicated. However, since this input screen must be constructed and that the graphical interfaces should be created based on the information added to this input screen then this will add one high complexity input screen and one extra high complexity output screen.

Summary:
Altogether the agency module does not contribute very much to the overall application complexity. To sum up this module will contribute with 2 high and 2 low complexity input screens and 1 high complexity output screen.

When the above mentioned items have been analysed together with the application that is being counted, Table 3 is used to calculate the "unadjusted function-point total".

Program Characteristics/ Function Points	Low Complexity	Medium Complexity	High Complexity
Number of inputs	x3	x4	x6
Number of outputs	x4	x5	x7
Inquires	x3	x4	x6
Logical internal files	x7	x10	x15
External interface files	x5	x7	x10

Table 3: Function Point Multipliers

Table 4 shows the total number of inputs, outputs inquires, logic internal files and external interface files from the analysis just presented.

Program Characteristics/ Function Points	Low Complexity	Medium Complexity	High Complexity
Number of inputs	10	2	7
Number of outputs	-	3	5
Inquires	-	2	3
Logical internal files	1	-	-
External interface files	-	-	-

Table 4: Total number of program characteristics

6.2.2. Influence Multiplier

The next step is to calculate an "influence multiplier" that is based on several factors and their influence on the application. These factors are data communications, online data entry, ease of installation and processing complexity. The influence multiplier ranges from 0,65 to 1,35 [McConnell, 1996]. Presumed that each factor have the same resulting impact on the influence multiplier and that all factors are considered to have a high influence on the application the influence factor will be considerably high. The influence factor is set to 1.25.

When this multiplier is calculated it is multiplied with the unadjusted function-point total to get the adjusted function-point total. The whole calculation is shown in Table 5.

Program Characteristics/ Function Points	Low Complexity	Medium Complexity	High Complexity
Number of inputs	10x3	2x4	7x6
Number of outputs	-	3x5	5x7
Inquires	-	2x4	3x6
Logical internal files	1x7	-	-
External interface files	-	-	-
Unadjusted function-point total			**163**
Influence multiplier			**1,25**
Adjusted function-point total			**203**

Table 5: Total function points

6.2.3. Application Classification

In order to get a fairly correct estimation using function points the application that is to be estimated must be categorized into one of three general project types. These types can be defined as follow:

Systems software includes operating software, compliers and code libraries. Embedded software, firmware, real-time systems and scientific software share many characteristics as system software.

Business software refers to in-house systems that are used by a single organisation. They run on a limited hardware, perhaps only a single computer. Payroll systems, accounting systems, and inventory control systems are good examples.

Shrink-wrap systems are software that is packaged and sold commercially. It includes horizontal-market products like word-processors and spread-sheets and vertical-market products like financial-analysis, screenplay-writing and legal case-management programs.

The application that ParaCell is looking for is a closely related to a software group called vertical-market software, which falls within the shrink-wrap systems. Vertical-market software is software that is developed for a specific market and for a specific clientele [Techterms, 2008]. In this case this product is very specific to ParaCell´s needs. The idea is not that this application is to be packaged and sold commercially but the development process and functionality required resembles shrink-wrap software. Some resources compare shrink-wrap software with project-planning software [Construx, 2008] which is very much comparable to ParaCell´s integrated application.

6.2.4. Jones´s First-Order Estimation Practice

The more complicated a project is the longer it normally takes to complete it. The complexity of the application is closely linked to the number of months it takes to develop it. When the complexity is known and the project is classified we can convert the function points into a basic schedule, expressed in number of months, using Jones´s First-Order Estimation Practice. To use this model you simply take the function points total and raise it to the power selected from Table 6 below. These exponents are derived from Jones´s analysis of his database of thousands of projects [Jones, 1995][McConnell, 1996].

Kind of software	Best in Class	Average	Worst in Class
Systems	0,43	0,45	0,48
Business	0,41	0,43	0,46
Shrink-wrap	0,39	**0,42**	0,45

Table 6: Exponents for Computing Schedules from Function Points

The application ParaCell is aiming to develop cannot be considered to be best in class since a first basic version is the first target. This application is also not considered to be worst in class since there are no specific applications to compare with. The numbers in the "Average" column is there out of interest in this estimation. This means that the first initial rough estimation of an in-house development schedule is **9 months** ($203^{0,42} \approx 9.31$).

6.2.5. Competence

The development of this application is not expected to be performed by one single programmer. The people doing the programming must have excellent knowledge about the programming language used *and* about the libraries needed for linkage between code and database and code and web interfaces. Optimal team compilation would be that two programmers construct the code while one GUI expert handles the graphical web interface aspects [Schubert, 2008]. Using to many programmers complicates the work considerably so there is a reason for limiting the

number of programmers. Using two programmers though will cut the development time in half. With the help of a GUI expert the time for the total development would be approximately 4-5 months, using the calculation of total man-months from previous chapters.

6.2.6. Cost Estimation

The last piece of the puzzle in the budget estimation is the cost of the developing people that will be used. This sub chapter will suggest two options that will result in two different budgets.

Option 1: ParaCell has been in contact with a company called Input Soft AB. This company develops a number of different software applications on a daily basis. Input Soft AB use programmers in Minsk, Belarus for the major part of their software development. Input Soft AB is specialised on handling the communication with the people in Minsk and writing specifications so that the correct software is developed. The programmers in Minsk check in their code every week and Input Soft AB goes through this code to see that they are on the right track and that the code is well written. These programmers take €20 per hour. In addition to that Input Soft AB will take their piece of the pie so it is estimated that the overall cost for using Input Soft AB will be approximately €30 per hour (300SEK per hour). This will result in a total cost of **430.000SEK** (300SEK per hour x 40 hours per week x 4 weeks a month x 9 months ≈ 430.000SEK).

Option 2: Assume that programmers from a Swedish IT company are hired to do the development of this application. Further assume that these programmers cost about 1000SEK per hour for their work. There are of course more expensive programmers and also cheaper programmers, but the total budget given here can be related to the actual price paid *if* a programmer with similar salary is employed to do the work. The total cost would be **1.440.000SEK**. (1000SEK per hour x 40 hours per week x 4 weeks a month x 9 months ≈ 1.440.000SEK).

6.3. The Complexity of Cost Estimation

As presumably already understood estimation software development is difficult. If the estimation is too low, planning inefficiencies will drive up the actual cost of the project. If the estimation is too high work automatically expands to fill available time (Parkinson´s law). There are some issues that will help to enlighten the fact that it is difficult to establish a common opinion about the requirements of the application among the users.

- Who is interested in the application?
- The ones that are, are they interested in a simple or more complex application?
- If you develop a simple application, will there be a need for a more complex solution in the future?
- How will the application be designed? There is typically a factor of 10 difference in the design complexity of different designs for the same feature.
- What will be the quality level of the application? Depending on the care taken during the implementation, there can be a factor of 10 difference in the number of defects contained in the original implementation
- How long will it take to debug the mistakes made in the implementation of the application? Individual performance among different programmers with the same level of experience has been found to vary at least with a factor of 10 in debugging the same problems.

- How would it take to integrate the application with other systems if that will be done in the future?

Researchers have found that project estimations fall within predictable precisions at various stages of the project [Boehm, 1995]. The estimation convergence graph below (Figure 13) shows how estimates of schedule and budget become more precise as the project progresses.

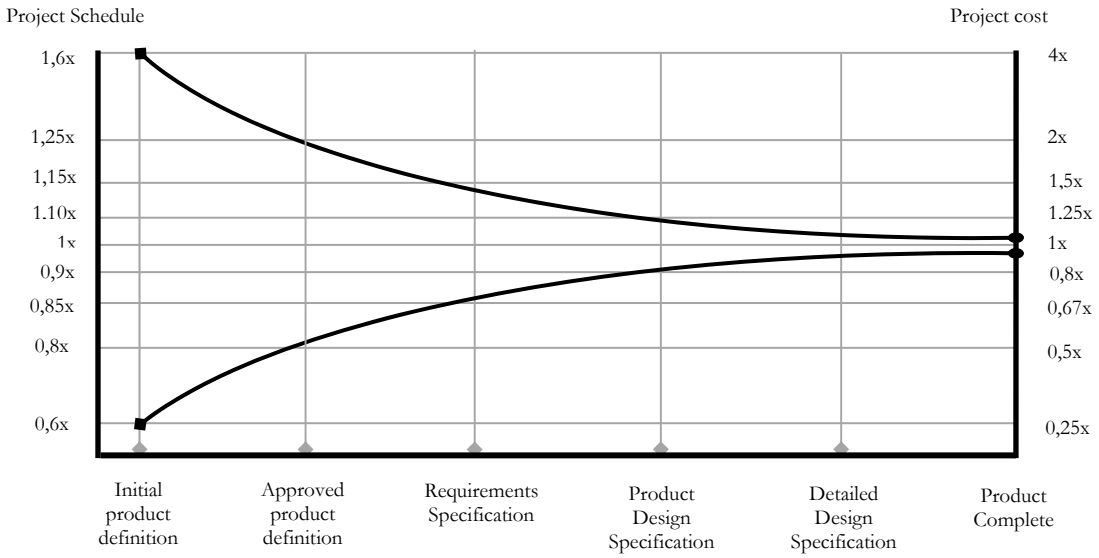

Figure 13: Estimate convergence graph

This graph very much captures the reason why software development estimation is hard. When developers are asked to perform a first rough estimate there can be a factor of 16 difference between high and low estimates [McConnell, 1996]. Even after the requirements have been completed you can only know the amount of effort needed to within about 50% [McConnell, 1996]. The ranges in Figure 13 can be summarized numerically in Table 7.

Multiplier compilation	Effort and Size		Schedule	
Project Phase	Optimistic	Pessimistic	Optimistic	Pessimistic
Initial product concept	0.25	4.0	0.60	1.60
Approved product concept	0.50	2.0	**0.80**	**1.25**
Requirements specification	0.67	1.5	0.85	1.15
Product Design Specification	0.80	1.25	0.90	1.10
Detailed design specification	0.90	1.10	0.95	1.05

Table 7: Estimation multipliers by Project Phase

As seen in Figure 13 the estimates should be very general in the beginning and then get more refined towards the end. At this stage, the ParaCell application development has passed the initial product concept and is closing up on an approved product concept. The numbers for the second project phase is therefore applicable in the estimation made for this report. Also as for now, the schedule for the development is of primary concern whereas the numbers in the two right side columns are relevant. If these numbers are used on the estimation made in chapter 5.2 we will get a range of total 7,4 to 11,6 man-months is the range ParaCell should expect. For further analysis of this estimation please refer to Appendix F.

In the early stages of a project, an algorithmic or table-lookup estimate, as done here, will be the most accurate. As the project progresses, maybe around mid-design time, estimating each of the tasks individually and then adding up them up will be more accurate and it will also remain so for the rest of the project.

6.3.1. Confidence-Factor Approach

Estimating a range of completion like above is interesting but it does not give the whole picture. An important and relevant question that should arise when presented to a range is, "What chance do ParaCell have of making the estimated date and ending up within the range?" Using the same principle as estimating the optimistic and pessimistic completion dates the statistics reveal there is a 50% chance of completing the project before your "most likely" date [McConnell, 1996]. Using the function point analysis and the Jones´s First-Order Estimation Practise, results in a "most likely" estimate. Your "most likely" estimate is the date that lay exactly the estimated time frame away from your start date. Then, as done in chapter 6.3, this "most likely" estimate is multiplied with Table 7´s "optimistic" factor to provide the estimate that can be used with a 5% confidence. Multiplying the "most likely" estimate with the "pessimistic" factor will provide the estimate that can be used with a 95% confidence. Thus, if the total man-months needed to complete this project is estimated to 9 months and the start date is set to the 1st of June 2008 the "most likely" date for completion is the 1st of March 2009 (assuming only one person is working with the project). This is then multiplied with the "optimistic" and "pessimistic" factors giving the final estimated schedule as presented in Table 8.

Delivery Date	Probability of Delivering On, Before or After the Schedule Date
May 15 2009	95%
March 1 2009	50%
January 15 2009	5%

Table 8: Confidence-Factor Estimate

6.4. Cost of Buying an Application

When the cost for developing this application from scratch has been estimated, the total cost for the applications that were recommended for further analysis in the market analysis must be estimated. To be able to decide between buying and developing this application the budget for these alternatives must be compared. The estimated budget for the IS-Tools, Antura and Omnix is presented in chapters 6.4.1 to 6.4.3.

6.4.1. IS-Tools

IS-Tools and their application IS Builder will be **option 3**. IS Builder, including five users, will cost €20.000, in its simplest version. After that there is €275 for every user and 16% per year of the total cost of the whole solution delivered. In addition to this there are costs for training and adaptation of the final solution to the organisations needs. IS-Tools estimate this to about €10.000 [Håkansson, 2008]. If the number of users are set to 20 as a starting value this would mean that the total cost of choosing IS-Tools would be approximately €35.500 plus additional €10.300 yearly for support and updating.

6.4.2. Antura

Antura Projects is **option 4**. The price for Antura Projects is SEK59.000 for the software and licenses [Andersson, 2008]. Then there is an additional SEK5.000 per month depending on the number of users the application should be able to handle. No support or operations and maintenance are included in this price. For that there is an additional cost of SEK2.000 to SEK5.000 per month depending on the configuration and size of the application that is used. As mentioned with IS-Tools there is always also a cost for consulting work and training when setting up the application. Conclusively there will be a total cost of approximately 179.000SEK the first year and then additionally 84.000SEK per year for maintenance and support (estimated user costs to 4.000SEK per month and 3.000SEK per month for maintenance costs).

6.4.3. Omnix

The Omnix platform delivered by Andrew is **option 5**. Estimation from Omnix states that an application that meet ParaCell´s basic demands will cost about €100.000 [Barker and Bray, 2008]. Similar versions have been made by Andrews and this price is normally what has been paid. Any integration that might be necessary in the future is not included in this price.

6.5. Conclusion

As realised in this chapter, estimating the budget for a software development is extremely difficult. The reason for that is that there are too many aspects that are involved for any person doing the estimation to keep track of and have accurate information of. In ParaCell´s case this estimation process is even more complicated due to the fact that there is no history of software development to refer to and there are no experts within the organisation that have experience in estimating time and budget. This led to an estimation process based on a couple of mathematical models and statistics. Firstly the complexity was estimated using a functional point analysis. The output of that analysis was a number that usually is compared to other projects in the same organisation tested with this model. The same number of complexity usually leads to the same development time and in the end, the same development cost. In order to use these numbers for comparison it is important that the projects used for the function point analysis are performed in the same organisation. The reason for that is that then the efficiency of the programmers, the effectiveness of the tools they use, the amount of time the programmers spend on other assignments etc are included in the estimation. Since there is no such projects within ParaCell tables of statistics are used instead. In Jones´s First-Order Estimation Practice, thousands of projects has been tested using this estimation model and an average of man-months used for each complexity number is compiled in a table. The table present a couple of exponents that the total function point number is raised to in order to get the total number of man-months needed for this project.

In ParaCell´s case, the application they need to integrate the supply chain and facilitate a more efficient communication throughout this chain would take approximately 9 months to develop. This according to the function point analysis made in this chapter. Due to the high complexity in software cost estimations, and especially when the estimation is made this early in the project, it is always good to create a range for the schedule and budget. This will demonstrate that the estimation is only a vague assessment and that the final cost will probably end up within the borders of this range. The rule of thumb is naturally that the earlier you are in the project the wider the ranges are. As the project progresses this range narrows down to a more specific final cost. According to Boehm´s Estimation Convergence graph [Boehm, 1995] this range for this application development has been calculated to 7,4 to 11,6 man-months. As Ulf Schubert stated, this kind of projects normally involve two or three programmers and one GUI expert. This

means that the total time to develop an integrated supply chain application for ParaCell would be around four months.

This chapter has presented five final options about how ParaCell can go ahead in realising their own supply chain application. These options are summarized in Table 9 below. These options and how ParaCell should prioritize these will be analysed in chapter 7.2 (Supply Chain Application Realisation). The prices originally presented in € has been converted to SEK using the exchange rate 10.

Alternatives	Initial cost (SEK)	Yearly support cost (SEK)
Option 1 (Input Soft AB)	430.000	Not estimated
Option 2 (Other Retailer)	1.440.000	Not estimated
Option 3 (IS-Tools)	355.000	103.000
Option 4 (Antura)	179.000	84.000
Option 5 (Omnix)	1.000.000	Not estimated

Table 9: Initial cost and support cost for the five options

7. Thesis Conclusion

The thesis conclusion will summarize the chapters presented in this report. It will present the options derived throughout this project and recommend how the future work should proceed. An analysis of the overall work will also state the difficulties and obstacles that I had overcome.

7.1. General Thesis Conclusion

After it had been pin pointed what ParaCell´s problem is and the goals had been defined it was realised that the outline of this thesis closely relates to another common organisational problem, namely to define and integrate your company´s own supply chain. The supply chain is a chain of companies and processes the enables the company to offer what the customer wants. This is the core aspect of ParaCell´s problem - they want to offer the customers and consultants updated information about the project progress of their telecom projects. This can be realised with an integrated supply chain application. After ParaCell´s own supply chain had been identified the next step was to outline what it is that ParaCell really *needs*. The result of this analysis was that ParaCell are in need of a application that can merge the different stakeholders of its supply chain by offering a reporting tool that is fast, simple, accurate, easy to access and constructed from terms and conditions outlined in the contract signed between ParaCell and the Main Contractor. The application should be extremely dynamic and offer opportunities to create a very simple overview over the entire project office with different log in profiles that present each user with only the information necessary. Each entry reported must also be logged and compared to an original data for when that entry were supposed to be reported according to the contract. Last but not least the application should handle fast and effective adding and editing of documents of different kinds.

When this was known the next step was to do an analysis of the current market. This market analysis showed that what ParaCell is looking for is an application that is very narrow but also very deep in scope. Few specific requirements are defined but the requirements that is defined demands an extremely dynamic product that simpler tools do not offer. No supplier that offers exactly the solution that ParaCell wants was found. More expansive tools do meet ParaCell´s requirements but they also offer a lot of features in addition to the ones desired. Before any decision about if any of these should be employed further analysis about in-house development costs must be made. This thesis therefore offers a recommendation about which applications and suppliers that should be considered when this decision is to be made. Projektplatsen.se, Microsoft Project, Microsoft Server, Microsoft Sharepoint Server, Sharepoint Services and Projektspecialisten are applications that are recommended not to employ in the future. IS-Tools, Primavera, Antura and Omnix are applications that offer what ParaCell is looking for and this thesis recommends that these applications will be taken into consideration in the future.

The market analysis created a more substantial foundation and a clearer picture about what it is that ParaCell needs. To make this an application it is important to plot all the *roles* that lay under ParaCell´s supply chain, hence the roles that should have access to a future application. The role list basically involves four main stakeholders – ParaCell, the Main Contractor, the End-customer and the consultants. ParaCell´s supply chain at one end starts with the End-customer that wants a telecom project to be performed in an emerging market. The End-customer signs a contract with the Main Contractor that will deliver the service in the end. If the Main Contractor realises that it lacks the competence for some, often locally, activities it then decides to outsource these parts of the project. ParaCell is a sensible choice because of its special competence in telecom projects executed in these markets. ParaCell then concludes the chain by contract the consultants they need to deliver their part of the contract.

As explained in Figure 4, the crucial aspect of ParaCell´s supply chain, and this thesis, is the information flow between the stakeholders. The input data is primarily in form of milestone completion reporting that is transformed into financial and project progress information. By constructing a simplified schematic model of how an integrated application could process input and present output, using knowledge from previous chapters, this mapping could be performed. The model shows basic functionality, built on levels, where reporting data is added on a low level by the consultants in one end of the supply chain and aggregated up to an overview level at the other end and viewed by the Main Contractor and the End-customer. The application should also be able to handle agency updating. The user at ParaCell will be able to use the application to keep track of their consultants, where they are, how much they earn, when they are paid etc. Knowing what roles that exist and what information that flow under ParaCell´s supply chain the next rational step is to link each role to an access class and level. The result was as follow:

- Top Management – Read-Only Access to all levels
- End-customer Management – Read-Only Access to all levels
- Project Management and Finance – Read & Write Access to all levels
- Administrator – Full Access to all levels
- Sub Project Management – Read & Write Access to Level 2 and 3
- Project Teams – Read-Only Access to Level 3.
- Others – No Access.

The report, up until chapter five has focused on ParaCell´s project business and how to keep track of the important milestones in its projects. This problem is closely linked to another part of ParaCell´s business, namely keeping track of its consultants. This problem, as described in Chapter 5, could preferably be an extra module, or more correctly functionality, in ParaCell´s Integrated Supply Chain Application. The resemblance and relevance between these modules is that it is all about creating a mean to follow the reporting status of important milestones. If these milestones are installation completion in a project or time report submission from a consultant does not matter from a functionality, interface and programming point of view.

The budget chapter stated the different methods that are generally used to estimate the budget of a software development project. The organisation either uses previous projects or experts to do the estimation. If neither of these are available, like in ParaCell´s case, mathematical models and statistics must be used. In this report the function point analysis, in combination with Jones´s First-Order Estimation Practice, has been used to estimate the complexity of the application. This result was used on tables presenting general statistics to calculate the total number of man-months. This resulted in altogether 9 man-months. If two programmers, and one GUI expert, would be used the total time would be around four months.

7.2. Supply Chain Application realisation

Looking at the options presented in Table 8, option 2 presented in chapter 5.2.6 (Cost Estimation) and buying Omnix (option 5) is firstly ruled out. These alternatives will cost too much in comparison with the other alternatives. IS-Tools (option 3) is not as expensive as option 2 and 5 but will still too expensive in the long run to be chosen as a legitimate choice. In order for a retailer´s application to be interesting to purchase it must provide something extraordinary, which could be a really good price in combination with a fantastic feature that no other vendors offer. As explained earlier, there is always an extra incentive to own your own application. You will have complete control over your product and it is yours to sell to whomever you want. These are aspects that are highly valued within ParaCell. The functionality and the price of IS-Tools do not offer the surplus value to be chosen as a final alternative.

Any of the two remaining alternatives, using Input Soft AB (option 1) as a retailer or buying Antura (option 4), are hard to exclude. Antura will initially be cheaper. The application is not at all expensive to deploy to meet ParaCell´s requirements. On the other hand, implementing Antura will lead to a somewhat expensive support and maintenance agreement that will be fixed cost for as long as this application is used. Obviously, an application built from scratch will also need support, but ParaCell will get the advantages of owning a product that will entirely meet their own requirements. They will own a product that they have total control over to use in whatever way they want and sell whenever they want. If supporting an in-house developed product will contribute to any monetary benefits or not, comparing to a support agreement of a bought application like Antura, is very hard to estimate. A thorough pre-study though will help the developers and ParaCell to understand what the problem is and what exactly it is that is needed. This will decrease the risks of ending up in an ever changing development process with massive amounts of supporting hours. Having a well defined pre-study will increase the incentives for building your own application. Buying Antura could lead to problems if ParaCell wants to take this application to next level. It could be that ParaCell wants to adjust it to a specific organisations needs and sell the application, or parts of it, to that organisation. This could be a major issue if the application is bought and someone else owns the code. If the decision is made to contract Antura to help them with their supply chain problem then some obvious benefits arise. Any updates or improving modifications that are made to Antura Project will also of course affect ParaCell´s application. Every somewhat complicated applications constantly needs to be developed and improved in order to survive and this is done automatically if the application is bought.

These are pros and cons that ParaCell has to weight against each other before a final decision is made.

7.3. Thesis Analysis

This thesis has an organisation specific approach where very little information can be found in any literature. Mapping an entire project structure for a company that is involved in projects with big complex organisations like Ericsson AB has been a great challenge. Defining ParaCell´s supply chain has been a helpful tool for getting started with creating a structured role list and information flow analysis. The reference group has been a great resource in defining organisations, roles and information needs. Without them this thesis would be insignificant and hollow.

The desirable conclusion for a market analysis would be the termination of unqualified applications and the unquestioning conclusion that the rest of the applications could be employed if ParaCell chooses to obtain this application. Unfortunately this decision is dependent on factors that lie outside the scope of this thesis and consequently these conclusions cannot be made.

The role list presented in this thesis should be seen as a generalised list where focus should be on each role´s responsibility and goal fulfilment and not on their title. Every project is unique and few projects employ all these roles but the responsibilities they represent are generally handled by somebody. The role list can initially be hard to grasp, because its title specific presentation, but the list is important because it defines the span of ParaCell´s supply chain which is the centre of this report.

One of the major challenges was to do a somewhat accurate and realistic software development budget estimation. This is a well-known difficulty that has puzzled experts for years. Having

access to experts or previous software projects is important in budget estimations. Since neither of these was available the estimation process only had statistics and mathematical models to rely on. Another aspect that further complicates the estimation process is that the project is still in a very early stage. All these aspects enforce a complexity analysis where a total project schedule range is defined.

7.4. Future Work

ParaCell now has to decide *how* this application should be obtained. Are they going to develop the application themselves or buy an existing application and modify this to fit the requirements that are defined? If it is decided that ParaCell will outsource this development and start from scratch to build their own tool, then this thesis project can be used as a specification, or request for proposal, when having negotiations with software development firms. If it is decided that this application should be bought the market analysis should be used as a foundation and start of proceeding works in analysing the interesting applications further.

I wish ParaCell and its personnel the very best good luck in its future pursue for a well adapted and efficient integrated supply chain application.

Glossary

A

Account Manager A person that normally is responsible for an account containing several projects or project offices. The Operations Manager reports to the Account Manager.

Adjusted Function Point The function point received after multiplying the unadjusted function point with the Influence Multiplier.

Administrator Owner of the integrated supply chain application. This person has full access to add, delete and administrate new roles and activities.

Analogy Costing Project resource estimation based on previous projects.

B

Business Controller A person that normally is supervising the invoicing processes.

C

COCOMO Parametric Costing Model using e.g. SLOC as input and presenting total project effort as output.

Contract Logistics Manager A person that normally is responsible for HW/SW ordering and shipment preparation and shipment fulfilment.

Contract Management Offering a flexible and secure environment for contract creation, contract visibility, and contract control.

D

Delphi Costing Project resource estimation based on expert opinions and reflections.

E

Emerging markets Developing foreign markets, involving greater volatility and higher risk than established markets.

End-customer The consumer that is the final user of the services produced in the project rollout. This end-customer initially signs a contract with the main contractor.

ESTERLING Parametric Costing Model using e.g. total effort and time as input and presenting total project cost as output.

Execution See project rollout.

F

Function Point Analysis Project resource and effort estimation using complexity parameters in deciding a function point used for further analysis.

H

Horizontal-market software Software packages, such as word processors and spreadsheets that are used in all industries (banking, insurance, etc.).

I

Implementation Manger A person that normally is responsible for the site survey, the installation and implementation process.

Influence Multiplier Using 14 factors in determining the factor with which the unadjusted function point should be multiplied to get the adjusted function point.

Invoicing A complete process of sending out an invoice after completion of milestones.

J

Jones´s First-Order Estimation Practice Using the adjusted function point to calculate a rough total project schedule.

M

Main contractor The party offering a tender to the end-customer and the party that outsources a part or a whole project to a subcontractor.

O

Operation Manager A person that normally

is responsible over an operation containing several projects. The Project Manager reports to the Operations Manager and the Operations Manager reports to the Account Manager.

P

Parametric Costing Model Project resource estimation using prediction models.

Parkinson´s Law Project work expands to fill available time.

Project Controller A person that normally is supervising the operational parts of a project.

Project Manager A person having the over bridging responsibility for the project rollout. The Project Manager reports to the Operations Manager.

Project execution See project rollout

Project rollout The project rollout is equivalent with the project execution. This is the process starting with the Contract Handshake and ending with the Project Closure process. Project execution excludes the sales process and the evaluation process.

R

Red Marking Report Report attached to the Final Installation Report that shows if the Installation has gone according to planned or if there are any deviations.

Resourcing A process of staffing projects with consultants and other necessary competence.

RFI Acronym for Ready For Installation.

Rollout See project rollout.

S

Service Delivery Manager A person that normally is responsible for projects delivering services, and not products, to the customer. This person functions as a PM and has the same need for information as a PM.

Shrink-Wrap Software A horizontal-market software or vertical-market software packaged and sold commercially.

SLIM Parametric Costing Model using Software Size, Process Productivity and Management Constraints as input and presenting total cost, staff required, probability of success and reliability as output.

Sources Line Of Code (SLOC) How many lines of codes the final application contain.

Subcontractor A third party that is contracted by the main contractor to do a whole or a part of a project.

Sub Project Manager A person that is responsible for an activity during a project, for instance installation, integration or testing.

Supply Chain A sequence of events in a goods or services flow which adds to the value of a specific good or service. It is an important factor in creating value for companies wanting to reduce costs and increase productivity.

Supply Chain Management (SCM) The management of the supply chain components, i.e. manufacturing and distribution.

Supply Manager A person that normally is responsible for HW/SW ordering and shipment preparation and shipment fulfilment

U

Unadjusted Function Point Total point given to a project using Function Point Analysis. The unadjusted function point is given after estimating the complexity but before multiplying with the influence multiplier.

V

Vertical-market Software Software packages that are designed for a particular industry such as banking, insurance or manufacturing.

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Appendix A - Interview Template

The interviews with the reference group all followed a basic template presented in this appendix.

The interview will focus on projects made with ParaCell.

- Interviewer explains the thesis and a summary of the problem discussion and purpose of interview.
- Interview candidate outlines his role in the overall organisation.

ROLES:

- Could I get an update on what you do in a typical project. Your role!
- Could you outline what parties that may have an interest in your projects, i.e. what stakeholders there are in your Customer Contracts? The roles!
- In a project, from sales to support, when are the different key roles involved?
- Which of all these roles do you believe are in need of this program?
- What demands do you put on Operations Managers and Project Managers?

REPORTING:

- What information are you interested in during a project?
- Do you have any responsibility to report any status to your company´s subcontractors during a project? Could be that "ok to send invoice" or "Project closure accepted".
- What information do you want to see from subcontractors like ParaCell?
- What methods do you use today to keep yourself up to date about what is going on in your projects and what the status of each project is? Does it work?
- What methods are used in other parts of the organisation today, are they unified?
- What are your "headaches" in this struggle of keeping yourself updated?
- How do you keep other people updated, what reporting are you providing and to whom? What are the obstacles and weak points in your reporting? What stakeholders are today satisfied, what stakeholders are today unsatisfied with reporting (mgmt, the sales guy, controller?)
- How does the handover, from for example sales to execution, take place? What if there is indifferences later on about what really happened? Is the handover logged?
- Are you using any internal tools/programs?
- What is good in these existing methods that you would like to promote for a future program?
- Is there any improvement programs going on within Ericsson to "improve" project control?

INVOICING:

- Describe your role in the invoicing process.
- What are the biggest problems in this process?
- In the specific invoicing process that exists today, how do you think a software program can help you, in the best way? What is missing in the process today?

- What aspects in the invoicing process are you interested in? What detailed information do you need access to?

CUSTOMER REPORTING:

- Do you, as a business controller, have any responsibility to update the end-customer? Do you have any reporting systems? Who has access?
- Are the customers satisfied with the way they are updated today?
- What are they dissatisfied with (communication, delivery status, quality...)? Do you see a solution to these problems?
- What processes are notorious for being difficult to satisfy the customers with?

NEW SOFTWARE:

- Mention a few key features that you would like to see in a software program that would help you to deal with these problems? In what way would they help you?
- What are the main status/reports that the KAM and finance would like to see during a project?
- What is the main status/ reports that the customer would like to see during a project?

INTEGRATION:

- Do you think that it is a requirement that this software tool have to be integrated with existing tools and software programs in order to be used or can it be a totally separated tool and still fulfil its purpose?

Appendix B - Detailed review of current market applications

This appendix present detailed information about the reviews made for each application.

Projektplatsen.se

Projektplatsen.se is one of many interesting applications that are web-based. It is easy to access (point 5 in the requirement list) which is important and the up- and downloading times are short enough for the requirements (10). Projektplatsen.se can be used as a reporting tool (1) but as it looks today it is far too extensible. It handles everything from project planning and resourcing to scheduling which is too much for ParaCell´s demands. This makes it hard to keep the tool fast (3) and simple (2). The secondary effect of this is that it is hard to keep the application accurate (4). With Projektplatsen.se it is possible to log all the changes made in the tool so that you have a history to go back to (8) but a downside is that no consideration has been taken to Contract Management (6) [Glaumann, 2007]. If the project requires that the application is divided into clusters or in any other way is adapted to demands set by the contract this can be hard to administrate. It is also hard for a PM using Projektplasen.se to have a good overview over the projects that are active (11). You have an overview of all your projects but in that overview you cannot see which projects that are going well and which ones that are delayed. You have to go into each project and look around to find the problems. If you have many projects running at the same time this can be a time-consuming task. For every entry added to the system it is possible to link this date to a reference date so that each change in status is compared to an original data. This makes it possible to determine if the entry added was late or on time (12). It is also possible to add and administrate documents (13).

Another problem with Projektplatsen.se is the ability to create multiple profiles with different accessibility to handle different kind of stakeholders (7). It is possible to create different profiles but you cannot set your own restrictions to each and every of these profiles. If the PM adds a profile, call it "customer", and then he/she adds a milestone, call it "customs clearance", and set the customer responsible for that activity which means that the customer is the party that mark the activity "completed" when the goods are cleared of customs. In this case it should *only* be the customer who can mark this activity "completed" and no one else, not even the administrator who added the activity. This cannot be done with Projektplatsen.se. If the PM has the authority to do this change eventually he/she will be the only one using the application and it is impossible to go back and see who has made what and when. These aspects indicate that projektplatsen.se is not dynamic and flexible enough for ParaCell´s needs (9). Projektplatsen.se cannot be integrated with other systems if required (14).

IS-Tools

IS Builder can be used as a reporting tool in project rollouts (1) and it is very flexible and dynamic (9). It can be configured according to ParaCell´s needs to be kept simple and fast (2 and 3). This will make it easy to keep the tool updated and accurate (4). IS Builder is web-based and updated automatically even when you are logged in and working in the system which will enable short loading times (10) and easy accessibility (5). It is possible to create many log in profiles and log every change in the system after time and user (7 and 8). One of the bigger advantages with IS-Tools is that they explicitly work with Contract Management that has led to a tool that is easy to construct according to payment terms in the contract (6). It is possible to create an overview over the entire project office. The user has a textual interface that tells the user if the project is

late but it is not as intuitive and clear as required (11). What ParaCell desires is a graphical interface showing a very intuitive picture of the entire project office. This is though a characteristic that can be modified if desired. It is possible to configure the application in a way that all the data added is compared to an original date so that it is easy to follow the progress compared to the original plan (12). IS-Tools does manage documentation handling (13) and it is also possible to integrate IS Builder with other systems in the future if wanted (14).

Sharepoint Services

BrightWork Reporter is a web based application that is easily accessible and has short uploading and downloading times (5 and 10). It is possible to create different profiles and to regulate that all the changes are logged with timestamp and user (7 and 8). Contract Management is not mentioned and considered using BrightWork Reporter (6). Since you are building most of the application yourself it is generally possible to integrate this application with other applications in the future (14). A closer review of BrightWork Reporter nevertheless shows that the tool is not simple and fast enough (2 and 3) for ParaCell´s needs. Using BrightWork Reporter it is somewhat difficult to manage profiles and access rights for every single user and the application does not meet the requirements for flexibility (9). There are features for Finance, Sales, Business Management, HR, Marketing, IT Management etc which make the tool expansive. Some training is required for this application to be used to its full extent. This means that it will be hard to persuade Project Managers, Sub Project Managers etc. to use it which means that it will be difficult to keep it updated and accurate (4). BrightWork Reporter mainly works as a platform for aggregating, compiling, presenting and distributing information from multiple sources and sites into and one single place. This means that this application does not mainly function as a reporting tool (1) for project progress. However, the application does handle documentation and it is possible to add reference dates so that each entry is compared to an original data (12 and 13). Also, In BrightWork you have a good overview of your projects when you log in, but after that it is somewhat difficult to locate what the problem is (11). You have to go into every activity to locate the problem which could be tedious.

Antura

Antura can definitely be used as a reporting tool where it is possible to create multiple profiles and configure what each profile should see and what access rights that user should have (1 and 7). By restricting what information you want available you can keep the tool simple and fast and also accurate and updated (2, 3 and 4). Antura Projects does not explicitly work with Contract Management (6) but the tool is dynamic enough to be constructed and configured after basically any type of telecom project rollout (9). The tool logs all events both by user and time (8), it is both easy to access (5) and it is somewhat simple to create a simple overview over each project and the entire project office (11). The application has short loading times (10) and it is easy to link every entry to an original data for comparison (12) and Antura does, as the rest of the tools reviewed, manage document handling (13). It is also possible to integrate Antura Projects with other software if needed (14).

Primavera

This would be a fast and simple application that can be used as a reporting tool (1, 2 and 3). It is not a requirement that planning features and resourcing features are included in a final solution. The simplicity of the tool will therefore enable the potential of using an accurate application (4). Primavera does not explicitly work with Contract Management (6) but they deliver a flexible and dynamic application (9) that generally can, in a simple way, mirror terms and conditions in a

contract. It is possible to create multiple log in profiles and the possibility to log everything that happens with date and user (7 and 8). The application is web based and easy to access from wherever in the world you are which is the first and most basic requirement for an application that has short loading times for adding and sending document and other entries (5 and 10). The application offered by Primavera does not feature the clear and simple overview that ParaCell´s wants (11). As in IS-Tools the overview is merely textual and does not provide the fast and simple location of problems that emerges in the projects. The application does handle documentation and it is possible to add reference dates so that each entry is compared to an original data (12 and 13). It is possible to integrate Primavera with some other systems, among these Hoogia as ParaCell uses today (14).

Omnix

The application can be configured to work as a reporting tool (1), with the opportunity to add and administrate several profiles (7), and it is web based which makes it easy to access (5). The application has short up- and downloading times (10) and Omnix also have time logging to keep track of new changes (8). Omnix do not work according to Contract Management and mirroring contracts is not something that has been taken into consideration when building the application (6). You can create graphical overviews that are connected to the milestone deadlines so that it is marked when passed and not completed (11). The application can be configured so that the simplicity demanded from ParaCell is granted (2). This is an example of how dynamic the application is (9), which will render a fast tool that is accurate and easy to update (3 and 4). The application does handle documentation and it is possible to add reference dates so that each entry is compared to an original data (12 and 13). It is also dynamic in the way that it is compatible for other software integrations (14). Andrew simply builds one adaptor on the Omnix side and one integration adapter on the integrating software side and if the software is changed or updated only the adaptor on the software side is modified [Barry, 2008]. This makes the integration process flexible and it is more likely that the application can be integrated with systems that initially is unknown Andrew.

Projektspecialisten

Projektspecialisten can be used to report significant project events (1) to keep track of your project progress. It is what it promises – simple and fast (2 and 3) which means that it is simple to keep it accurate (4). It is also surprisingly easy to create a simple overview over a project or a smaller project office (11) and it is possible to log all the events by user and time (8). As presented in the report the application is now web based but you need to download the application every time you use it. This does not meet the easy to access requirements (5) and it might lead to longer loading times for the user than acceptable (10). It is also possible to add contractual dates and data so that each entry added is compared to an original data (12). It is possible, but to a very limited extent, to create different profiles. You can create profiles and set what kind of access these profiles should have. With "kind of access" is implied that you can choose if the profile should have a read-only access, a read and write access and so on. Still, there is no functionality today that allows the administrator to choose what kind of information each user should see. It is therefore impossible to present each user only to the information that this user should be entitled to (7). Projektspecialisten does not work with Contract Management (6) and it is doubtful that it is dynamic enough to be able to handle the configuration of any thinkable telecom project (9). It is possible to add and edit documents (13) in an easy way. The simplicity of the application though makes it difficult to integrate the tool in the future (14).

Appendix C - Applications not fulfilling the requirements

Some applications reviewed during the Market Analysis did not fulfil the most basic requirements outlined in chapter 3.1.4. The results of the review and the reasons for why these applications did not meet these are presented in this appendix.

Microsoft Project

Microsoft´s most well known product for project management is MS Project. It is an all-round tool that is widely used throughout project organisations. It is a tool that can help the Project Manager with basically whatever he or she needs, it is simple to make Gantt charts, it is also easy to use the tool to make predictions about resources and even financial aspects. But it is a desktop tool that simply helps the PM and it is not meant to be a reporting tool for an entire project team. All the features also prevent the tool from being fast and simple. MS Project is used by ParaCell today for presenting a picture over the outline of each project to the customer but it is not used during the project rollout. The reason for this is that it is too hard to update which leads to that Excel documents, that are not standardized, are used instead. This shows that this tool is hard to keep accurate and updated. Also, it is not possible to create different profiles and, as an administrator, decide what accessibility each profile should have. Without any further analyse of MS Project it is clear that this application will not meet ParaCell´s demands.

Microsoft Project Server

In addition to MS Project, Microsoft has a web based solution that is called Project Server. Project Server, also known as Microsoft Enterprise Project Management (Microsoft EPM) can be seen as MS Project on the web. This tool can be used for everything from resource allocation to detailed project planning. The fact that it is web based shows that you can access it easily and that uploading and downloading times for using it decreases. But it is hard to keep a tool that can do all those things fast, simple and accurate. Project Server requires education to be used correctly so this tool is simply too extensive.

Microsoft Office Sharepoint Server

Sharepoint Server is also web based but it is still a tool mostly designed for a single purpose, to help the PM in the daily work. It includes interfaces for accessing databases for customer information, CRM systems, follow up information, business applications for resourcing projects etc. It is possible to create Gantt charts and to keep track of what is going on with the active projects but it is still not simple enough to meet ParaCell´s demands. This tool still requires some training to be used in the correct way which is not desirable.

Appendix D - Input-screen for project progress module

When adding a new *project* the administrator will be prompt to an input screen. This screen will help the administrator to fill in all the necessary information and to create all the different links and connections between milestones on different levels. Blue text marked with "/*" are comments explaining the coming fields and is not information that will be presented to the administrator when building the application.

The input screen when adding a new project will look like this:

New Project:

Project Information:

/*This section is general information concerning the overall project.*/

/* All Purchase Orders are tied to one Contracting Entity (Sweden, South Africa or Malaysia). This must be stated for every new project.*/

Contracting Entity: Sweden

Country:

Assignment Location:

ParaCell PO Name:

ParaCell PO Number:

ParaCell Representative:

Project Notes:

Customer Information:

/* This section states information about the customer*/

Customer name:

PO Name:

PO Number:

PO value:

PO Currency: USA,USD

Customer Representative:

Tel:

Email:

/ Having a profile set for each customer, checking this box will bring up the information tied to the customer given above./

Use previous Management company settings: ☐ Yes ☐ No

Subcontractor Information:

/*The number filled in below will decide how many subcontractors that are created.*/

Number of subcontractors: 2

Subcontractor 1:

PO Name:

PO Number:

PO value:

Sub Contractor Representative:

Tel:

Email:

Start date:

End date:

Contract description:

Subcontractor 2:

PO Name:

PO Number:

PO value:

Sub Contractor Representative:

Tel:

Email:

Start date:

End date:

Contract Description:

Payment details:

Customer

Total customer revenue:

Subcontractors

Total Subcontractor cost:

Project Margin:

Project member details:

/* The number filled in below will create equal number of project members to specify in this section.*/

Number of people hired by ParaCell: 3

Person 1:

/* The role selection will contain predefined role for this application. These roles are presented in Chapter 4. Each role has also been mapped to a specific access in Chapter 4. Checking the "Use pre-defined access" box will automatically give the user access as pre-defined. By checking the "Set manual access the administrator can manually set the access for a number of aspects.*/

Use pre-defined access

Name: Role: Please select

Tel:

Responsible for:

Email:

Set manual access:

Person 2:

Name: Role: Please select

Tel:

Responsible for:

Email:

Set manual access:

/*The access being able to choose from for each category is typically "Read Only", "Read & Write", "No Access" or "Full Access"*/

Level 1: Please select

Level 2: Please select

Level 3: Please select

General Information: Please select

Project Member Details: Please select

Project Assignment Details: Please select

Documents: Please select

Templates: Please select

Assignments: Please select

Person 3:

Use pre-defined access

Name: Role: Please select

Tel:

Responsible for:

Email:

Set manual access:

Project Assignment Details:

/* Some projects are divided into phases where some activities occur parallel. This section enables the administrator to divide the project into a number of phases. Each phases are given a start and end date, telling the application if they take place parallel or consecutively.*/

/* The number filled in below will build an equal number of phases in this section.*/

Number of phases: 2

Phase 1:

Scope:

Phase:

Roll-out Description:

Total Roll-Out Time (days):

Start date:

End date:

Phase 1 Notes:

Phase 2:

Scope:

Phase:

Roll-out Plan:

Total Roll-Out Time:

Start date:

End date:

Phase 2 Notes:

Project Notes:

Milestone details:

/* The information added on this level is important for the build up. The administrator firstly choose how many levels that the application needs to be built in for this particular project. The more complicated the more levels.

1)

Number of levels in this project: 3

/* In some cases the administrator needs to build the application to keep track of the details but the administrator only wants the users and the members of the project to access a few of these levels. This can be chosen below.*/

2)

Display level:

Commercial Milestones

/* The first milestones that are added are the commercial milestones. This is when ParaCell can invoice and how much ParaCell can invoice. This information will build the Finance timeline in

level 1. The administrator first has to choose between manually add milestones or let the application build one milestone per month between the start and end date given after.*/

3)

a) Number of commercial milestones in this project: 3

b) Milestone monthly from start date to end date: ☐ Start Date: End Date:

4)

	Milestone Name	Percentage of total PO Value	Invoicing amount
C. Milestone 1:			
C. Milestone 2:			
C. Milestone 3:			

Level 1 Milestones:

/* These milestones will build the Project timeline that is the timeline below the financial timeline. The dates chosen under "Compl. Date" will be the dates presented in the "Plan" row for each project. For each milestone the administrator must chose if the milestone should trigger a commercial milestone in the "Finance" timeline (that is if ParaCell can invoice after completion of that milestone). In that case the "Trigger?" box is checked and what commercial milestone that should be trigger are stated.*/

5)

Number of Level 1 milestones in this project: 5

6)

	Milestone Name:	Compl. Date:	Trigger?	C. Milestone?
L1 Milestone 1:			☐	
L1 Milestone 2:			☐	
L1 Milestone 3:			☐	
L1 Milestone 4:			☐	
L1 Milestone 5:			☐	

Level 2 Milestones:

/* Depending on the number of phases created under "Project Assignment Details" the phases below are created.*/

/* When you want the application to check all the triggers in all phases on level 2 before triggering a milestone on level 1 the box below is checked.

7)

Merge Phases: ☐

Phase 1:

/* The administrator first has to choose how many milestones there are in the first phase. The L2 Milestones are built accordingly. If the milestone should trigger a level 1 milestone the "Trigger?" box is checked and the L1 Milestone is stated. When the L2 Milestone is trigged and the "Trigger?" box is set the application checks if there are any more milestones on this level that

trigger the same L1 milestone. If so, all these milestones must be trigged before the L1 Milestone is trigged. If not, the L1 milestone given is trigged.*/

8)

Number of Phase 1 milestones in this project: 4

9)	Milestone Name:	Compl. Date: (if applicable)	Trigger?	L1. Milestone?
L2 Milestone 1:			☐	
L2 Milestone 2:			☐	
L2 Milestone 3:			☐	
L2 Milestone 4:			☐	

Phase 2:

/* The Phase 2 build up looks like the Phase 1 build up. If the "Merge Phases" box is checked, then the application checks all L2 milestones on level 2 before a L1 milestone is trigged. All milestones triggering the same L1 milestone must be trigged before the information is passed on to higher levels. If the "Merge Phases" box is not set only L2 milestones within the same phase is checked before a L1 milestone is trigged.

10)

Number of Phase 2 milestones in this project: 4

11)	Milestone Name:	Compl. Date: (if applicable)	Trigger?	L1. Milestone?
L2 Milestone 5:			☐	
L2 Milestone 6:			☐	
L2 Milestone 7:			☐	
L2 Milestone 8:			☐	

Level 3 Milestones:

/* The administrator first has to choose how many item (sites or nodes) that this project contains. The number chose n will build the items below.*/

12)

Number of items on Level 3: 3

Item 1:

/* It is important for the administrator to choose what phase this item belongs to. When an activity on this level is reported as complete, and the "Trigger?" box for that activity is checked, the application will check all the activities triggering the same L2 milestone. The application will though *only* check milestones belonging to items in the same phase. This is necessary to be able to divide the project into several parallel phases. The number of activities chosen will build up activities for each item.*/

	Item Name:	Compl. Date: (if applicable)	Phase
13)		**14)**	
Item info:			1

15)
Number of activities for item 1: 5

	Activity Name:	Compl. Date: (if applicable)	Trigger?	L2. Milestone?
16)				
Activity 1:			☐	
Activity 2:			☐	
Activity 3:			☐	
Activity 4:			☐	
Activity 5:			☐	

Item 2:
/* If the information for item 2 resembles the information for item 1 the "Use previous settings can be checked. That will fill in all the fields for this item.*/

	Item Name:	Compl. Date: (if applicable)	Phase
17)		**18)**	
Item info:			1

Use previous item settings: ☐

19)
Number of activities for item 2: 5

	Activity Name:	Compl. Date: (if applicable)	Trigger?	L2. Milestone?
20)				
Activity 6:			☐	
Activity 7:			☐	
Activity 8:			☐	
Activity 9:			☐	
Activity 10:			☐	

Item 3:

	Item Name:	Compl. Date: (if applicable)	Phase
21)			**22)**
Item info:			2

Use previous item settings: ☐

23)

Number of activities for item 3: 5

24)	Activity Name:	Compl. Date: (if applicable)	Trigger?	L2. Milestone?
Activity 11:			☐	
Activity 12:			☐	
Activity 13:			☐	
Activity 14:			☐	
Activity 15:			☐	

Appendix E - Input-screen for agency reporting module

When adding a new *consultant* the administrator will be prompt to an input screen. This screen will help the administrator to fill in all the information necessary for the application to be able to build the application. Blue text marked with "/*" are comments explaining the coming fields and is not information that will be presented to the administrator when building the application.

The input screen when adding a new consultant will look like this:

New Consultant:

/* All Purchase Orders are tied to one Contracting Entity (Sweden, South Africa or Malaysia). This must be stated for every new project.*/

Contracting Entity: Sweden

General Information:

/* This section states the PO information for ParaCell.*/

PO Name:

PO Number: Travel cost included? ☐ Yes ☐ No

Travel PO number (if no):

ParaCell representative:

Customer Information:

/* This section states the customer information.*/

Customer:

Customer PO Number:

Customer Representative: Tel:

Email:

Employment information:

/*This section states information about the consultant.*/

Consultant name:

/* This field will clarify if the consultant will have any access to the application to submit the timesheets directly. If the box is checked the user name and password fields must be filled in.*/

Time Sheet level access: ☐

Set user name:

Set password:

Consultant title:

Country:

Assignment Location:

Management Company:

/Normally it is the same person for one management company. Having a profile set for each management company, checking this box will bring up the information tied to the management company given above./

Use previous Management company settings: ☐ Yes ☐ No

Management Comp Representative:

Tel:

Email:

/If "Management Company access" is given the management company will have access to the application to submit time sheets received from the consultants. If this is granted then user name and password must be filled in. If "Use previous setting is checked above this will be filled in automatically./

Management Company access: ☐ Yes ☐ No

Set user name:

Employee Notes:

Set password:

Start date:

End date:

Payment details:

/* This section contain basic financial information concerning the consultant.*/

/The choice here will create the checkboxes for "No. Of paid travels" as in the figure./

No. Of paid travels: 1

/* The number filled in here will tell the application how long it will take before a yellow box (as in ready for invoicing) to turn red (as in invoicing delayed). For Medical Insurance it can be selected if ParaCell or the consultant pay.*/

Least no. of days from time report received to paid consultant: 1

Gross Rate: USA,USD

Consultancy Fee: USA,USD

Management Fee: USA,USD

Payment Terms: USA,USD

Working days pro rate:

Medical Insurance: Please select

Invoicing frequency:

Insurance amount:

Milestone details:

/* This section states the information the application needs to build the graphical interface.*/

/* Just as when building a project, the administrator first has to choose between manually add milestones or let the application build one milestone per month between the start and end date given under "Employment Information".*/

1)

Number of milestones: 12

Milestone monthly from start to end date: ☐

/*Either each milestone name is filled in manually. Checking the "Monthly" box in the end will automatically generate the month date from start to end. If the administrator wants to set the last date of the month as completion date for each milestone the box "Last day of the month" can be checked. Normally all the milestones are trigger points in a consultancy build up. In that case the "Select all" box in the end will check all the boxes.*/

2) Trigger:	Milestone Name:	Completion Date:	Payment
Milestone 1:			☐
Milestone 2:			☐
Milestone 3:			☐
Milestone 4:			☐
Milestone 5:			☐
Milestone 6:			☐
Milestone 7:			☐
Milestone 8:			☐
Milestone 9:			☐
Milestone 10:			☐
Milestone 11:			☐
Milestone 12:			☐

3) Monthly: ☐ **4)** Last day of month: ☐ **5)** Select all: ☐

Appendix F - Efficient schedule and size estimation

When the first basic man-month estimation has been made, this schedule can be analysed using the table below. SLOC and a total schedule in months can be derived from a man-month estimation. This is the efficient schedule summarization which represents a "best case" schedule that will apply when no major obstacles affect the project. Seen in the table is that an effort of 9 man-months will result in approximately 12,000 lines of codes and a little bit less than 7 months of programming.

Efficient Schedule	System Products		Business Products		Shrink-Wrap Products	
System size (lines of code)	Schedule (months)	Effort (man-months)	Schedule (months)	Effort (man-months)	Schedule (months)	Effort (man-months)
10,000	8	24	4,9	5	5,9	8
15,000	10	38	5,8	8	7	12
20,000	11	54	7	11	8	18
25,000	12	70	7	14	9	23
30,000	13	97	8	20	9	32
35,000	14	120	8	24	10	39
40,000	15	140	9	30	10	49
45,000	16	170	9	34	11	57
50,000	16	190	10	40	11	67
60,000	18	240	10	49	12	83
70,000	19	290	11	61	13	100
80,000	20	345	12	71	14	120
90,000	21	400	12	82	15	140
100,000	22	450	13	93	15	160
120,000	23	560	14	115	16	195
140,000	25	670	15	140	17	235
160,000	26	709	15	160	18	280
180,000	28	910	16	190	19	320
200,000	29	1,300	17	210	20	360
250,000	32	1,300	19	280	22	470
300,000	34	1,650	20	345	24	590
400,000	38	2,350	22	490	27	830
500,000	42	3,100	25	640	29	1,100