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School of Business and Management

Master's Programme in Supply Management

Improving supply chain performance by enhancing integrated material management in telecom project execution

Master's Thesis

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Projektiympäristössä toimivien toimitusketjujen tehokkuuden mittaamisessa käytetään tyypillisesti samoja suorituskykyä mittaavia indikaattoreita, kuin organisaation muilla alueilla. Toimitusketjuihin linkitettyjen automaatio- ja pilvipohjaisten palveluiden yleistyessä on mitattava niiden vaikutusta olemassa olevien toimitusketjujen suorituskykyä mittaaviin indikaattoreihin. Tutkimuksen tavoitteena oli analysoida uuden pilvipohjaisen materiaalihallintatyökalun käyttöönottoa, vaikutusta toimitusketjun tehokkuuteen ja vaikuttavuutta projektiympäristössä. Tutkimus suoritettiin toimintatutkimuksena neljää tapausprojektia hyödyntäen, tutkimuksen tekijä oli osallisena työkalun käyttöönotossa, operatiivisessa käytössä sekä käyttöprosessin vaikuttavuuden mittaamisessa.

Tutkimus osoittaa, että integroidun materiaalihallinnan avulla kohdeyritys pystyy vaikuttamaan positiivisesti projektin toimitusketjun näkyvyyteen, läpimenoaikaan ja resurssien hallintaan. Näiden tekijöiden yhteys toisiinsa ja olemassa oleviin toimitusketjun suorituskykyä mittaaviin indikaattoreihin oli selvästi nähtävillä tuloksista. Tulokset osoittivat, että uuden materiaalihallinnan työkalun avulla toimitusketjun hallinnalliset tehtävät virtaviivaistuivat huomattavasti entisestä. Samalla resurssikohtainen käytetty aika pystytään kohdistamaan uudelleen, automatisoimalla tunnistetut vähäisen arvon operatiiviset tehtävät. Tulosten ohella todettiin käyttöönottoprosessin olennaisuus ja sen vaikutus projektin toimitusketjun kyvykkyyteen koko projektin aikana, sillä operatiivinen strategia muodostetaan sen perusteella.

Abstract

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The performance of supply chains working in project environment is usually measured using same indicators as other organizational functions. As automation and cloud-based services are more commonly used within supply chain functions, it becomes important to investigate what their impact is on the performance indicators. The object of the study was to investigate the impact of deploying a new cloud-based material management tool on supply chains efficiency and effectiveness in project environment. The research was conducted as an action research using four different case projects from which the deployment, usability and operational processes were studied to measure the impact.

The study shows that with integrated material management, case organization is able to have a positive impact on the project visibility, throughput time and resource efficiency of the specific project. The link between the three deliverables and the impact that they have on existing performance indicators was also noticeable. The findings showed that the amount of manual work conducted by supply chain team decreased significantly within the supply chain process introduced by the material management tool. Simultaneously the ability to automate time consuming non-value adding processes helps with improving the resource efficiency within project environment. During the study it was also noticed that the deployment process has a major impact on the supply chain functions effectiveness for the duration of the project as the operational strategy is defined through it.

Forewords

I want to thank my employer, the whole project team and especially Pekka for giving me this opportunity.

Espoo 26.04.2021

Janne Bruce

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1. Introduction

There is a vast number of studies related to organizational changes in the form of integrating supply chain information systems in order to gain added value and differentiating the organization from competition in a positive way. There are also many studies that look at the different factors that create value and add performance for organizations through optimizing supply chain functions by introducing new information systems. Even though information systems and supply chain performance have been widely studied, there is still gap between the implementation of supply chain information systems within project environment. (Qrunfleh & Tarafdar, 2013; Sillanpää, 2015)

Integral part of every new system deployment is to analyze the impact that it has on the efficiency and effectiveness of operations that are measured to show the impact on performance through specific Key Performance Indicators (KPI). Depending on the organization, the measured performance has a direct on in-direct impact on the revenue that the organization is able to generate. This is good to understand, because the deployment of new and innovative solutions often depends on the trust from higher management and the company owners.

The objective of each customer driven project is to supply both the equipment and services that the customer requires. From project perspective, it is critical that supply chain can deliver the correct material on time to the correct site. The complexity of supply chain is determined by the scope of the project itself, and it is clear that due to several different factors such as globalization, supply chains are increasingly becoming more complex (Bartlett et al., 2007). To be able to manage these supply chains, organizations use ERP systems linked through real-time interfaces (RTI) to supplier and partner systems/databases in order to have constant visibility of ongoing processes and introduce concepts such as of Vendor Managed Inventory (VMI) (Kelle & Akbulut, 2005; Marques et al., 2010).

Telecom projects normally consist of delivering complete radio networks for customer. This includes the modeling of the network architecture, defining the equipment needed for each base station, supplying the equipment, setting up the base stations and setting up the software for connecting the hardware. There are several factors that can go wrong, from supply chain perspective, within the end-to-end process when dealing with thousands of sites for which materials need to be delivered on time, in line with the project schedule and customers schedule (Thunberg et al., 2017). In a business environment as competitive as telecom, it is increasingly more important to find competitive advantage from different sources.

Within global markets, it becomes vital to find competitive advantage through supply chain functions (Anand & Grover, 2015) in conjunction with having leading edge product portfolio, to be able to answer the increasing customer demand towards having transparency for growing need of sustainability (Sancha et al., 2015). Logistics and supply chain are in charge of ensuring that products are at the right place at the right time in order to reduce the waiting time of customers (Ran et al., 2017). More demanding customers and the search for added value through supply chain functions leads to the development of tools and processes that ensure the transparency and functionality of the logistics and supply chain processes.

As the demand for turn-key style projects increases within telecom industry, it becomes important to improve the visibility between all of the project stakeholders. Supply chain has a key role in making sure that both the material and information flows are working during the project. One of the key activities is to define the whole supply chain during the setup phase of a project, which is used for the duration of the project. As the supply chain tasks are now linked to a platform, it is important to make sure that all the necessary details are defined both in the e-2-e supply chain and in the tool. The tool itself includes most of the supply chain tasks and the target of this study is to find out what benefits will be gained from using the tool. The empirical part of the study will investigate, how a new tool is able to generate additional value and benefit for both the supply chain functions and the project stakeholders.

2. Research methods and limitations

2.2 Research questions

For the purpose of the study, we need to break down the main topic of improving supply chain efficiency into smaller more targeted questions. This is done in order to have a clear view of the topics related to the study. It also gives us the information of what are the topics which impact the supply chain efficiency in terms of the benefits and the additional value that is created for the organization. To answer the main question, three sub-questions have been defined. Each sub-question answers a specific part of the main research problem and each sub-question is broken into additional agendas, that in turn limit the scope of each individual question. This scope limitation by precise question definitions is also a limiting factor within the whole research project.

How do we generate supply chain efficiency in telecom project execution via integrated material management?

1. *How does the tool impact supply chain management practices?*
2. *What are the key benefits that the deployment has for supply chain team?*
    a. *Identify key benefits for supply chain*
    b. *Validate the potential through cases study via pre/ post comparison (throughput time & resource efficiency)*
3. *What are the key takeaways towards project value creation?*
    a. *Define key benefits to project teams*
    b. *Key considerations for successful deployment*
    c. *Utilization "essentials" for supply chain team and project managers?*

The research questions are defined in a way that they answer the research gap that exists between supply chain practices in project environment and the impact of information systems on the operational supply chain execution.

2.3 Research methods

To answer the before mentioned questions, the research method needs to be defined. The research will be conducted as an action research, using qualitative methods such as interviews as a complimentary method of data gathering. For analyzing the impact of the new tool, a method of visualization is used to showcase the impact of individual tasks within the process. As the research is mostly done as an action research, a large amount of material is based on attending meetings and workshops that are related to the implementation of the new tool. By mapping the process of how supply chain is linked to the tool, it becomes easier to generate conclusions about the benefits and the impact that the tool has on measuring KPI shifts. This allows to reflect the empirical findings against the interview/questionnaire findings.

There are a few different ways that the data will be gathered for the research. One is through interviews which look at the different aspects of the tool and what the precepted benefits are from the user's perspective. Second is by having regular online sessions with the tool development and project teams to understand the reasoning behind some of the parts that the tool provides. This second method of gathering data is according to the principles of action research. This means that the findings are based on the first and secondhand observations and usage of the tool which is object of the study. Additionally, to this, data will be gathered through observations made during the deployment phase of the ongoing project and during the deployment of the platform.

Action research ties the gap between theory and practice and is therefore a suitable research method to evaluate the impact and benefits of a new tool that is still in the deployment phases. Through the use of action research, we can look closer at the actual use of the tool, which is conducted by the project resources that are responsible for operating it during the project and as such it gives a new perspective of recognizing certain bottlenecks and the functions that are most important and beneficial for the case company.

2.4 Limitations

The study will be limited to finding out the different indicators which have an impact on the supply chain functions in project environment. Outside of this scope will be left out for example the study of the actual impact of the different indicators. The perspective of the study will be from the supply perspective and all the other perspectives (customer, sub-contractor etc.) are left out. The other perspectives are to be studied separately. This study is only to find out the supply chain impact on project performance and material management impact on supply chain efficiency.

Another limitation to the study is the timeline in which it is conducted. As the ongoing projects are set to be conducted over several years, it is difficult to find out the actual impact until the projects have been closed. Similarly, for new projects, the actual benefits and created value can only be measured once the tool has been in constant use. This is why the study will focus more on the benefits that can be measured during the early stages of project rollout and during the deployment stages of the project.

Further limitation that needs to be made has to do with all the linked functions that are adjacent to the supply chain functions within the project tool. The idea is that adjacent functions will not be measured and are standard. Only those functions or tasks, that have an impact or are affected by supply chain functions are to be measured and the linkage is to be measured. Other functions that are only indirectly related to supply chain, will be left out of scope due to the possible complexity of the relationship between the functions.

3. Literature review

In this thesis we will define the benefits of a new project management platform through predefined variables and see, which of these variables can be “manipulated” to gain additional value from supply chain perspective. The second part will see how people perceive the tool and the operational benefits using the tool and in case of a possible gap between the old and the new.

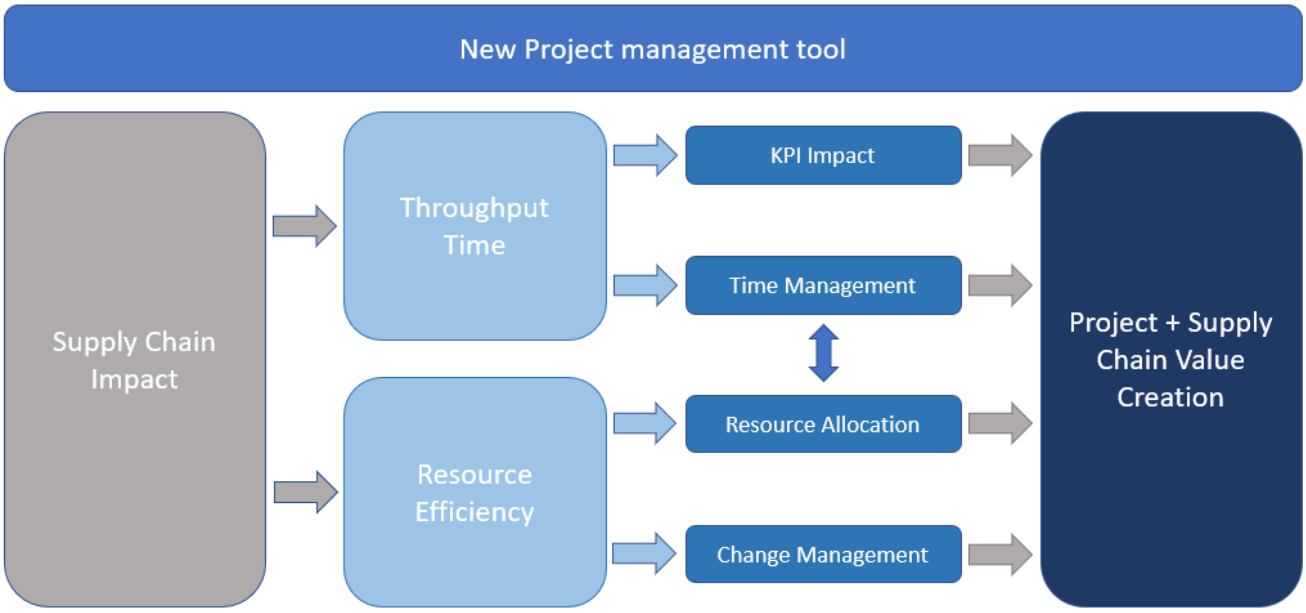

Figure 1 Research theoretical framework

Figure 1 illustrates the basic process for the study. It looks at the different factors that have been identified as the key elements impact the value creation. The framework has been limited to the elements described in figure 1 to keep the before mentioned scope in tact and to only the supply chain perspective within this study.

To begin with the identification of changes and benefits that a new information system might introduce to the field of supply chain management within project environment, we need to identify and study key topics from theoretical perspective

as to understand the current understanding and how the theory is linked with the current case. The main topics will be project supply management, information systems in supply chain management, supply chain performance and value creation by looking at the concepts of efficiency and effectiveness. As a supporting subject we will look at change management, which always has an impact on the deployment of any new process or tool.

4. Supply management within project environment

A new and integrated project management tool is able to provide wide variety of data from all of the ongoing and past projects for future decision making, which can have a positive impact on the value that is delivered to the customer (Brinch, 2018). By having a comprehensive tool, it becomes easier to justify to the customer their need and value that they gain from a turnkey project, which is possible to achieve by using such tools. The gained transparency and exchange of vital information between project parties leads to gained benefits as found out by Bartlett et al. (2007) in their study of supply chain improvements through added visibility.

With the rise of project management and execution as a service for customers, the need for automating operative tasks becomes more viable. By mapping the use and effectiveness of the tool, we are, for example, able to create a list of tasks that are both time and resource consuming. McComb, Kennedy, Green and Compton (2008) found out that a sufficient setup phase is crucial for the efficiency of the project during the execution stages. The mapping will help with the correct positioning of resources and this again will be realized as cost savings during project execution and also help with improving the e-2e cash flow, by minimizing the need for far too large inventories and by improving the time between the customer approval (site on air) and invoicing.

The reason for the study is to research the potential that the new project management tool and its material management module can bring to the project supply chain management (SCM) team. The implementation will be done before the project deployment, but the usage and the measurement of realized benefits have not been studied further from SCM perspective. For SCM to work efficiently, it is vital to have the necessary IT tools and equipment available (Gunasekaran and Ngai, 2004). The idea is to generate a conclusion to show how much more efficiently projects can be executed from the supply chain point of view, by having a comprehensive tool to help with the management of project tasks. Efficiency can be defined in multiple different ways, depending on the perspective that is used. For this research, efficiency is seen as a way of optimizing the use of resources in order to generate additional value for the supply chain operations within project. The research will also investigate the current methods of measuring of supply chain performance within the case company, in order to create the linkage of measuring the additional value through the use of the material management module.

Projects are won through competitive tender processes. During this process, the quantity of sites (A site is what the customer receives during the e-2-e project and it includes both the hardware, software and setup of the base stations) is communicated by the potential customer and they also specify both the frequency band that they work within. After the project has been won, the number of sites is specified and the setup phase begins in order to understand the customer needs and defining a portfolio of supplied equipment (Found & Harrison, 2012).

The current gap in understanding is the lack of experience with the new tool. As always there are certain prejudice towards the need of new tools and platforms in the form of change resistance (Hon et al., 2014). One of the open topics from case perspective is that at the current moment the full potential of the tool has not been tested in a complete end-to end manner as the tool is new and still under development. Parts of the tool have been tested on existing projects, but there are no real-life data regarding the use of the tool in completely new projects. The tool introduces an end-to-end process which enables the complete tracking of

equipment, site work and information flow, from the site design to base station acceptation.

Ala-Risku *et al.* (2010) found in their study of site inventory tracking in telecom projects that any customer changes to pre-defined modules will have a negative impact on the supply chain performance. This in combination with the fact by Collin and Lorenzin (2006) noted, in their study about collaborative forecasting using a project management tool, that demand planning on customer level usually relies on a rollout plan and that all stakeholders should be involved with the forecasting exercise, brings us to the reason why a comprehensive platform is required in order to track the rollout plan versus demand plan for n-1 period. The exercise of involving all the different stakeholders is part of integrated business planning within the case company. It also makes the case for constant monitoring of realized demand versus planned to increase the future accuracy.

Another aspect that needs to be looked at closer, are the logistics models that are used within supply chain management. Hub model is different from general logistics center or warehouse operations. The operating model relies on the constant movement of equipment and materials instead of generating longer term inventory. Hubs are used to generate flexibility within organizational supply chain and the study by Ran et al (2017) noted that numerical data suggested that hub model generates the before mentioned flexibility and is better in that sense then decentralized distribution models. Hub operations are usually outsourced to a third-party partner or logistics service provider (LSP) that is specialized in the matter of organizing distribution and warehousing processes (Ran et al., 2017).

In project environment it is most important to understand the customer demand and their need. From the customer perspective, the only requirement that they have, is that the project is finished within budget, on time and that the delivered products and services work flawlessly. These deliverables are measured by the customer within their tools for tracking project status against set of targets created for the project. This means that the customer does not have any opinion on what the supplier interface will look like, or what the input is as far as the deliverables are

met. From management perspective, this increases the amount of necessary coordination as customer is the one setting the pace for the project even if the project team is in charge for delivering according to the customer's needs. From supply chain perspective, the deliverables are equipment and materials, which are sourced from various different suppliers within a global supply network. As mentioned by Ala-Risku et al (2010) forecasting for telecommunication projects needs to be well aligned, with the project plan. At the same time, the equipment and materials need to be standardized. The standardization means that there is as little as possible variation in the supply chain design as possible. The impact of variation during the mass rollout of the project usually leads to rising logistics and variation within quantities, both of which impact the schedule of the project (Baud-Lavigne et al., 2012).

One of the biggest possible issues that need to be managed within projects are possible delays. Delays impact the schedule and the financial targets of a project in multiple ways. The increasing complexity of products and the higher demand for customer specific customizations may lead to situations in which corrections to the design and equipment need to be made in order to achieve the target set by the customer. The downside to these types of changes is that any change made during the project will have an impact on the supply chain lead-times. (Mello et al., 2020)

5. Information systems in SCM

The effect of integrating information systems into supply chain management processes has been widely studied from different perspectives and through different industries (Bayraktar et al., 2009; Giannakis, 2019; A Gunasekaran & Ngai, 2004). The common conclusion that all of the studies have, is that for supply chain management to gain increasing traction and value within organizational strategies and operations, it is vital that organizations invest into the development of systems that integrate supply chain functions into the daily operations of a company. As

supply chains become more complex due to changes in competition and changes in technologies, organizations are bound to implement information systems in order to have the ability to simplify the complex processes in order to achieve organizational goals (Mirchandani & Lederer, 2014). Interorganizational information systems generate value by creating a medium that can be used for interacting with suppliers, customers and possibly other stakeholders as well such as contractors (Shah et al., 2002).

5.2 Cloud Computing as part of SCM

This has brought a new way of thinking and using information systems by introducing concepts such as software as a service and platform as a service, both relying on a wider topic of cloud computing (Giannakis, 2019). What this means is that instead of having physical software, the software is web-based and can be accessed through typical internet connection. This ties in with the idea of greater integration of separate operations into one in order to increase efficiency and performance of both operations impacted by the information system (Mirchandani & Lederer, 2014). Having an online based platform as the medium collecting data from different sources simplifies the already complex structure of having separate tools that only function for certain tasks within a larger process, such as a supply chain (Radhakrishnan et al., 2018).

As Giannakis (2019) notes that cloud computing can be used to increase productivity of organizations as the main focus can be moved to core business activities from tasks that are seen as waste from the perspective of creating and maintaining business value and growth. This thinking is one of the reasons for the necessity of this study. To show the additional value of cloud-based supply management platform through various indicators that measure the performance of the supply chain functions within project.

Cloud computing itself is a larger topic, so to narrow the scope for the study, it is important to know which layer of the whole cloud computing structure we are looking at. There are multiple cloud computing layers, that are visible to different stakeholders.

For this study we are looking at the two topmost layers (figure 2). The first one is *Cloud Software Environment*, which has been provided to the project use to create the project instance as a part of the larger infrastructure. The second layer is *Cloud Application* itself, which is the visible software that is used by the different project stakeholders. The *Cloud Software Infrastructure*, *Software Kernel* and *Firmware/Hardware* are not part of the study as these cannot be changed or altered for single project instances but are applicable only if we look at the whole tool itself on a global high-level perspective. (Prasad et al., 2014) This is not the case for this study that focuses on single projects that use both the platform and the end-user software to customize and create the project instance.

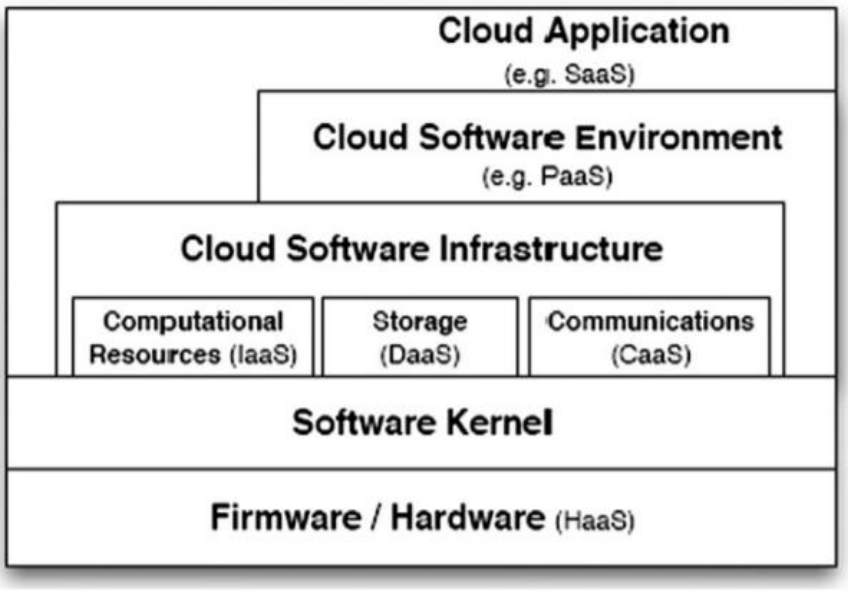

Figure 2. Cloud computing layers (Source Prasad et al., 2014)

5.3 SCM Information Systems in Project Environment

Implementation of information systems into organizational practices has also an impact on the supply chain agility within fast changing markets (Degroote & Marx, 2013). The integration of such tools is vital on organizational level as such, but it is even more important for the smooth operations within project deployment and execution as market changes have a high impact on project as issues tend to lead to possible delays that are likely to impact the outcome of the project. (Mello et al., 2020) Integration of IS into SCM practices resolves some issues by enabling a method of coordination between supply chain members both internally within organization or project organization and with external partners, such as subcontractors and customers (Kanda & Deshmukh, 2007).

Not only are information systems used for SCM practices on higher level to gain traction and value. Organizations are creating linkages with suppliers and logistics partners and the warehouse management systems in order to gain efficiency and performance that is necessary especially within modern fast changing market environment (Faber et al., 2002). The use of inter organizational information systems is a step towards supply chain integration that enables performance benefits to both parties (Radhakrishnan et al., 2018). As Prajogo.D and Olhager.J (2012) found in their study of supply chain integration and its effects on supply chain performance, that logistics integration has a significant effect on the actual operational performance. This is one of the reasons why the implementation of both internal and inter organizational information systems is important within project environment. As projects are highly vulnerable towards any delays within supply chain, any way of increasing responsiveness and efficiency is welcome in order to mitigate the listed risks (Williams et al., 2013). This speaks for the integration of project management tools in for of information systems interlinked with other functions, both internal and external.

6. Supply chain performance and value creation

It is important to understand that supply chain performance is traditionally measured by the amount of costs that can be saved (Cai et al., 2009). The more modern take on measuring supply chain performance is to find ways of generating sustainable value and to create competitive advantage through supply chain functions, by having full control and understanding of the supply chain network and supply chain capabilities (Klibi et al., 2010). The idea that supply chain consists of sales, procurement and logistics adds to the idea of creating a way of full control of all of these. A topic, which has been widely written about, is the actual measuring of supply chain performance and the difficulty of measuring the performance (Beamon, 1999). There are several different ways that companies measure the performance of their supply chain. One is to create certain KPI's that visualize both the efficiency and effectiveness of supply chain operations (Graham et al., 2015). KPI's are easier to measure for supply chain working with material goods, but with services it is more difficult to define the added value within the supply chain as the value of a service is harder to measure as it includes more than just the price of the service itself (Giannakis, 2011).

There are several key performance indicators (KPI) that can be measured to determine the performance of a supply chain. KPI's are usually interconnected with each other and the one of the most common issues with measuring performance through KPI's is that improvement in one might cause extra cost and/or extra effort in accomplishing another KPI. This is important to understand as some KPI's might have an sequential impact on each other or even a coupled impact in which the improvement of one KPI's has impact on a separate KPI and vice versa. (Cai et al., 2009)

Supply chain management has to be acknowledged as one of many company internal functions that are there to create value. In the past, both logistics and SCM have been seen as cost creating functions (Christopher & Gattorna, 2005; Skilton, 2014). In their study Christopher and Gattorna (2005) mention that most modern

companies use out-sourcing to move major cost producing activities outside of the company. This means that organizations are relying more on their suppliers and subcontractors for their services, which increases the required visibility in order to have a full scope of visibility over all functions within the supply chain. As stated earlier, achieving supply chain excellence should be one of the key drivers for organizations to differentiate themselves from their competitors (Anand & Grover, 2015) and in order to gain competitive advantage, by not only using technological advantages, but through having something that competitors would not be able to deliver to the customer through other services. For this study, we are looking at supply chain excellence as it is one of the most important business functions within the modern type of global business environment (Chicksand, 2015).

Another topic which is seen as a supply chain value creating activity is the cash-to-cash cycle time. The cycle time begins as soon as supplier gets paid for their work and ends as soon as customer pays for the end product, service or deliverable, which includes the work that the supplier has done. The activities related to reducing the cycle time can be seen both as value creating and performance enhancing (Liao et al., 2017). Therefore, it is important to connect project management with supply management in the environment of the research.

To fully understand and measure the performance of an organization, the key concepts are efficiency and effectiveness. Mouzas (2006) defines efficiency as a mandatory condition or hurdle that is reflected in the organizations operating margins and effectiveness on the other hand is the organizations ability to generate growth in the surrounding business environment. That is why it is important to take a closer look at the two concepts and how they are visible within supply chain management.

6.2 Supply chain efficiency

Supply chain efficiency can be linked with measuring the performance of a supply chain. By measuring parameters such as cash cycle times, lead-times and inventory age, organizations are able to show the performance of their supply chain. Efficiency comes from the results of these parameters and by analyzing the numbers, management is able to identify if their supply chain is efficient or not. (Sillanpää et, al, 2015) Gunasekaran and Kobu (2007) state in their study that measuring performance can be defined as a process of quantifying efficiency. What this means is that the measurement of supply chain performance is a way of showing the actual efficiency of that same supply chain. Qualitative supply chain metrics consist generally out of quality, innovativeness, visibility, reliability, responsiveness, flexibility, cost and asset management (Angappa Gunasekaran & Kobu, 2007).

The methods of quantifying supply chain efficiency vary between organizations as the use of KPI's to show the efficiency of their operations vary. Ideally KPI's are there to show how teams within organizations are able to increase the efficiency of their operations by trying to achieve certain yearly or strategic targets. (Anand & Grover, 2015) To understand efficiency, it is important to look at how supply chain performance is measured, what are the key drivers that create value in supply chain and what the understanding of supply chain as a value creating process is in the current literature.

In this study supply chain efficiency will be divided into three different categories. Each of the three categories have an impact on the supply chain efficiency, which is visualized by KPI's and other indicators that are subset within the categories. These categories are throughput time, Resource efficiency and Project visibility or transparency.

6.3 Supply chain effectiveness

The second part of qualifying supply chain performance is to study the impact of effectiveness. Effectiveness of a supply chain is as important as is the efficiency but has been relevant from managerial perspective in the past. These two combined create a way of quantifying supply chain performance (Mouzas, 2006). As Walters (2006) argues that efficiency itself is not enough to identify the full value that a supply chain is able to create and talks about introducing a demand-driven view, which should combine both customer relationship management and supply chain management. As efficiency is seen more as a way of minimizing costs and improving operational margins, effectiveness on the other hand is the organizations ability to create sustainable business growth (Mouzas, 2006, 2016).

For a demand driven view, one of the most important measures is flexibility as it defines effectiveness of a supply chain and simultaneously ties in the importance of information system integration, as it is one of the key concepts of how organizations are able to improve the effectiveness of their supply chain(Ayers, 2006; Hadaya & Cassivi, 2006). The improvements with supply chain efficiency mean that the organization is able to create growth and thus improve the revenue generation capability of the organization (Wong et al., 2015) This would mean that an investment in a supply SCM information system for project management should affect the resource utilization and thus the effectiveness of the project team.

7. Change management

Next topic that has an impact on the study is change management that occurs as organizations try to improve existing processes or introduce new methods of working. Studies show that the commitment of employees plays a key role in defining if an organizational change is a success or a failure (Taylor & Seo, 2012) It is highly important that organizations are aware of the possible change resistance that might occur, during the time of implementing new processes within work stream,

as it is affects the success of the change initiative (García-cabrera & García-barba, 2014).

The rise of IT services complimenting the defined work processes within organizations is increasing as the need for transparency rises within quickly evolving global markets. Simultaneously by creating such IT services, organizations are able to differentiate themselves from competitors by having better resource management. (Aral & Weill, 2007) This increases the importance of actually selling the organizational changes to the employees that are impacted by the change. This means that the people in charge of the made changes have to be able to show what the tasks are that are impacted and most importantly, show that there are no additional tasks or time spent to fulfill those tasks.

Most of the time when changes are made into any predefined process, there will be some scrutiny regarding the actual need for the specific change. This type of behavior might become an issue if the benefit and value of the changes are not clear for the ones who are affected by it. It is crucial that the benefits of the change can be brought forward, for example in the form of listing things that workers want to change and then explaining how the planned change will tackle the bottle-neck functions that majority of workers want to change. Change resistance is a widely studied phenomena, which takes place when new tools or processes are introduced into organizational environment. This includes changes both on strategic and operational level.

8. Empirical case study

The case organization is undergoing development and deployment of an companywide project management system that will not only substitute previously used system, but will also enable better project governance in terms of financials, better resource utilization as well as greater visibility between different functions and processes, including supply chain functions. Within this larger entity, one of the key

modules is Integrated material management (IMM), which is used by the whole project team, but mainly governed by supply team that governs the project supply chain of specific project. The IMM will be covered in this case chapter as its own entity as it is the main focus area of this research and includes all the processes and information that are beneficial for the supply chain team and for the project team as such. It is vital to understand the benefits from supply chain perspective as these benefits impact the project efficiency and performance.

In this chapter we will be studying the different aspects of the integrated material management tool and look at the use cases within different projects. The target is to gain a better understanding of the tool and the theoretical benefits and value that it is thought to create, before we actually create conclusions based on real life use cases in the following chapters. This chapter will be answering the main research question

“How does the tool impact supply chain management practices?”

As the question is more related to the actual process changes that are required from the supply chain functions, when deploying the new SCM project management tool, it becomes of what the introduced tool and processes are. We will look at the different methods of supply management within projects that have been in place so far. Then we will look at the processes that the new tool introduces. Once the standardized process and the, new, introduced functions are clear, it becomes easier to look at the benefits and value that the tool might introduce. The benefits and value are created by the changes and the additions that the new method of working bring forth, but these can only be analyzed by having a clear picture of the process.

With the introduction of a new technology comes an increase in modernization projects that see customers upgrade and add to their previous generation equipment and rollout new generation of base stations to provide consumers the latest technology within their networks. There is a large increase in the demand for network access as more and more consumer and business products and equipment are linked to the internet. Simultaneously customers are demanding higher internet

downlink and uplink speeds as, for example, supply of higher quality media services increases.

Additionally, current and future telecommunications projects are more about increasing network capability and optimizing capacity by using leading edge technology. Customers are demanding improved performance and capacity out of products. This also impacts the supply chain as this requires more flexibility, which tends to lead to worse/shorter visibility on the supply chain side. This leads to the need of developing tools and processes, which enable the required supply chain visibility, flexibility and responsiveness that the project stakeholders are looking for.

This study will be looking at one case company and use multiple projects as a basis for creating solid answers to the proposed research questions. There are several different perspectives that can be used in measuring the impact and benefits that the implementation of a new information system has on the value creation within organization and its stakeholders. Therefore, the focus of this study will be solely on the impact that the tool has on supply chain management operations in telecom project environment. During the research there were in total five projects, which were compared within one organization. As mentioned earlier, these projects were in different phases, two have been ongoing for over a year, two are currently in deployment and one has been finished without any project management tool in use. The easiest comparison can be made with the finished project that had no project management tool in use and one of the new projects as the project supply chain team consists of same resources and because of this, the feedback and comparison is easier to conduct.

9. Current tools within project supply management practice

Until now the case company has used an integrated project management tool on global level, but it was noticed that the tool was limited from supply management point of view. Secondly the tool was lacking flexibility towards different supply types. Now it is important to note that in telecom projects, the end-product is a fully functional base station which is linked to the communication service provider's (CSP) network. Old project management tool was lacking flexibility once it was linked with the organizational ERP. What this meant was, that once information was given in the tools, it could not be changed and if the information could have been altered, it was after several changes and through a lot of effort. This is common especially within project as equipment and material might change site by site.

Currently there are a few different methods of supplying the required material to the sites. Choosing bulk or site-based ordering process does not affect the process of how material flows within the supply chain. The difference is in both order quantities and equipment quantities. Both of the standard ordering processes using global supply are always linked with the Hub processes that was previously looked at from a higher-level perspective. The basic idea to understand is that Hub buffer stock is based on the business unit forecasts of that same region. Hub processes are forward leaning and thus it is One is to have a local warehouse, which stocks the standard radio and antenna equipment, which are used in the project. The inventory would be for example for a certain quantity of base stations and would be replenished through warehouse management trigger as sites are requested to be completed according to project timeline. This means that the parts are open to be used for any of the sites so it would be open warehouse for the project use. Certain universal materials would be supplied by local suppliers as these are not core equipment and are highly standardized.

The second option and the currently more preferred option is to order project materials site based. This means that similarly to the first method, we use a local warehouse for project equipment. The difference is that this time all the parts in the

warehouse have been ordered against a customer purchase order with strict delivery times. For this to work, all the equipment and materials in the warehouse have been mapped to a certain site and will be delivered on a project specified time. This method has its benefits, for example inventory levels will be more stable and every item has been mapped beforehand and can be traced throughout the supply chain flow from the suppliers to the base station implementation. The negative with this method is that it is relying highly on the rollout and demand plans. This means that there is no flexibility towards sudden changes. Once all the equipment reaches the designated sites, subcontractors are responsible for assembling the base stations and once the implementation work is done, invoicing is triggered. Invoicing has project specific milestones, which are defined in the contract. These milestones are to be triggered through project management tool by project manager, once subcontractors give green light that sites are on-air and have passed certain tests regarding the stability and are connected to the customer network.

For this case we will be looking more into the site-based ordering process as it is the more preferred ordering model option within project environment. At the same time, only one of the five used cases are currently using bulk ordering model and because of this site-based is the more relevant model to research at the moment. From the two it is also the more resource demanding ordering process, due to the higher reliance on a detailed plan showing the exact dates when equipment and materials are needed in the project. The need for more resources within site-based ordering is apparent as the method is not flexible for any changes.

The project information flow is much easier to follow as the platform is linked to other tools, which can generate information directly to the tool using RTI linkage. The tool will also help with reporting as it combines all the data from different interfaces and combines them and provides combined availability view that improves the transparency. This makes it easier to analyze specific KPI’s and the impact that possible changes might have on them. Figure 2 illustrates the basic supply chain that the case company is using on a high level. Information and funds flow include the regular updates to forecasts and of course both sales order (SO) and purchase

order creation (PO). In a project setup this flow changes slightly as a secondary module is included. A secondary supply flow is added towards Super Vendor (SV) for materials that are critical from the project deliverables perspective.

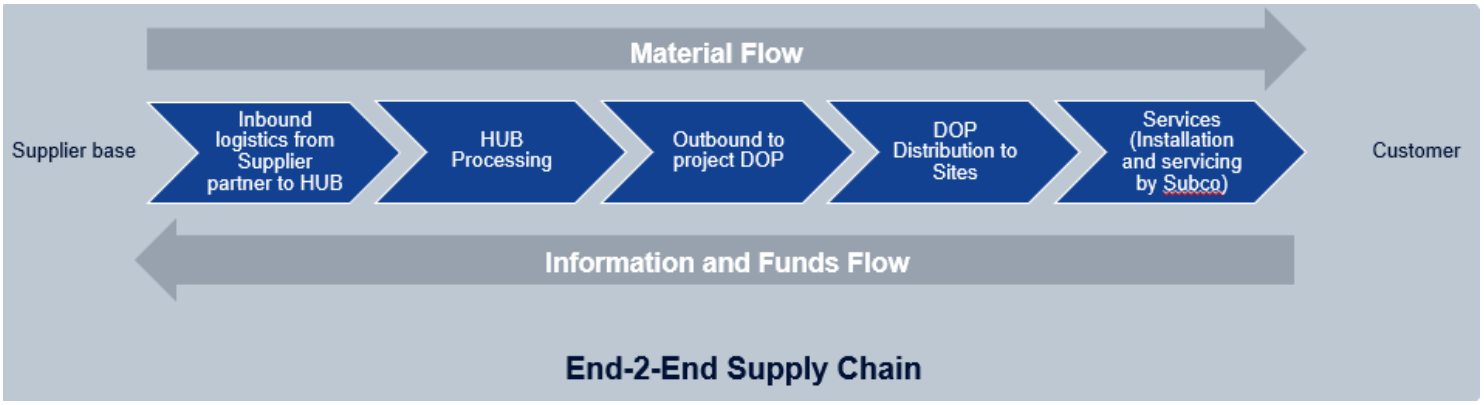

Figure 3. Case organizations high level e-2-e supply chain

It is easy to understand the impact that both different approaches have on the actual flow of both equipment and information within predefined supply chain. Both approaches rely heavily on the trueness of three different factors (figure 3) that create the framework for the actual operative use. In figure 3, the operative use consists of the material management module itself and last mile logistics module (LML). LML defines how project equipment reaches the correct sites on time within the target country. Issue in any of the three defining factors it that, they have an impact on the critical path of the supply chain. Next, we will need to look at the three factors to have a clear understanding what they are, what they consist of and what their impact is on the project management tool process.

Customer product configurations are related to material management in the sense that quantity contract is a frame contract which includes the products and the product quantities that have been agreed upon, within the project, to be delivered to the customer. It is in place for tracking costs and is compared against the actual order quantities. Product configurations are constructed from individual products

and when combined into a configuration, create a package which includes everything that is needed for the construction of a single base station. Within project scope, there are usually one or two lists of configurations which are used, but there can be upwards of hundreds of product configurations on these lists. The link between the two is that once product configurations are done, they are added to the complete list of project specific product and service configurations.

Project rollout plan is generated by project manager and it defines the timeline towards which, the equipment and services need to be in place for site construction work. Rollout plan is generated against the customers given project timeline and works as the baseline for demand forecast. It can be viewed as a baseline which is used to determine the product and service needs at each specific point of time during the project. From supply chain perspective, project rollout plan is used as the baseline for several different functions. These include demand planning, material and equipment definition on site level and for ordering timeline purposes.

Demand forecast is created on the basis of the rollout plan. Demand plan is done locally, but is added to a demand management tool, which consolidates the demand from different regions to one global demand plan. The global demand plan is then distributed to the supply network, which makes sure that the equipment is available with optimized landed cost when the forecasted demand is realized. Demand planning is done separately on both short and long term. Short term demand forecast is done on a 1-5-month timeframe and updated on at least monthly basis. Long-term demand forecast on the other hand is based on the business view and accounts for 12 months of planned demand.

This brings us back to figure 1 illustrating the high-level supply chain, in which the information flow is towards the supplier. It is crucial that both the demand plan and rollout plan are in line with each other to ensure the material availability from suppliers.

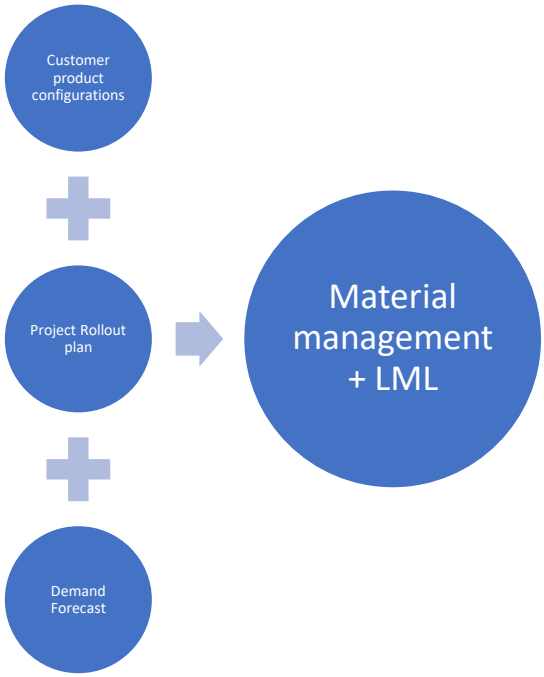

Figure 4. Three main components for a working material management tool

10. Evaluating supply chain performance within case company

The evaluation of supply chain performance is important to gain full understanding of how the case company operates. It gives the understanding of how supply chain performance is measured. By knowing the full extent of measuring performance, we can compare if the given performance indicators can actually be improved, using the new project management tool.

Key performance indicators (KPI) give a good understanding of the different performance metrics that the company values within their operations. In the case company, there are several KPI's that are measured from the project supply chain perspective. These KPI's are divided into four different categories: customer, Fulfilment, inventory and cost. Within each category, there are individual KPI's for which the trend is tracked on a monthly basis against a business unit target. This is a way of increasing the demand planning accuracy KPI when used correctly.

From the case perspective, it is important to understand which KPI's can be impacted positively with the implementation and the use of the new tool. IMM is able to connect rollout planning and short-term demand planning, by creating a timeline for the quantity of sites and what those sites include on equipment level. As an example, the tool can be used as a platform of sharing the rollout plan on a weekly or monthly basis, giving the information for demand planning, which influences the Demand Plan Accuracy KPI. Simultaneously the tool gives a method of constant monitoring and reporting through separate tools that are linked with the project management interface.

The understanding of why there are KPI's is important. By the end of the day, these are the indicators, which the top management is looking at regularly. If the tool has a negative impact on these indicators, there will be changes. On the contrary, there need to be improvements within the KPI's as only that way does management understand the actual impact of the tool on both supply chain performance and on project performance.

It needs to be noted that for some of the beforementioned KPI's, project supply chain team cannot be in full control of them as they are also impacted by the global availability of equipment. The global availability is in the hands of the Hub procurement. This means that the project-based supply chain team is only able to make decisions regarding the logistics for the material flow. From performance perspective this means that the supply team is only able to perform once material is timely available in hubs according to the up-to date demand forecast.

11. Integrated material management

Integrated material management (IMM) is a tool in which project team can monitor project supply status and generate equipment and material call-offs accordingly. The main idea is to have one platform, which is in contact with all other platforms, such as ERP, Logistics Service Provider (LSP) warehouse management system and ideally customer project platform as well. The tool itself is a cloud-based solution, which means that it is available for users without the need to download any software. The need for IMM stems from the need to have a solid method of checking and monitoring product availability against project timeline. The basic idea is to create a timeline that is built by lead-time as for equipment, subcontractor services and all other materials that are required for deployment of a base station. The timeline can be used in order to identify chokepoints both within the project processes and the supply chain processes. Simultaneously as the tool enables the visibility regarding possible issues within processes and supply, it can cut costs and add value to the ordering processes and material handling processes, by eliminating manual tasks and possible delays and issues in communication.

On higher level, each individual site is generated into a site module package within a larger scale project management platform in which IMM is the supply tool. The higher-level platform, that includes IMM, involves all of the tasks that go into the end-to-end process defined for the project. The whole project management tool is on an online based platform, which allows a wider integration of service suppliers into the project management process. This online environment consists of different smaller entities that include different project related tasks and IMM is one of them. In telecom projects the delivery includes technical site surveys, network planning, network integration as well as base station implementation of both hardware and software. During the end-to-end process, IMM is the module which includes all of the tasks and milestones that go into delivery of equipment, materials and services for a complete customer site. This is why IMM is included as its own process to ensure that equipment and materials are accounted for and the availability and status is clearly communicated to the other functions within the project.

To better understand the benefits of such tool, it is important to understand the whole process, from defining all the goods and services to processing last-mile activities. It is necessary to realize that the actual process is only as good as the planned setup. If the operative phase of the project begins without proper effort of defining processes, roles and input, it becomes difficult for the project to operate as all the visibility is lost regarding the supply chain timeline versus the project timeline. That is why it is important to have a clear deployment phase that allows the team to define all necessary tool deliverables for the smooth transition to the operational phase of the project.

For deployment, there are five different operational tasks that are required for the full implementation and use of IMM. These are material and service definition with lead-times, business volume plan / rollout plan, logistics setup including warehouse management and last-mile logistics as two different entities and site survey module. Figure 4 illustrates the site level flow of information that is within IMM and how it corresponds to the actual flow of services and goods. If this is taken into bigger picture, the BVP is done for all sites, but it needs to be clear that each site has individual planned dates within the project and that plan includes the information of the necessary materials for that specific site and how long the lead-times are for those items. This allows for the timely execution of material flow.

Each of these are defined either before the operational phase of the project begins, or during other operations within the total project end-to-end process. For example, materials can be listed and defined before the project to a certain degree, but only after site survey, do we have the full scope of materials that each individual site requires. There are also other functions that need to be well defined before the project can begin. This includes roles that each resource has and other steps within the end-to-end process.

Within the tool, materials are categorized in three different categories A, B, C and D. Table 1 shows how the different materials are divided into the four categories. For this case we will be mostly investigating the impact of IMM on the supply of category A and B equipment, as these are globally sourced through a internal supply

chain, which consists of several functions that are closely related to the implementation of the project management tool IMM.

Table 1. Material categories and definitions

Material category	Materials within the individual category

A	• Global equipment
	  • Radio modules
	  • System modules
	  • Antennas

B	• Global Equipment
	  • Mounting options
	  • Site accessories

C	• Local materials
	  • Vendor material
	  • Site accessories

D	• Customer supplied Equipment
	  • Antennas
	  • Site accessories

Another important function, which is also the function that begins once material arrives at the local warehouse. Within IMM there is the ability to manage inventory within project specific drop-off point (DOP). With earlier project management tools, this has not been possible, and the warehouse status has been checked manually with the help of the project logistics partner. The addition of IMM increases the visibility towards the DOP status and can automate call-offs using the pre-uploaded delivery times from DOP to the base station sites.

The final task that is managed through IMM is the last-mile logistics (LML) and invoice triggering. IMM enables the monitoring of goods that arrive at the warehouse and creates a notification for the delivery request which informs the warehouse

management to prepare defined goods for transport and depending on the last-mile setup, it will also inform the transportation partner about the pick-up. In a site-based environment this would mean that the goods are transported from the local central warehouse or country DOP to either a forward DOP or pick-up point, which the subcontractors use as they receive the goods at a location, which is close to the pre-planned sites. Once subcontractor receives the goods, they will inform that the receival has been done without issues, using the mobile application, which is directly linked with the IMM process. Invoicing process can begin once the site work is done and subcontractors declare site work as finished. What this means in IMM, is that project manager will be able to monitor the status and declare that sites are ready for invoicing. Once sites are declared ready for invoicing, project supply chain team issues the invoices and sends them to the customer.

This means that the whole IMM loop begins with supply chain receiving CPO according to demand plan and issues material call-offs according to the CPO. This triggers the global supply and most of these materials should be already available at the assigned hub via demand-driven replenishment, (which has prepared for the demand and made sure that once the orders are generated according to the demand plan, material is available for deliveries). Of course, there are some products that are not ready at the hub once the call-off is issued, but these are only a small portion of the total pool of materials and generally purchased on large scale.

Figure 5. IMM process in connection with practical supply chain flow

11.2 Expected enhancements introduced by IMM

Integrated material management is a module within the project management platform. It is linked to other modules within the e-2-e process flow that is defined within the larger scale project management platform. There are several key reasons for introducing the module even as a standalone function within a larger platform in charge of other end-to-end project activities. It is there to enable automation and information transparency within two different supply chain functions. First it helps to

plan the project demand on a site level and enables more efficient order management through RTI with ERP.

Before measuring the actual benefits and value that IMM is able to generate, we need to look at the conceptual benefits that actually were the reason for introducing the new tool in the first place. There are several benefits that can be thought about in theory. On a process level these benefits include end-to-end transparency, simple process follow-up, easy access to data, better time management and improved resource allocation. On financial supply chain level, the tool has a positive impact on inventory management, material forecasting, invoicing processes and project communication.

Secondly it helps with inventory management and the last mile logistics (LML) tracking from local warehouse to the sites. With the regular stock report updates that the DOP management partner does within the tool, project is able to monitor the equipment status. With site-based ordering this would mean, that all of the equipment flowing through DOP would be ear-marked to certain sites and the idea is that the inventory should not age and there is a constant flow of inbound and outbound goods. Target is that there would be no inventory that would tie any additional costs.

There are other theoretical benefits to IMM that are related to higher level of supply chain management. This includes the fact that the tool becomes a medium that connects project related stakeholders and introduces a way of communicating with stakeholders and simultaneously generates data that management is able to use to report the effectiveness and measure the added value that such information systems is able to provide.

Since the implementation is on its early phases within organization wide projects, it is too early to speculate about the magnitude of collective benefits, that the tool is going to introduce over a longer period of time. Standardizing supply chain management functions in project environment could potentially lead into a positive situation in which there would be an influx of feedback and lessons learned through

every project. Standardized processes would mean that resources can be shuffled from project to project and the takeover period would be shorter as the policies and ways of working would be the same.

11.3 The response to towards IMM

From the beginning it was clear that there will be some doubt and resistance towards the deployment of a new integrated material management tool. This uncertainty is visible on both the project team side and supply team side. Both are accountable for the success of the project, but the separation between the two is visible and can be seen as a gap. There is doubt towards the actual benefits that the tool will introduce, and it seems that some of the doubts are valid as the tool is new to the users. Many have been using old project management tool which was developed over multiple years. Only through the development was it in a state in which the full potential could be used. It is easy to compare the positives and negatives of both, but it is visible that there are constant updates to the new tool, which bring great features, that were not there in the old tool.

There are several simultaneously ongoing projects that are implementing the tool as part of an effort of standardizing operational side of projects with having one tool which would be used on a global scale. For new project implementation, the response should be positive, but some resistance can be sensed. There might be several different reasons for the resistance, such as the question of why we need a new tool and what has been wrong with the old project execution methods.

The new tool has not been validated in real use before the time of study and is completely custom for the case organization. A custom tool means that there is no other tool that has the same parameters or inputs as the tool is relying on the policies and processes that have been defined in the past and that are in use outside of the tool. This includes the use and processes for the ERP system, all the financial reporting that is done and how it is tracked as well as the product management

which introduces the way that equipment and material are developed, supplied and are introduced to other stakeholders within the organization and to customers. The observed response has been quite good as terminology and processes outside of the tool are almost the same as before. Terminology might not seem a big deal, but global organizations use their own wording and abbreviations and it helps with understanding any new processes, if the terminology is kept the same.

Other reason for the introduction of a new tool is that other tools and platforms are usually for single purpose. Solutions are either for demand planning, ordering, warehousing and distribution, invoicing etc. This means that the tools cannot really be used for other functions unless they are connected with the ERP system, which is used within the whole organization. The new tool is combining all of these into one platform, that is used for input in the beforementioned tasks. At first it is difficult to grasp the complete picture which is created through the introduction of IMM and the whole platform, in which IMM is the tool for supply management in order to track the realized material flow versus the planned demand. The response is clear, there is some lack of trust towards the data accuracy and even when data has been verified as being correct, ERP system is still used for monitoring material flow.

12. IMM impact on supply chain functions

The next chapter will study the three different indicators that have been identified as the factors that have a positive impact on the day to day supply chain operations, within project environment. These factors are the throughput time, the resource efficiency and project visibility, all of which are impacted by the introduction of a new tool into the operational project management from supply chain perspective. All three factors can be seen as being part of a bigger entity of performance benefits. Each has its own impact on the project governance and on the actual operational side of the project.

The three factors were chosen based on the preliminary findings and studies that have been organized within the case organization about the factors that are improved through the implementation of the new IMM tool. During the research there were in total five projects, which were compared. As mentioned earlier, these projects were in different phases, two have been ongoing for over a year, two are currently in deployment and one has been finished without any project management tool in use.

Evaluation of supply chain benefits through a new supply chain project management tool, become vital as the usage begins. The implementation of information systems into supply chain processes has been a widely studied topic. It has been proved that organizations benefit from having systems in place, which enable the monitoring of material flow from initial customer purchase order to the final invoicing of the delivered goods. Deployment of a platform outside of ERP system for project management purposes has a valid argument as typically ERP systems do not have enough flexibility to cope with project planning, which can be done in the project management tool. The connection between the two is done through RTI-linkage, which works as a way of identifying the correct orders for a specific project by having correct elements that have been uploaded into the project management tool.

Several key factors have been identified, which link the project team, responsible for governing the project from schedule, quality and financial perspectives. Supply chain is interlinked to the project by making sure that possible issues with the supply of the deliverables is monitored and that the forecast given by the project is in line with a global forecast. The new platform is able to interlink the two by acting as a platform which shows the status of the material flow and the up to date project schedule that is to be used as a baseline for forecasting efforts.

The impact on supply chain management practises (question 1. “*How does the tool impact supply chain management practices?”*) is apparent through multiple contact points that SCM resources have on the tool itself. One of the biggest impacts is that the tool enables visibility towards the on-time order triggering, which has been an issue within projects that have not used the material management tool. How this is

actually visible in the tool is through the supply chain process, which begins by defining lead-times (LT) for all global materials and those lead-times combined with lead-times given by subcontractors for site work generate triggers for project managers (PM) to call-off the materials from global supply to local warehouse. Once this call-off has been completed, PM is able to trigger last-mile deliveries from the local drop-off point to the subcontractors just-in-time (JIT) for the site implementation work.

Operationally this means that the responsibility of order triggering and the checking of material correctness are moved to the project team and supply chain has the responsibility of providing the necessary equipment and materials according to the pre-communicated lead-times which are used as the baseline for project schedule. This has been an issue within several projects that have not had the possibility of tracking hardware lead-times, as orders were generated without any real-time visibility regarding the LT of individual items, which may vary within a customer specific package from two to ten weeks depending on if the equipment is made to stock or purchased against order. This shows how vital it is to have a sound project rollout plan in order to secure material availability.

13. Supply chain performance benefits

As studied by McComb et al (2008), project setup is one of the most crucial parts to determine the success of a project once the operational part of a multiyear project begins. Clear plan and role definitions during the setup, help the project team with understanding the expectations and outcome that is required from them either by the customer or by the organization.

From setup to actual rollout, there are certain important factors that need to be in place for operations to go smoothly. One of these factors is to have clear role definitions. This is important as a project over multiple years involve a large quantity of stakeholders and the stakeholders might even change during the project. By

creating clear roles, the project will always be able to rely on the decisions that were made during the project setup.

The collaborative information sharing and the information sharing, introduced by the tool, enables supply chain team to better communicate with the project team. The governance of different stakeholders within project team becomes easier, when a platform-based tool is introduced. The tool itself is not able to provide data as such, but the linkage to other reporting software leads to more accurate analysis of supply chain performance as all the data gathered from different steps of the process are gathered in one place.

The introduced standardized operating model that IMM enables needs to be looked at closer from supply chain perspective. The idea is to check, what are the main points during the process, which create additional value from supply chain perspective and thus can be seen as tasks that are able to generate additional value by improving KPI values or by introducing new way of working, which allows a new way of organizing resources from unnecessary non-value adding tasks to tasks that actually are beneficial for the organization.

The first supply chain related step within the tool, is to include lead-times for all the equipment and materials (categories A-D). This improves the visibility towards project organization and creates a way of tracking the total timeline for project orders within the tool from any service lead-times to the actual delivery of equipment to the site. The tool will automatically calculate the necessary schedule that is required to receive all the equipment on time and use that as a trigger and notifies project rollout team to generate call-offs on time. This is important as equipment is sourced on global level, lead-times between different equipment vary depending on the global demand and the source of supply. This is also the next link towards forecasting, as it is done based on the project demand for the upcoming months of project rollout.

Base stations can be deployed only once all of the necessary equipment has been delivered and thus the site demand is calculated based on the longest lead-time for a single piece of material that is required in each site package with all the specific

items for an individual site. It is also necessary to note, that lead-times are normally calculated for the time that it takes for equipment to reach the country. On top of this there is a period of time that needs to be added for the last-mile logistics from local warehouse to the actual site. This is important as base stations are built in various locations and access might be limited depending on the site type. This is not only an issue in rural areas, but also in cities as base stations might be located on top of buildings that are not accessible unless requested well in advance by the building management/owners. What this means is that lead-times and keeping lead-times is vital as delays might lead to situations in which the time window for site implementation is missed and access might be gained later than scheduled and this impacts the whole deployment schedule.

Demand planning for project is done in a separate tool, which is manually linked to the IMM tool. In the IMM project team is able to setup a timeline for site volume plan, which shows the quantity of sites that need to be delivered within a certain period of time. This volume plan is closely linked with having the lead-times in place the SVP task is then able to calculate the time it takes to fulfil the equipment requirements for each specific site. This creates a trigger to the rollout team regarding the call-off dates for individual sites.

Material management process starts with the identification of standard equipment that is necessary for all base stations and to begin to forecast these in alignment with the customer expectations regarding the project schedule and budget. Once all the standard equipment and material have been defined from the four different categories, rollout can be planned accordingly. Once rollout is planned, can the plan be converted into a demand plan, which is on item level. As Ala-Risku et al., (2010) observed in their study, rollout plan and demand plan have to go hand in hand to get the best possible results once the project rollout begins and materials need to be delivered. As mentioned before, the delivered materials are not the final deliverable within an e-2-e project, which includes project management as a service for customers, who are only included in the governance of the project. For sure, the supply chain functions end once all the materials are delivered to sites, but as has

been observed during the research, there are always setbacks within large scale projects. Missing material, faulty equipment and last-minute material changes are bound to come up as volumes increase within multi-year project. These situations are likely to lead into project delays and because of this, once orders are received, they need to be locked and any changes that the customer or other organizational functions might want should not be executed on existing orders (Collin & Lorenzin, 2006; Mello et al., 2020).

In one of the case projects it could be observed that several changes to existing orders were made due to both requests by the customer and by the global supply to change. This led into a vast amount of manual effort in changing existing orders within ERP system to accommodate the additional materials. During the deployment phase of a project, this affected around 30 equipment orders, but each order had to be modified at least three times. From resources perspective this impacted the workload of three resources and additionally there were several stakeholders that needed to be involved as some changes required alterations into predefined customer packages. In total this would mean that 5 resources are constantly in loop and several others had to be kept in loop for reporting and governance reasons. These sorts changes should be avoided as supply chain functions in contact with the customer interface are the ones that have to make the changes manually to each individual order within the ERP system.

The before mentioned issues should be minimized once the IMM tool is in full use. Project has two separate instances for issuing orders for equipment and materials and all additional needs must be seen as not possible, as they are not according to the predefined plan and simultaneously impact the schedule of the project. Within IMM there are no limits to the amount of orders that each specific site must include. The site-specific orders can be predefined into categories, which can be altered and increased according to the project needs. Of course, it is important to note that ordering cannot be initiated during certain processes as the timeline would not match with the project schedule.

13.2 Project visibility benefits

The project visibility benefits become clear as soon as the end-to-end usage of the tool is under closer look. The tool enables the quicker processing of both hardware and service orders, by creating a medium which replaces manual order and email sending with tasks that are able to show the current state of the process and possible issues with background data becomes more visible to different stakeholders. Without the tool, the case project would be using manual ordering based on e-mail exchanged between the subcontractors that inform variations between base stations, supply chain, project team and the customer. The inclusion of an end-to-end tool enables us to get all the information from the different parties into one platform, for further processing. This information includes the project timeline, warehouse status, delivery status and material planning for triggering orders to both third-party vendors as well as to the internal global supply.

Of course, there are some risks regarding how much visibility can be generated through the tool. As has been observed, customers can be very concerned over data security and data usage for project purposes. For example, at some parts of the world, the full-scale project management tool could be able to track the movements of subcontractors in order to help them to find remote base station locations. In Europe, the General Data Protection Regulation (GDPR) and other laws and regulations deny the possibility of using this. GDPR regulates the transfer of personal data outside the EU.

The main issue with this is that the material flow, cannot be tracked all the way to the base station and because of this, last-mile logistics is only to the subcontractor warehouse. The other implication is that both the project team and supply team need to rely on the subcontractor to have the equipment and materials at the site on the day of implementation. For this, the workaround was to track the movement of goods from the subcontractor warehouse by getting daily stock and outbound reports in IMM that show the movement of goods.

From the process perspective within the tool, the visibility becomes apparent from the setup phase as it enables all the project affiliates to see all the necessary information from one platform, instead of having multiple separate operational tools or reporting tools that need to be updated manually and with the possibility of breaking the line of communication from what is actually happening and what the stakeholders understand is happening during that moment in time. For example, project team members might have different opinions regarding different issues or possibilities, but everyone should have the same data available for further analysis in same format. What this enables, is that also reporting is standardized by having same data available in same format, instead of having to manually cross-check different reports, in order to get the data into a format that can be analysed further.

When looking at the added transparency that the IMM module enables, the case organization and their project teams are better able to report any data driven milestones to the project customer. This also includes the possibility of unforeseen delays due to issues that the project organization is not contractually responsible for. For example, during the site survey process, subcontractors might notice issues that cannot be handled by the supplier such as weather damage at the sites, which in this case is the case organization. These sorts of issues are logged into the tool and thus are available for the related stakeholders at any given time. From supply chain perspective these changes might include global material, as structures and sites differ, and thus certain antennas or modules might not be suitable for the site type and need to be changed. Similarly, the issue might be that instead of having a pre-recorded quantity of materials, there might be additional needs that need to be recorded well in advance for project team to react quickly enough in order to issue additional material call-offs with the supply chain team.

From the three listed benefits, project visibility improvements might be having the biggest impact on the project rollout and the outcome. The benefit of having all relevant data in one place not only increases the value of the data, but it has an actual positive impact both the t*hroughput time* and *resource efficiency*. First, by having material, timeline and site data are all found in one place project team is able

to cut down non-value adding steps of generating data into a correct format before actually using it. This impacts the *throughput time*. Secondly as resources are able to find the relevant data in one place, they do not need to access different platforms or tools in order to generate the data that is actually relevant for the supply chain processes. As mentioned before, for the project to succeed, it is crucial that the project plan is aligned with the supply chain as only once these are aligned, can project operations succeed flawlessly.

The addition of greater visibility not only helps with the communication between the project team and supply chain team when generating and tracking orders. It has an impact on asset efficiency, which has been described as one of the performance indicators by Gunasekaran and Kobu (2007). Better visibility impacts both the resource efficiency and throughput time which have been observed as the other two supply chain efficiency indicators that are impacted by the implementation of IMM.

13.3 Resource efficiency

Resource efficiency becomes apparent through the standardized way of working, which the tool enables. The full view of the different functions that shape the project supply chain become visible as a standard process is defined. The standardized process is the best way of defining the responsibility that each role includes within the e-2-e process. As was previously mentioned, the amount of time that is saved on the operational level, will have an impact on the resource efficiency as well. With less time taken by time consuming and non-value adding tasks, supply chain resources can focus on tasks that improve the project execution.

Resource efficiency is also measured by the required quantity of working resources and the efficiency at which each of the resources can work at. Not only is it possible to save labour costs, but resources are also able to adjust and shift their focus on more time consuming and value creating activities. Thus the efficiency of work is

improved and the effectiveness of each resource is improved as they are able to focus on creating growth (Mouzas, 2016).

One of the clearest improvements is the functionality of tracking orders and deliveries on an end-to-end scale. Supply chain is able to define and maintain lead-times in a way that has not been there before. Due to the constantly changing supply environment with possible material shortages, supply chain can communicate possible delays and changes by updating the lead-times and material sources on item level. This enables flexibility for the project, but at the same time these types of changes need to be communicated clearly with all of the stakeholders and the customer.

As mentioned earlier, the tracking of deliveries and orders becomes easier as the IMM system relates to the organization wide ERP system through the before mentioned RTI linkage. What was noticed during the monitoring of both SO and product configuration messages between ERP and the project management platform, was that the user interface was far simpler than the one in ERP. This was likely due to the sheer quantity of data that is saved in ERP or due to the more complex nature of all the activities that are conducted within ERP. Most of which is not important for the monitoring of material flow from supply chain perspective. On the other hand, the information within the project management platform, is squeezed to only include that information which is necessary in order to track the status of individual orders and to have a linkage with the logistics and the financial side as well.

As IMM is linked to ERP system through RTI, data is always up-to date. Without IMM project team would need to manually check the site status in order to know what has been ordered, what is in the warehouse and what has been implemented at the site. IMM automates this, as it tracks the status of each site and project team is able to work on real-time. Once tasks are conducted within the IMM process, it automatically sends a notification to the resources that are responsible for the next tasks in the process. With all the ordering, invoicing and implementation milestones planned within the tool, there is less need for any manual checking and as

mentioned the milestones are fulfilled automatically as project stakeholders execute their pre-defined tasks. This also mitigates the need to question if orders have been created or if the sites have been accepted and ready for invoicing. These details come through the tool.

Understanding the use of the tool is key. If users are unaware of the impact that their tasks have on the process flow, they might not be able to make sound decisions by taking all different factors into account. This is only possible if the users are aware of the tasks that are required from them. Introducing a new tool can be difficult because of this, as it means that the users might not understand, what is required from them unless it is made very clear using models such as RACI or other charts that indicate the responsibilities that each individual has within the process.

Another part of operations that has become much more efficient, is the communication of material availability towards project team. Demand planning is done on a project level as well as on a global level, which means that to secure the project specific materials, the forecast must be accurate. This needs to be done in correlation with the project rollout plan which defines the quantity of sites for the whole project so if the number of sites goes up, so does the quantity of certain equipment increase on the demand plan. Through the use of IMM supply chain is able to provide equipment level lead-times and inform project team about possible changes in deliveries. The only issue with this is that all of the parties need to accept the consequences if orders are not generated on time. Lead-times cannot be altered as they are locked on global level and possible logistics changes are bound to increase costs. This means that the flexibility within projects working on a site-based model, needs to be found from somewhere else.

This type of situation could be compared to fixed and variable operations, in which the lead-times for equipment and materials should be fixed. Corresponding operations, such as technical site survey is a variable, as the timing can be changed to better suit the supply chain needs. The trade-off is of course, that it is an investment that is made well before the project can see any cash-flow, but in order to avoid any contractual penalties because of delays, it is an investment that needs

to be carefully thought about. Worst case scenario in a global supply chain is that an order is made without any linkage to demand plan. This leads into a situation in which the case project will face lead-times between 15-20 weeks. The project rollout plan could not stand these sorts of lead-times, so the importance of planning is highlighted.

To be able to improve the planning, the manner of approach should be changed to a forward leaning one. What this means is that, as earlier surveyed, the project team should have a better understanding of the lead-times and logistics then what they would have had previously adapted. This becomes highly possible with IMM as it creates the beforementioned timeline, that is then synchronized with the project schedule. Without IMM this sort of visibility would not be possible and with hundreds of simultaneously handled sites, it would be impossible to create a working system to monitor that for each site, the process would be triggered on time in order to successfully meet the project targeted deadlines. Automated systems are able to help with these types of tasks by maintaining the identified target dates for site implementation and then use those as the baseline for the in-time order triggering, which is the beginning for the material flow process.

Another improvement that was observed as the best practice in two completely separate project was a more efficient method of creating and maintaining product configurations. The idea was that previously large configurations consist of multiple material entries and if one changes, then the whole configuration needs to be updated which is a very time consuming task within ERP as it is still used as the organization wide system that links all organizational functions. Linking materials with each other to create standardized packages on the configuration level would be great in business that sees minimal changes with products, but within telecom projects, there are regular changes and updates to existing products as more advanced technology is introduced requrarly. With thousands of base station sites, there are inevitably variations due to the development process of new hardware, which means that configurations would need regular updates. These updates would affect the time it takes to generate orders as the configuration change process

needs the input from additional resources from people that are in charge of creating and maintaining customer specific product configurations.

For the case project, most of the product configurations were created on a one to one level instead. What this means is that equipment and materials are in a single item configuration. These are then converted into standardized packages within IMM as it is easier to create and maintain these in the tool instead of a database that affects the tools adaptiveness. This increases the flexibility as project is able to add and remove materials without additional needs to update configurations. Similarly, this should not affect the demand planning if it is already done on a single item level and not on configuration level. Although most configurations were on single item level, some of the configurations were created beforehand as standardized packages or templates that had larger pre-built configurations with the equipment and services that were needed at each site. Even this slight standardization had an impact on the project execution as the equipment tied to these templates were usually the ones that carried the most risk and value and as such were made easier to follow-up on and plan as planned equipment per site was already available well in advance during the site package creation phase.

13.4 Throughput time

Throughput time is one of the factors that influence the organization level KPI's such as order fulfilment time and logistics cost efficiency. Order fulfilment time can be improved by defining a clear process, which relies on the setup as stated earlier. Key service level agreements (SLA) in this process are the defined order creation time and the processing time that is determined for the warehouse and Hub operations. For both it is stated that the processing time should not be more than two working days. Logistics cost efficiency is also something that can be highly impacted with IMM. What IMM enables is the full control of project inventory and how the inventory is moving from local central WH to forward warehouses.

The use of IMM has a large impact on the process of receiving a customer order to the point of generating the order and securing the necessary equipment for delivery. The idea of processing orders quickly has to do with the time sensitivity of site-based project orders. Possibility of facing problems during the procurement phase of the material might lead into delays even if the materials have been originally confirmed according the plan. A one-day slippage in supply could lead to delays and increased cost during implementation as subcontractors have a tight schedule and delays usually lead into extra costs due to required overtime work.

Additionally, the added benefit of the inventory management within DOP enables the quicker response once all the material and equipment arrive for a specific site. Without the IMM module project and supply chain must constantly monitor ERP system for possible delivery dates and confirmations, which can at times be available a day later from the actual receival. How this impacts the throughput time is quite clear. By having a more up to date information, the cash flow cycle time can be impacted positively. From financial side, this would mean that the number of delayed receivables decreases.

The visibility of inventory is managed by third-party organizations as warehouse operations are outsourced to improve efficiency. Yet the biggest impact is on the throughput time, as has been observed in the case project. This is because the logistics provider is responsible of both the warehouse management and the transportation of goods. This shortens the amount of time that it would take to involve different organizations and the synergy benefit is in the integration of IMM stock reporting and outbound reporting, with the warehouse reporting that would be done manually otherwise. In the case project the visible benefit is that the inventory is updated every day as the warehouse takes in goods once a day. Similarly, all the outbound shipments are reported once a day, due to the required use of full truck loads. Simultaneously the warehouse is works more like a hub, and the largest part of goods are not kept in stock for more than a few weeks as the sites are called off on a tight schedule to begin with, and because the site based ordering principle is that there is no requirement for long-term inventory.

The total throughput time can be calculated in various ways. One would be to calculate, how long it would take to process a single customer order all the way to the final acceptance of the deliverable. This would be first calculated without the tool and then afterwards with the tool in use. The calculations were based on the feedback by project personnel who are each responsible for certain tasks within the total process. In a project that is handling multiple orders per site, even a decrease of 20% workload per order is a lot. With project having 3000 sites and for each site there need to be at least five orders. This would mean that in total a project would have 12 000 order to be issued in the ERP system during the span of the project.

Another aspect that has been thought of during the deployment phase of the case projects is to standardize equipment as far as possible. This has an influence on both the throughput time as well as resource efficiency. The standardization has a major impact on the quality, flexibility and responsiveness of the supply chain. Quality of supply increases as there is less deviation between equipment that would initially lead to a more complex material flow with possibly longer lead-times and with greater risk of having wrong equipment on the wrong site. Flexibility increases within IMM as products packages are standard and are easier to assign to each site. If each site would need a customized material package, the task of demand planning would be nearly impossible, and the throughput time would increase in case each site is configured individually. On operational level, each configuration takes one extra day of work and waiting before order can be placed. To give an example of the IMM throughput time improvements that were identified, during the case project the supply team was receiving tens of equipment call-offs for a larger project cluster. The way that hardware and services are divided, this leads to approximately 100 orders and deliveries. With even slightest deviation in packages or pre-recorded information, the order throughput time is likely to be delayed by 1-2 working days. To put this into a higher perspective, an example project might have 200 sites with multiple call-offs per site and the total order base might be as high as 1000 orders (Hardware, software and services included) and without automation through IMM these orders would be flowing through constantly as sites and related equipment and implementation are planned in one system.

What this planning means from tools perspective is that the standardization can be done in IMM by generating standard packages that are linked to each individual site package. As has been observed, once these standardized packages are linked to individual sites, it generates the site-based demand. Once project team connects the correct package with the correct site in the tool landscape, the package will be visible once the material flow for that specific site begins. Of course, the knowledge of quantities is not relevant unless there is a time frame linked. This time frame is generated by the project team in form of a project rollout plan.

From supply chain perspective the main benefit of introducing the material management flow in such a way, is that it generates a standard process in which project team has clear tasks of filling in the information that is necessary to enable smooth supply flow for the duration of the project. Information consists of planning the equipment and material for each individual site, managing the timeline of when sites are implemented and maybe the biggest impact on throughput time is the method of using the planned site data in a way that it cuts down the time it takes to generate orders and track deliveries on individual site level. This enables structure that makes it easier to communicate any changes with the monthly site quantities for an N-3 period.

Table 2. IMM order-to-site acceptance process versus non-IMM process

Task No.	IMM	Non IMM
1	BOQ's planned in advance	Configurations created once site type is known
2	OET created according to BOQ	Configurations added to material list / manual BOQ
3	Orders created in ERP and RTI links directly with IMM	F&C confirms and requests ordering
4	Orders confirmations site based through RTI	Orders generated manually in outside tool
5	Inventory receival and outbound at and from warehouse visible through IMM	Orders become visible in ERP system
6	Material at site acceptance visibility	Order confirmations order based
7		Inventory tracked manually without real-time status data
8		Manual checks with subcontractors if goods received
9		Goods receival in ERP
Total no. of check points	6	9

Table 2. illustrates the quantity of tasks within the process generating one order all the way to the invoicing. The list is on high-level and the actual difference would be much larger, when all steps would be mapped, but as these steps are outside of IMM scope, we are not mapping them in this study. The time required for conducting the IMM process is far leaner than what it would be without IMM. The biggest impact that IMM has in this process is that it eliminates most of the needs for having outside

order tracking. This includes the tracking that is done in ERP order by order based and because of the project scope, only certain individuals would be able to access this data. With IMM the data is available for all stakeholders.

Of course, it needs to be noted that the IMM process relies heavily on the planning and on pre-defining all the critical data within the tool before the order to cash process begins. This means that without proper information governance within IMM, the process does not work, and the order output won't be accurate, or it cannot be even created. Great example of critical information that needs to be checked is that the BOQ items are up-to date and that they can be also found in ERP. If not, the order entry template (OET) can not be generated as the system checks the input correctness against the data that it receives from ERP.

Once site level material list is created and the site level delivery process is created with the corresponding warehouses for delivery purposes, project is able to use the standardized process as the framework for ordering, with less time wasted with corrections during the actual rollout as corrections and updates can be done before the process is stuck on certain issues that would not be noticed on-time without IMM. As has been the case, any corrections usually have had a negative impact down the line and as such, changes within the system need to be avoided at any cost. The issues might not be apparent during the time of the correction, but once the process moves to invoicing, it will be an extremely tedious manual task of updating items and values to match with the customer purchase order.

14. Discussion

From management perspective, there are several learning opportunities with discovering the impact of a new information system implementation within project environment. As corporate reporting is based on KPI's, it is important to know the impact that the deployment of a new information system has on them. In this study we looked at three different contact points that can impact the KPI's. Throughput

time, resource efficiency and project visibility. All of the three have varying degree of impact on the measured project performance. As studied by Gunasekaran and Ngai (2004), the development of information technology tools has been an essential task for organizations in order to gain value from integrated supply chain functions. The deployment of IMM gives project team the ability to generate sound decisions on real-time data that they receive from the tool and all the linked functions that are feeding data into the tool. It became clear that through the implementation of a cloud-based tool, the project organization is more capable to increase efficiency and impact the effectiveness of the project deliverables. The impact of having a customizable cloud-based tool is clear as it improves the operational processes of the project supply chain.

For supply chain to be able to function, there are several linking points with other functions that need to be in place in order to gain benefits from the new tool. This implies that the setup phase during the project planning phase is crucial (Thunberg et al, 2017a). By having clear expectations and communication between different parties in the project, supply chain can improve visibility. In practice, this visibility helps with project cost management as a clear and coherent planning helps in case of changes. Thinking on end-to-end level the planning would be done in a way that would account for all of the process parts from Equipment planning based on the base station type to the equipment and service call-off triggers which leads to site-based deliveries. As is the case with many processes within organizations, the efficiency and performance impact are usually translated into financial savings or value added.

Simultaneously by having clear communication about global equipment availability and possible risks, project can take precautions in order to dodge possible delays in the critical path of the project. This would definitely show improvements within supply chain efficiency which would have an positive impact on the projects and the organizations operating margin (Mouzas, 2006)

The benefits that the project team would receive from the implementation are not easy to measure. Maybe the biggest impact is that with the tool in use, project team can gain trust with the supply chain functions and simultaneously relocate resources to other pending topics. The main benefit from the tool would be the timeline that it creates for the individual site process from order intake to invoicing. As discussed earlier, the main risk with the use of a new project management tool is that all the stakeholders do not adapt it into the operational use. It is important get full commitment of the users towards taking the tool into use. This can be done by creating inducements that show the actual benefits of the tool in relation with their current work effort versus what it could be (Taylor & Seo, 2012). During the study, it seemed clear that supply chain team had clear inducements from taking IMM into use. The transparency of the site-based material flow increased for the project team a, as all the project relevant data was stored into the same location. This included material lead-times, inventory status plus order intake and creation, which would be checked manually through ERP if IMM was not in use. The same benefits should have been visible for the project team as well. Normally all the order related information would be exchanged through long e-mail conversations, but with the use of IMM the order requests are created in the system directly, without further need to check or validate information quality. This is also why the deployment phase is important as the planning done at that stage, decreases the amount of effort that the project team needs to put into the use of IMM on later stages.

There are still gaps regarding the knowledge that is necessary in order to fully utilize the capabilities that the new tool enables. Mapping for material flow in conjunction with project timeline has been done to understand how much different processes can be streamlined by using the tool. From the study it was clear that some of the processes might have been mapped optimistically and, those tasks would take similar time with or without the tool. The only difference is that the workload shifts from one resource to another. This workload shift leads to tasks moving more upstream, which in turn mitigates the risk of errors and increases the chances of getting all the information right on the first time without unnecessary changes later once the operational rollout has begun. To answer question 2. “*What are the key*

benefits that the deployment has for supply chain team?" the biggest benefit of deploying IMM is the impact that it has on the necessary resources that are tied into the project. From supply team perspective this shift in workload means that resources tied to execution follow up and reporting can move to more valuable tasks such as proactive planning and supply risk prevention. This is in direct link with previous studies in which it was concluded that cloud based computing improves the productivity of organizations as focus shifts to core activities (Garrison et al., 2015; Giannakis, 2019). The tool itself won't replace the need for an ERP system, but it supports with having project data in one place instead of having it scattered around ERP. This is especially true as some data that can be controlled through IMM cannot be controlled in ERP. This includes for example project lead-time data, site specific planning and project planning in general.

As was observed, projects are heavily impacted by several different factors, such as changes and time constraints. Supply chain functions have to be integrated closely with other project functions in order to mitigate material supply risks that may occur during a multi-year project (Ala-Risku et al., 2010; Collin & Lorenzin, 2006) The deployment of IMM module within a larger tool landscape enables the closer interaction between project parties towards minimizing any slack and delays within communication, material processing and order management.

processing and finally invoice processing. On a lower level, there are many sub-processes within each of the processes. This makes the process complex, but the introduction of standardized ways of working bring forth more streamlined ways of working with impact on all the three studied supply chain performance benefit indicators: throughput time, resource efficiency and project visibility. As seen in table 3, there are several factors that are impacted by IMM within the three categories.

As shown in table 3 each of the three identified performance categories can be directly linked with corresponding KPI's that are used to measure the performance of supply chain functions. Interestingly the impact on organizational KPI's cannot be directly measured, but as Customer perceived value (CPVi) is a companywide KPI, it is easy to note, that better project performance leads to better perceived value at

customer side. This is mainly caused by the sheer amount of additional information that is readily available on the cloud-based platform. On a higher level it became clear that to improve the supply chain effectiveness, efficiency needs to be improved first.

Similarly Demand planning accuracy (DPA) is impacted by the resource efficiency. As IMM introduces a more pro-active way of handling and maintaining material flow, it becomes easier to measure the future demand. Additionally, process and task standardization increase the accuracy as the whole team working on the project and its supply chain work on the same platform with the same data. With project deliverables clearly visible in the tool, it becomes easier to calculate the demand for strategic and bottle-neck equipment that are crucial for the implementation.

The inventory turnover rate is also affected by the introduction of IMM. Without IMM, warehouse management would be relying on LSP system and the information would be transferred to the project team manually. With IMM, LSP partner updates the inventory and outbound status regularly. With this, both the supply chain team and project team have improved flexibility for LML deliveries. With the added flexibility, supply chain team is able to plan further and improve both the efficiency supply, by having better understanding of the site material availability (table 3), which in turn is linked to both the visibility benefits and the throughput time. From financial side, the ability to constantly know the inventory value is important as it impacts the bottom line of the project. This is also one of the key benefits of site-based ordering and when combined with the use of IMM, project should be able to have a better ability to manage and plan the rollout for the implementation work. The main difficulty with this setup is any major incidents with material availability from suppliers, but this would be the same case with any form of ordering within project environment (Collin & Lorenzin, 2006).

Table 3. IMM impact on organizational performance indicators

	Changes introduced by IMM	Benefit of changes on SCM	Measured value of IMM
Throughput Time	• Integrated warehouse management • Single platform for e2e order processing	• Real-time knowledge of orders and deliveries • Decrease in e2e throughput time from customer order receival to invoicing • Eliminates the need for an additional order creation tool	• Improved project inventory turnover
Resource efficiency	• Standardized processes and tasks • Equipment and material planning	• Resources can be moved away from non-value adding tasks • Decrease in time consumed during each order creation	• Positive impact on DPA
Project visibility	• Single platform for site level progress tracking • Less manual monitoring and reporting • Information communication advantage	• Real-time inventory visibility • Site material availability • Increasing visibility between rollout planning and demand planning • Project can see the available global equipment and lead-times	• CPVi improvement as project data is more aligned • Rollout accuracy

The understanding of IMM and the level of implementation is still something that will come clearer over time as the development of the tool is constant and as users are getting familiar with the tool. This development and user engagement is still in early phases as both new and ongoing projects are implementing the module at least to some extent, but presently there are no projects that have the full tool in use. 100% of new projects are deploying the tool, but there are no real pilot projects that have been used as benchmark to measure the impact of the tool with enough resources and time to create best practices. To conclude, the case project can be seen as a pilot project, as most of the ongoing projects and past projects have only used some parts of the full-scale project management tool and only parts of IMM.

15. Conclusions

The impact of the IMM tool is wider than anticipated. The actual benefits become visible through the set-up phase before the actual deployment of the project. Similarly, to what project management research has previously concluded, the most important phase of the project is the set-up or planning phase as it defines the processes and the policies that are used during the actual project. From the tool deployment perspective there are three things that need to be well defined during the planning phase, in order to gain the perceived benefits.

First, it is important to have a clear project rollout plan in place. This is what defines the quantity of base stations that are delivered in the project and simultaneously gives an estimate of what equipment, materials and services are needed in order to achieve the project target set by the plan. Second benefit factor is related to the first one. It is very important to define a clear and accurate set of equipment, materials and services, as supply flexibility is defined by the lead-times that each individual item has, regardless of the equipment category. All of the listed items are crucial from the project perspective, when site-based ordering method is used, as base station can be deployed only if the required material is available on site, on time according to the predefined schedule.

During the research it became clear just how important the deployment phase of the project is from the IMM perspective. This is the stage in which all the frameworks and processes are created for the duration of the project. Roles must be clear, processes must be well defined, materials need to be identified, plans need to be created. As has been identified by other studies as well, project outcome is greatly impacted by the amount of time and effort put in to the planning stages (McComb et al., 2008).

For project team it should be clear what the benefits of a working project supply chain are. By implementing a standardized method of managing both the material flow and project planning in a single cloud-based platform, project team is able to plan, perform and report the project status and outcomes in a way that is in line with all the other project related functions. As IMM enables better tracking of orders from the first trigger to invoicing, it should be beneficial for the project to apply the tool into use. The use of IMM is a method of improving project management quality as it improves the operational supply chain management tasks through increased visibility and more flexible ways of reporting and generating relevant information that can be used to improve project communication between different project related stakeholders. To answer question 3. *What are the key takeaways towards project value creation?* Project team is able to create value for the project by implementing IMM processes into the project operational planning to increase efficiency through increased visibility, better resource efficiency through well defined roles and responsibilities within IMM and by improving these, project is able to impact the throughput time of supply chain as data correctness towards demand planning improves at the same time as order are placed on time with the help of the timeline that has been planned within IMM.

16. Future research

The impact of such tool should be studied over a longer period of time, in order to generate plausible conclusions regarding the benefits, that it creates within projects. This is due to project specific differences. For this study, the case projects had similarities that enabled us to create sound conclusions, such as the lack of a tool for tracking orders and inventory against project timeline. This is because all the projects were within the same market. Globally markets differ and due to a lack of certain level of standardization, different markets have different processes and tools that can be seen as necessary and working from supply chain management perspective and simultaneously the introduction of a new management tool can be seen as a waste of time and resources as it overwrites the existing processes.

The level of standardization could be improved by enabling and developing more levels of automation within IMM processes. These sorts of improvements are there to help with increasingly more complex projects that tie a vast amount of time and resources into the implementation and the process definitions for each individual project. With time there will be more use cases of IMM and the bigger project management platform and from there, it should become more resource efficient and less time consuming to deploy IMM in new projects. Over time this should be studied more to make sure that the best practices are in use and it can be possible to calculate how much the processes have been streamlined from the time of this study.

Additionally, the use of the IMM tool should be researched further. Currently there are only a handful of case projects that have implemented the new tool. The issue is that there are no projects that have been using all of the functionalities of the tool for more than six months, meaning that there is no real user feedback or collective use cases within a larger organization. Simultaneously the identified benefits need to be tracked on a longer period of time. This way the financial impact could be calculated for example by measuring how many man-hours have been saved or how inventory can be managed on a tighter schedule, leading to decreasing inventory

costs. Secondly the fact that the tool is cloud-based gives multiple opportunities that could be researched further. Once a project has been ongoing for a period of time, it would be possible to assess specific functionalities based on the gathered data.

Global demand planning and the linkage to IMM should be researched further as supply chain could benefit from a more customer specified response if there are changes in the global supply and demand of equipment. Similarly, sudden changes with demand for equipment within different markets should not be taken away from markets, which have planned their demand carefully for the upcoming six to twelve months. Forecasting is very important in order to secure project materials on time. In a situation in which there is a sudden spike in demand, organizations begin to place one customer over another to preserve customer satisfaction within larger customers and these sorts of decisions have a definite impact on projects.

The whole idea of coordinating project supply chain with the help of information systems, is not new, but with the introduction of supply chain integration and the use of software automation, organizations are able to gain better results with less effort. Only by mapping the use and results over a whole project, are organizations and projects able to show the quantifiable value of creating new medium for supply chain management within project environment.

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