Development of an integrated planning and control concept for a global dispersed internal supply chain

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Development of an integrated planning and control concept for a global dispersed internal supply chain.

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Abstract

This master’s thesis project studied how to organize integrated planning and control for global dispersed internal supply chains. A hierarchical framework is provided showing options and requirements for both vertical and horizontal supply chain integration. The framework shows how planning and control decision functions at the procurement, production, distribution, and sales stage of the supply chain can be aligned. The academic concepts of Hierarchical Planning and Control, Supply Chain Operations Planning, and Supply Chain Sales and Operations Planning form the main elements of this framework. The applicability of the framework is shown in a case study at a manufacturing firm with a global dispersed internal supply chain. The concepts of the framework are transferred into a conceptual model for Supply Chain Planning and Control integration, specifically designed for this firm using real field data. A plan for implementation is provided, showing the critical actions needed for a phased implementation.
Acknowledgements

This thesis is the result of my graduation internship at Hilti. The completion of the thesis project, under supervision of the department of Industrial Engineering and Innovation Sciences (IE&IS), concludes my master’s program Operations Management and Logistics at the Eindhoven University of Technology (TU/e).

The internship at Hilti provided me the opportunity to apply my supply chain management knowledge in a business case and develop myself both academically and professionally. As I was located in the market region Hilti North America during the project, I also had the chance to live and work in the US, which was a great experience.

The completion of my thesis project would not have been possible without the support of other people. First of all I would like to thank my university supervisors Henny van Ooijen and Ton de Kok for providing me the opportunity to participate in a project abroad and supporting me towards a successful completion of my master’s program. Special thanks for your involvement in all the business meetings we had during the project. You even participated in the two days during workshop organised in Kaufering, which I truly appreciate.

I would also like to thank Jed Ginter, my supervisor at Hilti in the US. You guided me through my internship, and made always time for reviewing my work and explaining Hilti’s supply chain concepts. In addition I would like to express my gratitude to Alessandro Sasso, for the weekly alignment meetings and your role in the central steering of the project.

Last but not least, I would like to thank my family and friends for their support during my graduation project and the rest of my studies. You were important in making my studies an enjoyable time.
Executive Summary

This report presents the result of a master’s thesis, representing one of the three researches that together study how to organize integrated planning and control for a global dispersed internal supply chain. The research is conducted at Hilti, a manufacturing company in the construction industry. The Hilti supply chain is under internal control from supplier to customer and is characterised by a global dispersed geographical footprint. This particular master’s thesis was conducted at Hilti North America in Tulsa under the supervision of the University of Technology Eindhoven.

Problem Statement

The complexity of supply chains in many industries is growing in highly competitive, global dispersed markets with increasing customer expectations about product variety and delivery lead times. In order to successfully plan and control for these increasingly complex supply chains, companies are focusing more and more of their attention on Supply Chain Integration (SCI). The potential of SCI lies in achieving higher service levels with lower supply chain costs by overcoming the poor cross-functional alignment; poor alignment between hierarchical levels (strategic, tactical, operational); and local optimization. However, a planning and control concept that integrates an internal supply chain both horizontal and vertical is not addressed in the existing literature. This leads to the following research aim:

*Develop integrated supply chain planning and control for a global dispersed internal supply chain.*

Hilti, recognizes the importance of SCI in its planning and control design, especially because of the complexity of the supply chain with a large number of suppliers, multiple production plants, multi-echelon distribution network and integrated sales channels. The result of better SCI will be visible in topics that are important for Hilti as lower inventories, better reliability of the lead time to the customer and less volatility in the production sites. Two main issues were identified at Hilti causing integration problems. Firstly, a hierarchy in the planning and control is missing in the current situation, limiting integration between decisions that should be taken at different levels. Secondly, a consistent cross-functional integration between decisions is clearly missing, resulting in departments that work as silos.

Framework for Integrated Supply Chain Planning and Control

A hierarchical framework is provided showing options, requirements, and challenges for both vertical and horizontal supply chain integration in order to come to a solution for the problem. Fleischmann et al. (2002) use three hierarchical levels of planning in their Supply Chain Planning (SCP) matrix: strategic/long-term, tactical/mid-term and operational/short-
term. These levels, as well as the decision functions in the SCP matrix, form a hierarchical representation of planning and control landscape of a general supply chain. The main concepts used in this framework are the Supply Chain based Sales and Operations Planning concept and the Supply Chain Operations Planning concept, integrating the supply chain on tactical level, operational level, and cross-functional. Furthermore, tactical parameters are proposed, providing optimized parameters for the steering of the entire supply chain.

The importance of decision functions proposed in the supply chain planning and control framework varies with respect to the functional and structural attributes of a supply chain and varies with respect to the firm’s environment. The concepts used in the framework to achieve integrated planning and control, and the hierarchical positioning of the decision functions can be general applicable for a supply chain design. The strategic and tactical parameters are eventually supply chain specific and need to be designed for each particular case.

A Case Study at Hilti: Development of a Conceptual Model

The theoretical framework is applied on the business case at Hilti to come to a conceptual model. Following this framework, some tactical parameters that are currently set locally, will become part of a central tactical parameter setting. This includes: MRP type selection, direct/indirect distribution, safety stock levels/positioning, lead times, and decoupling points. The mid-term forecasting, sales planning, and distribution planning functions are added in the new concept in order to come to the preliminary delivery plan. Also, to come to a preliminary production plan an aggregated MRP, a capacity planning and a personnel planning function are included in the concept. Following the model of Feng et al. (2008) the preliminary distribution plan and production plan serve as preparation for the SC-S&OP decision, balancing demand and supply on the mid-term in the conceptual design for Hilti.

Furthermore, certain operational decisions are currently made decentralized, while a centralised steering could overcome much of the silo problems identified at Hilti. These functions are divided into central control (SCOP) and decentralized production unit control (PUC). The SCOP function contains decisions of both releasing materials and resources in the supply chain. The decision functions that are currently made decentralized, but will become part of the central SCOP decision include: MRP, warehouse order release, plant order release, production planning, material ordering, warehouse order management, and plant order management.

Implications for Hilti North America – As HNA is concerned with the sales and distribution stages of the supply chain, the new concept will have in particular implications for the forecasting, distribution planning and sales planning at HNA.
Firstly, the distribution and sales requirements in the region will be considered in a mid-term planning that is balanced with the supply possibilities. This balancing will take place in a SC-S&OP meeting, in which HNA will provide input about the requirements in their distribution network. For this mid-term planning, a forecast and sales plan on an aggregated level will be created by HNA Material Management in collaboration with Marketing/Sales. The final decision to balance the demand in the region with the supply possibilities along the entire chain will become the end-responsibility of the BU. Secondly, warehouse replenishment will become the responsibility of the central Supply Chain Specialist Team placed in the SCOP function. The operational material flow along the entire supply chain will be controlled by this central function.

Both implications will be leading to more transparency and alignment in the material flow, which eventually results in better lead time reliability to the customer and lower inventories in the logistic region.

**Conclusions and Recommendations**

This research has provided a framework for horizontal and vertical alignment of decisions required for the planning and control of a supply chain. The framework describes in general how to position and coordinate the decision functions in order to achieve better integration, which makes it a tool for many firms struggling with their SCI, in different industries. The concepts of the framework have been applied in a case study at Hilti, which resulted in a new conceptual design for the planning and control of the Hilti supply chain. This design is a first step towards better SCI for Hilti, but is highly conceptual. In order to achieve the full potential of the conceptual design, this research also provided an implementation plan showing the next steps towards a better integrated supply chain. Finally, several recommendations can be made for further research.

Recommendations for scientific field:

- Further research the general applicability of the theoretical framework.
- Further research to quantify mathematical implications of the concepts in the framework.

Recommendations for Hilti:

- Quantification of the effects of the proposed concepts by means of a pilot.
- Further investigation of the organization of Sales to cover the complete range of Hilti’s functional decisions.
- Investigation of operational improvement of the production units.
- At HNA: starting a pilot to forecast on an aggregated level.
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ATP</td>
<td>Available To Promise</td>
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<tr>
<td>BA</td>
<td>Business Area</td>
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<td>BI</td>
<td>Business Intelligence</td>
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<td>BPMN</td>
<td>Business Process Modeling Notation</td>
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<td>BU</td>
<td>Business Unit</td>
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<tr>
<td>COP</td>
<td>Customer Order Perfect</td>
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<td>CW</td>
<td>Central Warehouse</td>
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<td>DC</td>
<td>Distribution Centre</td>
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<tr>
<td>DM</td>
<td>Demand Management</td>
</tr>
<tr>
<td>ET&amp;A</td>
<td>Electric Tools and Accessories</td>
</tr>
<tr>
<td>F&amp;P</td>
<td>Fastening and Protection</td>
</tr>
<tr>
<td>FTE</td>
<td>Full-time Equivalents</td>
</tr>
<tr>
<td>GL</td>
<td>Global Logistics</td>
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<tr>
<td>GM</td>
<td>Global Manufacturing</td>
</tr>
<tr>
<td>HAG</td>
<td>Hilt AG (representing headquarters)</td>
</tr>
<tr>
<td>HC</td>
<td>Hilti Center</td>
</tr>
<tr>
<td>HIPP</td>
<td>Hilti Integrated Planning Project</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>JCL</td>
<td>Logistics Distribution Centre</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicators</td>
</tr>
<tr>
<td>LCN</td>
<td>Logistics Center Nendeln</td>
</tr>
<tr>
<td>LEC</td>
<td>Logistics Europe Central</td>
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<tr>
<td>MM</td>
<td>Material Management</td>
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<tr>
<td>MO</td>
<td>Market Organisation</td>
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<td>MRP</td>
<td>Material Requirements Planning</td>
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<tr>
<td>MTO</td>
<td>Make-to-order</td>
</tr>
<tr>
<td>MTS</td>
<td>Make-to-stock</td>
</tr>
<tr>
<td>NDC</td>
<td>National Distribution Centre</td>
</tr>
<tr>
<td>PM</td>
<td>Product Management</td>
</tr>
<tr>
<td>PU</td>
<td>Production Unit</td>
</tr>
<tr>
<td>PUC</td>
<td>Production Unit Control</td>
</tr>
<tr>
<td>RDC</td>
<td>Regional Distribution Centre</td>
</tr>
<tr>
<td>S&amp;OP</td>
<td>Sales and Operations Planning</td>
</tr>
<tr>
<td>SAP</td>
<td>Systems, Applications and Products in Data Processing</td>
</tr>
<tr>
<td>SCI</td>
<td>Supply Chain Integration</td>
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<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
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<td>SCOP</td>
<td>Supply Chain Operations Planning</td>
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<tr>
<td>SCP</td>
<td>Supply Chain Planning</td>
</tr>
<tr>
<td>SC-S&amp;OP</td>
<td>Supply chain Based Sales and Operations Planning</td>
</tr>
<tr>
<td>SCST</td>
<td>Supply Chain Specialists Team</td>
</tr>
<tr>
<td>SKU</td>
<td>Stock Keeping Unit</td>
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<tr>
<td>TM</td>
<td>Transport Management</td>
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<tr>
<td>TSP</td>
<td>Transhipment Point</td>
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<tr>
<td>WM</td>
<td>Warehouse Management</td>
</tr>
<tr>
<td>WOW</td>
<td>Way of Working</td>
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1. Introduction

1.1 Supply Chain Integration
Firms in many industries have to deal with highly competitive markets in which customers are increasingly demanding high product variety and shortened delivery lead times, resulting in increasingly complex supply chains. This forces firms to focus more of their attention on Supply Chain Management (SCM) in order to more effectively synchronize the supply chain processes from the supplier towards the customers. SCM is here defined as: *the design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally* (APICS, 2013a).

Within the field of SCM it is widely recognized by both academics and practitioners that Supply Chain Integration (SCI) can be a significant contributor to supply chain performance. SCI is the degree to which firms strategically collaborate with their supply chain partners and manage intra- and inter organizational processes (Flynn, et al., 2010).

Existing literature indicates the importance of an integrated Supply Chain Planning and Control (SCPC) design in achieving more supply chain integration. The potential of integrated planning and control lies in achieving higher service levels with lower supply chain costs by overcoming the poor cross-functional alignment; poor alignment between hierarchical levels (strategic, tactical, operational); and local optimization. However, this potential can only be realized by recognizing the connections and inter-relationships between different parts of the supply chain and ensuring a good fit between its design and operations and the company's competitive strategy. (Stevens, 1989).

SCPC deals with the planning and control of both the material flow and related information in a supply chain. The aim is to get the right materials to the right place at the right time, while optimising a certain performance measure and satisfying a given set of constraints. (Ghiani et al., 2004). The planning and control of a supply chain is often managed by a large number of different interdependent decision functions. In these functions trade-offs have to be made to find a satisfying balance between supply chain costs and performance. The functional separation in most supply chains causes conflicts and prevents achieving the best overall balance. To compensate for the conflicting planning and control decisions of different functions, excessive inventory and capacity are required, leading to unnecessary higher costs (Stevens, 1989). In order to make planning and control decisions that are best for
the overall supply chain instead of local optimisation it is important to align the decisions made by the different functions along the supply chain and thus achieve better SCI.

A substantial part of research on SCI has been focused on inter-firm integration, with a focus on supplier-manufacturer integration and manufacturer-seller integration, but less research has been conducted on intra-firm integration to come to integrated planning and control. Intra-firm supply chain integration deals with aligning the different internal supply chain functions, which are under full control of the firm, in order to improve the firm’s overall supply chain performance.

Linking any firm effectively into a complex supply chain requires first that its own internal processes are aligned with each other and adapted to its environment. Many firms try to link with suppliers and customers, but find out that external relationships fail because of a lack of integrated control in their own internal business processes. Firms desire to have corporate systems supporting effective cooperation between different departments across the internal supply chain. However, this can only be accomplished by functional integration, which is the process of integrating all supply chain functions to work together (Koh et al., 2006).

In this research multiple SCPC and SCI concepts are used to investigate how the planning and control of an internal supply chain with a dispersed global footprint can be integrated. The concepts are applied in a case study at Hilti AG, the Hilti Integrated Planning Project (HIPP), in order to develop concepts for a more integrated planning and control design for the Hilti supply chain. The case study at Hilti was carried out within two plants, two logistic regions and the headquarters to cover the full scope of the supply chain. The case study was divided into three different researches. This particular research was carried out at Hilti North America (HNA) in Tulsa, representing a logistic region and therefore this thesis elaborates on this location. For a complete overview of the case study, this thesis is complemented by the thesis of Kreuwels (2014) and Broft (2014). Eventually, also a design of implementation will be presented, showing a Hilti specific implementation plan of the concept.

1.2 Business Context

1.2.1 Company Background
Hilti AG was founded as a family company by Martin Hilti in 1941. Currently, still being a family company it grew significantly and expanded its operations into more than 120 countries, with about 20 thousand employees. The organisation format consists of almost a complete supply chain; including production, distribution and sales of more than 60 thousand finished products yearly, mainly for the construction
The corporate goal of Hilti is to “passionately create enthusiastic customers and build a better future”, whereby the strategy up to 2015 focuses on growth, differentiation, productivity and people. In order to combat the effects of a recent financial crisis the company implemented a number of cost savings operations. However, despite of the company’s recent growth and introduction of the lean management into the production processes the profit remains unsatisfactory.

![Figure 1: Hilti's Plants and Allied Suppliers](image)

The products range from specialised tools or commodity consumables to perishable chemicals. This is contributing to a wide variation in terms of value-density, lead times, sales volumes, and storage, handling and transportation requirements. In total, Hilti owns five plants for consumables and three plants for power tools as can be seen in Figure 1. These plants are under corporate responsibility of two so-called business area’s (BA); Electric Tools and Accessories (ET&A) and Fastening and Protection (F&P).

![Figure 2: Hilti's Market](image)

Hilti also has allied suppliers represented as partners in the figure. As a global competitor, its turnover is still largely represented in European sales. About 55 per cent of the revenue is from Western Europe, 21 per cent is from America, 12 per cent from Asia and also 12 per cent from Eastern Europe and the Middle East as can be seen in Figure 2.
1.2.2 Hilti’s Business Environment

Hilti is a manufacturing company in the construction industry. In this industry Hilti has a focus on professional power tools and accompanying accessories. When analysing the Hilti industry, different aspects can be identified that need to be supported by its supply chain design. One aspect of the industry is high competition. There are many companies in the market with a comparable product portfolio. As can be distracted from the company’s strategy, Hilti tries to outperform the competition in being best in identifying customer needs and providing innovative solutions through direct customer contact and research. Hilti positions itself in the market for high quality tools & fastening systems aimed at professional customers in the construction and building maintenance industry. Hilti’s main strategic imperatives are: product leadership, market reach and operational excellence.

In order to meet these imperatives, Hilti requires market organisations placed close to the customers in all geographical markets it is operating. Furthermore, to serve all customer needs, Hilti offers a large portfolio of products, which requires many different suppliers and various manufacturing plants. This leads to a global dispersed supply chain. Geographically dispersed global supply chains consist of suppliers, internal production and other facilities, as well as sales divisions and customers strategically located in different countries and regions of the world. The dispersed supply chains involve trade-offs in the form of supply chain complexity that can cause negative effects on the firms’ competitiveness. For example, it can cause increasing costs of logistics, longer lead times and lower customer service levels (Lorentz et al., 2011).

To be able to react on changing customer demand and to deliver innovative products, the SCM strategy of the firm is to be demand driven. This means that the supply chain has to be designed in such a way that it is flexible, that manufacturing plants can easily adapt to demand changes, and that delivery lead times to customers are set to a minimum. At the same time the firm has to control its supply chain costs and service levels in order to secure profit margins and customer satisfaction in a competitive market. This requires an integrated supply chain planning and control system that can translate volatile customer demand into stable and feasible production plans and good coordination of the different supply chain functions along the supply chain.

1.2.3 Hilti’s Internal Supply Chain:

Hilti Global - A broad overview of the supply chain of Hilti is given in Figure 3. The entire value chain from production till sales is under corporate control. Hilti competes globally and has suppliers, plants, Central Warehouses (CW), Distribution Centers (DC) and Hilti Centers (HC) located all over the world. There is, however, a
strong European footprint accounting for more than 50% of Hilti’s total turnover and the majority of plants and CWs. From the plants and allied suppliers the materials flow to CWs from where National Distribution Centers (NDC)/Regional Distribution Centers (RDC)/DCs are replenished or directly to NDCs/RDCs/DCs. The routing of the material flow mainly depends on the size of the material flow and the lead times. Small material flows or material flows that need to be shipped to locations with a long lead time are consolidated in the CWs or the Transhipment Point (TSP) first. Customer orders enter the supply chain at HCs and other sales channels, which are directly or indirectly replenished by NDCs/RDCs/DCs; this depends on the distribution design in the region.

**Figure 3: Hilti's global internal supply chain**

Hilti's supply chain covers the material flow of a large number of items for the construction industry with great differences in turnover, controllability and demand. This leads to a wide variation of item characteristics in terms of: value to weight ratio (value-density); lead times; sales volumes; and storage, handling, transportation and requirements (i.e. hazardous goods). Many items in Hilti’s supply chain can also be characterized by great seasonality in demand. This seasonality is strongly driven by the European market, due to its large share in total global demand. In total Hilti produces around 31.000 unique global end-products, of which roughly 7% generates 80% of the turnover. Since spare-parts are out of scope of this project they are not counted is this number.

**Hilti North America** – The headquarters of Hilti’s market region North America, hereafter also called HNA, and a NDC are located in Tulsa. The market region consists of 6 different MO’s: East, West, Central, Canada, Rental Authorized Distributers and Energy & Industry. The last two mentioned MO’s are based on specific market characteristics instead of sales region. Approximately 2700 employees are working for HNA.

The sales and distribution of items inside the market region North-America is the responsibility of HNA. The supply chain of this market region is illustrated in figure 6.
Customers can reach HNA via the following sales channels: customer service, retail centers (HCs), account managers (Sales Vans), and e-business. After order acceptance HNA strives to fulfil customer orders within a delivery lead time of one day. In order to achieve this delivery lead time, items are stocked in warehouses located in a wide spread distribution network. This distribution network consists of two NDCs, located in Dayton and Tulsa, and eleven DCs from where retail centers and account managers are replenished. These warehouses also have an assigned area from where direct customer orders are fulfilled.

HNA receives goods from plants/suppliers/warehouses outside the HNA network at one of the central warehouses. This is in most cases an NDC, but can be a DC for long/heavy/big goods. After the incoming goods have arrived by truck, they will be unloaded and stocked in a central warehouse. If this warehouse receives orders for replenishment of downstream stock locations or direct customer orders, the orders will be picked and packed in the warehouse and loaded into a truck. From the NDC the orders will be transported to downstream stock locations in the network and to customers. Downstream stock locations include DCs, HCs and Sales Vans. In case of an emergency shipment orders can be shipped by air. External transporters execute all transportation. In the DCs the products are stocked for replenishment of HCs, Sales Vans and fulfilment of direct customer orders. In the HCs and Sales Vans the goods are stocked in relative low quantities, from where it will be directly sold to customers.

1.2.4 Planning and Control at Hilti:

Hilti Global - The main planning and control activities can be seen in figure 4, with the frequency indicated above the activity. The planning starts with the selection of the Material Requirements Planning (MRP) type. This type decides whether or not the material is part of the MRP and if so, it determines the type of material planning that is required. It also defines if a forecast is needed and what safety stock method is used.
A demand plan is created for all forecasted items and subsequently the safety stock levels are updated based on this demand plan. In parallel to these activities the event-based decision is made whether markets will have direct or indirect deliveries and what decoupling strategy to use. A direct delivery is a delivery directly from the plant towards a warehouse in the market region, whereas an indirect delivery will route through a central warehouse or transhipment point before being shipped to the market region. Decoupling creates independence between the production in the plants and the supply of goods to the market regions. “It refers to inventory that often is collected between operations so that fluctuations in the production rate of the supplying operations do not limit the output of the next operation” APICS (2013b). Examples of decoupling strategies used at Hilti are: make-to-order, make-to-stock, and assemble-to-order. Depending on the customer requirements and the production possibilities the decoupling point is determined once, and only exceptionally changed. The next planning activity is the MRP, which translates the (expected) end-item demand into net requirements for end-items, components and materials along the supply chain. Based on the net requirements materials are ordered and warehouse replenishment orders are released. In the plant this triggers the production by means of a plant order release. The monthly resource planning in the plant is translated into a daily production planning and eventually into a detailed daily production schedule. In order to deal with changes occurring in the MRP during the planning horizon, warehouse order management and plant order management are daily activities. These functions cope with exception management for the warehouses and production plants.

Figure 4: Hilti’s current planning activities
Hilti North America - HNA Logistics, consisting of Warehouse Management (WM), Transport Management (TM) and Material Management (MM), is responsible for the planning and control processes at HNA. The aim of this planning and control is to achieve high customer satisfaction by fulfillment of customer orders within the delivery lead time, under minimal inventory and transportation costs. Because of the long lead times at HNA from supplier/plant to the customer, customer demand needs to be fulfilled from stock. Stock levels serve as a buffer to cover for uncertainty in demand and supply. Planning is required to have the right product in stock, in the right quantity, at the right location, and at the right moment in time.

A main planning process at HNA is the planning of demand to determine the amount of goods that need to be shipped at lead time for replenishment of the two tier distribution network. This is a responsibility of HNA MM. Demand planning follows a monthly cycle in which the history and forecast are reviewed and adjusted if necessary in predetermined weeks, but where daily adjustment is possible. The demand planning is conducted on item/location level for each demand planning warehouse (NDCs and a few DCs) with a horizon of 18 months. HNA MM uses the demand plan as input for safety stock adjustment to determine the right safety stock levels at NDCs and DCs. The forecast accuracy is an important variable to determine the safety stock levels. Besides safety stock adjustment, decisions are made by HNA MM to determine: which replenishment strategy to use; which safety stock method to use; and where to position stock. In the MRP system the demand planning together with information about stock levels, safety stock, and inbound/outbound deliveries is input for the daily net requirements calculation. The net requirements information is shared with the plant and Hilti AG, such that tactical and operational decisions for production and supply can be made. The net requirements trigger the warehouse replenishment order decision to release purchase orders for the replenishment of demand planning locations from suppliers/plants/warehouses outside the HNA network. This release decision together with various warehouse order management decisions are also tasks of HNA MM. The net requirements are furthermore inputs for the almost completely automated deployment from the demand planning warehouses to downstream locations. A detailed summary of the current planning and control processes at HNA can be found in Appendix A.

1.2.5 Integration of Planning and Control:
Hilti, recognizes the importance of SCI in its planning and control design, especially because of the complexity of the supply chain with a large number of suppliers, multiple production plants, multi-echelon distribution network and integrated sales channels. The result of better SCI will be visible in topics that are important for Hilti as lower inventories, better reliability of the lead time to the customer and less
volatility in the production sites. This ultimately will be leading to a better competitive position for Hilti throughout the world.

Although Hilti is a firm aiming for excellent supply chain integration, it is struggling with leveraging it effectively. The cause for poor supply chain integration is anticipated to be insufficient coordination in the planning and control of the supply chain. Two main gaps were identified causing this poor coordination. Firstly, a hierarchy in the planning and control is missing in the current situation, resulting in an inappropriate integration between decisions that should be taken at different levels. Secondly, a consistent cross-functional integration between decisions is clearly missing, resulting in departments that work as silos.

**Hierarchical coordination** - Strategic decisions and strategic plans seem to be present, but no clear division between the tactical and operational levels exists. Without a tactical level that controls the operational level the decisions made at the operational level only optimise the represented location instead of the entire supply chain. If on a tactical level the aggregated supply and demand are aligned to optimise the overall supply chain, this can steer the operational decisions by setting boundaries in which it can operate. However, without steering at the tactical level there is no visibility to make a local short-term decision that is best for the overall supply chain planning.

Since the tactical level is not present, Hilti is unable to deal with uncertainties by aggregating demands for the entire supply chain. Short-term demand plans on item/location level are used for mid-term decisions, such as capacity and resource planning in the plants. On the operational level this demand plan is designed to support the short-term order release decision for warehouse replenishment. Due to the lack of aggregation, this demand plan is not accurate or stable enough on the mid-term to base tactical decisions on, but currently this is the only demand plan used for decisions throughout the supply chain. It leads to volatility in the plants, as this demand plan is frequently changed in the Market Organisation (MO) to make the best replenishment decision when better more recent demand information becomes available.

**Cross-functional coordination** - The planning and control of the supply chain is primarily managed by the Material Management function, which at Hilti is organised in different silo’s. The silos emerged by the fact that the supply chain of Hilti exists out of several stages of the supply chain with their own legal entity, all wanting to perform optimal within their boundaries. There is a lack of ownership since responsibilities are scattered, eliminating an end-to-end responsibility. This leads to dispersed responsibilities of the Hilti material flow into marketing/sales regions,
logistics regions and production facilities. As a result, the current planning and control of the supply chain can roughly be divided in: Hilti Headquarter (HAG), Market Organizations (MO)/regions combined with logistic regions, and plants, under the Global Manufacturing (GM) umbrella.

**Tactical** - Demand plans created in the MO and production plans in the plants are not clearly communicated through the silos. The in the MO forecasted quantities become visible at the production site in the MRP, but without the arguments supporting the numbers. When forecasts fluctuate heavily over time and are not always accurate, plants don’t trust the forecasted quantities anymore and sometimes ignore forecasts that are seen by the plants as too high or low. At the same time the MO expects to deliver what is forecasted and may have had good reasons for the deviating forecast, such as a promotion or market developments. On the other hand, the plants don’t clearly communicate any supply or capacity issues towards the MO’s. At the moment supply issues become clear in the MO’s it is often too late to take adequate actions to prevent stock outs.

Poor communication between marketing/sales and MM is also causing problems. Sales tend to come up with higher forecasts than MM. The main target for Sales is the sales quantity, which will be negatively affected by a shortage in supply. The MM department is held responsible for both under-supply and over-supply and thus has an incentive to not overestimate forecasts.

The tactical parameter setting, necessary for central control of the SC, is missing in the present situation. Safety stocks are set by local MM, but changes in decoupling point, lead times and lot sizes for replenishment from outside the local distribution network is the result of decisions made by plant MM, HAG MM or Global Logistics. These decisions are mutually dependent and have consequences for the planning of the entire supply chain, but are made independently from each other, which results in sub-optimal decisions.

**Operational** - A central decision function at the operational level is missing, meant to steer the release of materials and resources through procurement, production and distribution and therefore the required cooperation between these functions is missing. In the current situation the release of resources and materials is done in a decentralized manner and is not integrated. Each silo is responsible for order release to control its own stock points, assuming unconstrained resources and materials upstream and thus on time delivery. Because there is no insight in the materials and resources upstream when an order is released, there is no possibility to smoothen the material flow through the production plants. This leads to nervousness in the system, lower timely fulfilment of internal orders and eventually lowers reliability of lead-time to the customer.
There exists misalignment in timing and frequency of the decision functions along the supply chain. The coordination between the function of the supply chain planning and control is supported by a central information system. However, because there are no guidelines in when to update information in the system decisions are not always made at the right time. For example, demand information or safety stocks may be changed after the dependent decisions have already been made. Flexibility is important for Hilti to be reactive to customer needs, but in combination with low stock levels changing plans frequently may cause problems in supply chain coordination.

The lack of cross-functional and hierarchical integration eventually results in:

- Volatility in demand at production plants
- Poor reliability of lead times to customers
- High supply chain costs

These outcomes are considered unfavourable and symptomatic of a poor intra-firm coordination. In contrast to inter-firm coordination, these symptoms are the result of misalignment between planning functions that are part of the company and under full control. Improving intra-firm integration requires a different approach then inter-firm integration. A main difference between these two is that functions along an internal supply chain eventually have a shared interest in making maximum profit for the company, while different companies often also have conflicting interests. As a result, planning and control models for intra-firm integration are more focused on centralised/decentralised decision making and control, while inter-firm integration literature more focuses on how to organise collaborative planning with suppliers or sellers.

1.3 Thesis Outline
Following this chapter, the project definition will be provided in Chapter 2. Thereafter, in Chapter 3 a theoretical framework for internal SC integration will be presented. Based on this theoretical framework a new concept for Hilti will be introduced in Chapter 4 considering the context, constraint and current state of the planning and control design at Hilti. Chapter 5 provides a feasible implementation plan to come from a highly conceptual design to actual change of SCPC processes along Hilti’s supply chain. Finally, in Chapter 6 the conclusions and recommendations are presented that followed from this research.
2. Project Definition
After the introduction of the thesis, in this chapter the project will be further defined. The problem leading to the research will be stated in Section 2.1. Based on this problem the research assignment will be formulated in Section 2.2, which is translated into research questions provided in Section 2.3. A summery of the literature review conducted as preparation for the thesis will be included in Section 2.4. Concluding this chapter, the research design will be described in Section 2.5.

2.1 Problem Statement
The current business structure within Hilti is strongly characterized by silo thinking. There is a lack of ownership since responsibilities are scattered, eliminating an end-to-end responsibility. As a result, the planning functions can roughly be divided in three different silos: Hilti AG, Market Organizations and Plants. Furthermore, there is at Hilti a lack of integration between decisions that should be taken on different hierarchical levels.

2.2 Research Assignment
After having defined the problem statement, the overall research assignment can be formulated.

Assignment: Investigate how the planning and control of an internal global dispersed supply chain can be integrated and develop a solution for the internal Hilti supply chain based on these findings.

The scope of the research includes the internal supply chain of Hilti. To make the planning landscape of Hilti concrete and to be able to generalise to the whole internal supply chain, the research has been carried out in two production plants, two logistic regions and the central decision entities. This research elaborates on the logistic region HNA.

2.3. Research Questions
Considering the problem statement and assignment, the following research questions are formulated:

RQ1: How can the supply chain planning and control of an integrated supply chain best be organized internally?

This research question consists of three sub-questions that build upon each other.

1.1: What options and requirements do exist?
1.2: What are main challenges?
1.3: To what extend is the design of the SCPC system contingent on the firm’s environment?
RQ2: Given Hilti’s situation and current planning and control landscape what is the best solution for internal supply chain integration?

For this research question, the context, current state and constraints of Hilti are considered. The current planning landscape is defined by analysing the planning decisions. Also the relationships of the planning decisions and their cross-functional character are analysed if it impacts the planning in the supply chain. This research question consists of two sub-questions that build upon each other.

2.1: What way can the internal supply chain planning and control system of Hilti be integrated?

2.2: What way can the new supply chain planning and control design be implemented at Hilti?

2.4 Summary Literature Review

In order to study integration of the planning and control of an internal supply chain characterized by a geographical dispersed footprint a literature review is conducted. This literature review focuses on both the horizontal and vertical dimension of supply chain planning and control integration. By focusing on both dimensions a comprehensive view can be generated to find requirements, challenges, and solutions in literature that are relevant for this research. Horizontal integration involves a cross-functional integration on the strategic, tactical and operational level. The vertical integration involves the integration between the tactical and operational level. The hierarchical planning and control literature is examined to research this subject and a summary of these findings will be presented.

Hierarchical Planning and control
Hierarchical planning coordinates the planning modules such that they can interact in an integrated way at the strategic, tactical and operational levels introduced by Anthony (1965).

Strategic level - the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use and disposition of these resources.

Tactical Level - the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishments of the organization objectives.

Operational level - the process of assuring that specific tasks are carried out effectively and efficiently.
Hierarchical Demand Planning
Here the term hierarchical demand planning is defined as: “the process of providing forecasted demand data on different hierarchical levels.”

To support planning processes on different hierarchical levels, the demand planning process also needs to be modelled in a hierarchical structure. The levels of aggregation and the planning horizon of demand plans are different per level. The complexity of demand planning increases with a growing number of item/location combinations and number of planning periods. Aggregation in product, time and location can structure the demand planning process that enables forecasts to be accurate and efficient.

On the tactical level, the main purpose of demand planning is to support mid-term decisions on how to utilize production, capacities, inventory and transportation efficiently. On the tactical level it is important to find an aggregation level that limits the amount of demand data, uncertainty of the forecast and complexity of the model. On the operational level demand planning provides data for deployment decisions and order acceptance.

As demand forecasts will change over time, the rolling horizon principle with frozen horizon can limit nervousness in the planning system. The frequency of forecast updating and the length of the frozen horizon need to be chosen such that the right balance between flexibility and stability occurs.

Hierarchical Production Planning
The leading question concerning hierarchical production planning throughout the review was: “How does academic literature propose to align the tactical and operational level within a hierarchical production/assembly environment?”

Hierarchical Planning Frameworks - Hax and Meal (1973) - The model of Hax and Meal describes a hierarchical planning and scheduling system for a multiple plant, multiple product, and seasonal demand situation. First, using long-term capacity provision and utility decisions products are assigned to manufacturing plants. Second, a seasonal stock accumulation plan is prepared on a tactical level. This plan makes allocations of capacity in each plant among product types. Third, on an operational level, product families are scheduled into detailed plans allocating the capacity among the product families in the type. Fourth, using standard inventory models individual run quantities are calculated for each item in each family.

Schneeweß (1995) - The model of Schneeweß describes the hierarchical structure using a top-level, a base-level and an anticipated base-level. Three key constructs to align these levels are: anticipation, instruction and reaction. The top-level and the
base-level reach a final agreement which will be implemented in the operations environment.

Bertrand, Wortmann and Wijngaard (1992) - The model of Bertrand, Wortmann and Wijngaard describes a hierarchical structure that is directed toward decision functions, which can be allocated to organizational positions and responsibility areas. They introduce two key constructs; goods flow control and production units. A production unit can be seen as an organized set of resources that, from a production control point of view, should be distinguished. This means the PU is authorized to use its capacity resources internally as it seems fit but has a responsibility towards the committed work orders set by the goods flow control. At the level of goods flow control, these work orders are created and released to the PU in a predetermined order.

Cross-functional integration
Looking at existing literature about planning and control mechanisms on the tactical level, the cross-functional integration can be achieved by means of Sales and Operations Planning (S&OP). The main question here is: “How does Sales and Operations Planning contribute to the integration of the supply chain?” S&OP has been defined as: “a business process that is placed on the tactical level, thus it is placed between and interacts with the strategic and operational levels; It produces plans that balance demand and supply which should be one set of plans settled by several functions and actors.”

The major findings can be summarised as follows:

- The need for a structured process for the creation of realistic sales and operations plans has been acknowledged by successful companies because it is believed to be necessary in order to compete and respond to the market.
- Supply chain planning is vital for supply chain integration and S&OP integration is fundamental for an integrated supply chain planning.
- As the companies differ in type of their products, in volume of their production, in size and organisational structure, and geographical location it is obvious that they also vary in the approaches towards S&OP, or even, in case of large supply chains, that there may be multiple S&OPs within one chain, acting sometimes independently but preferably in a coordinated, integrated manner.
- S&OP requires a specific company culture, namely managers with an extensive work effort, who are prepared to except process ownership, collaborate within the assigned mandate and focus on a common goal, adjusted incentive schemes and, when the S&OP is properly understood and supported, enabling technology (software).
• The effects of S&OP on the firm results are facilitated by mechanisms of planning and control, joint forecasting and planning, information systems between organisational units and horizontal collaboration within the firm.

The above findings show the importance of S&OP for integrated planning and the need for a custom developed concept for integrated planning. They lead to the belief that S&OP can contribute to the development of a holistic integrated planning concept.

2.5 Research Design
The design of this research is based on the regulative cycle of Strien (1997). This cycle is designed for business problem solving research in real context. A visual representation of this cycle is shown in figure 5 and consists of five subsequent steps. The outcome of the research is a conceptual solution for integrating Hilti’s supply chain, and a change plan for introducing the concept.

![Regulative cycle](image)

**Figure 5: Regulative cycle**

**RQ1:** To answer the first research question a literature review is conducted. During this literature review existing literature on SCI both cross functional and hierarchically are examined, focusing on integrated planning and control of a supply chain consisting of procurement, production, distribution and sales functions. To form a comprehensive framework for SCI, concepts on SC Sales and Operations Planning (SC-S&OP), hierarchical SC planning, and SCPC are cited in this research. The literature review is conducted with emphasis on the main challenges and requirements for SCI.

**RQ2:** After having identified a comprehensive framework, the current planning and control landscape of Hilti (AS-IS) is mapped. The concepts of the framework are
applied to Hilti’s supply chain with the current planning and control landscape as starting point, to develop a solution for better SCI. The AS-IS is modelled using the Business Process Model Notation (BPMN), where the decision functions of the SCPC have been modelled as activities, which is depicted in Appendix G. These activities are connected with arrows in the model to reflect the interdependencies of the functions. Swim lanes are used to indicate what department is responsible for the decision. Also events are added to the model to represent the triggers for making the decision.

After the current situation at Hilti was mapped, the findings of the literature review have been applied on the case of Hilti. The decision functions that have been identified during the AS-IS mapping have been taken as starting point here. In different workshop rounds with stakeholders the Hilti specific constraints and requirements for a solution are identified. Stakeholders is asked what input is required to make a certain decision, what the output would be of the decision and if there are specific requirements for the timing, frequency, and planning horizon for a decision. The concepts of the framework are applied to the decision functions of Hilti, considering the input identified in the workshop rounds.

**Method of data collection and interpretation:**
The data is collected making use of process documentation, semi-structured interviews, and observations.

**Documentation:** the first round of data collection consisted of collecting process documentation. This documentation consisted of “cookbooks” and flowcharts, describing the Material Management tasks with corresponding timing.

Limitation of this method of data collection are:
- Tasks are not always executed as stated in documentation
- Not all tasks are documented

**Interviews:** to create a more complete view of the current planning and control landscape and mitigate the limitations of using process documentation, in the second round Material Managers and Product Managers were interviewed. The Interviews have been conducted based on a semi-structured approach with the goal to not only describe the AS-IS situation, but also to be able to map the responsibilities and communication lines. In order to add the time-aspect to this mapping, the interviewed employees were asked to categorise their tasks into daily, weekly, monthly and event-based tasks. The aspects of the BPMN have been used for these questions, consisting of:
Activities: decision functions
Events: triggers
Swim lanes: responsibilities
Connections: input/output, communication

Key Performance Indicators (KPIs) have been covered in the interviews to reveal friction between the targets of different departments in the supply chain. The semi-structured interview questions can be found in Appendix C.

Observations: as a last method of data collection employees were observed while performing a task to verify if actions corresponded with process documentation and interview answers.

Focus group: in order to come to a reference model for personnel selection for the first interviews a meta-analysis of models in literature is performed. This reference model is included in the AS-IS description as shown in appendix A. A reference model is of high importance to effectively handle the limited time dimension and to be sure that the chance of covering all logistical functions needed for a complete AS-IS view is the highest.

Time: the time available for the research does not offer the possibility to conduct a longitudinal study and therefore the research findings represent just a couple of moments in time instead of repeated findings (Blumberg et al., 2011).

The research environment: three researchers are located at different Hilti locations, which supports solution development that takes a wide variation of perspectives into account. The research takes place under the real conditions, which are described as field conditions. Two students are placed at the market-side of the supply chain while one student is placed at the production-side of the supply chain. Also the project is seen as a cooperation between the different “silos” in the company rather than a headquarter solution that will be implemented top-down which is likely to result in more support and thus increases the chance of a successful implementation of the solution.

Relevance and position of HNA in the research design: HNA served as one of the two logistic regions for mapping the current planning and control processes at the sales and distribution site of Hilti’s supply chain. HNA is one of the largest logistic regions of Hilti. This region is characterised by long replenishment lead times, due to the geographical distance from the plants in Europe and a dispersed regional distribution network. This contributes to the importance of this region in the research to develop a good planning and control system for a global dispersed
internal supply chain. The region represents a large share of the total turnover of the company and has large influence on the total performance of the organisation. This provides another argument to include HNA in the research.

Interviews have been conducted at the MM and Marketing departments of HNA. The interviews in this region were initially conducted for the identification of the main problems, and later on for the mapping of the AS-IS situation. With its typical characteristics some problems in the current planning and control landscape became more clearly at HNA than the other researched region, which is Logistics Europe Central (LEC). In particular because of the long lead times the results of misalignment between the planning and control functions have bigger impact for HNA compared to LEC, which is considerably closer positioned to the main plants and warehouses of Hilti. The demand planning process at HNA is more extensive than the other market region in this research, and the dependency on this function is larger. This contributed to the insight that a lacking mid-term forecast causes SCI problems and that missing aggregation/disaggregation methods the demand planning process exacerbates. Furthermore, the dispersed two tier distribution network at HNA made the focus on distribution planning in the development of the concept more important. Allocation of stock plays a more crucial role in this region than at LEC.

Some processes were also more developed at HNA, which have served as “best practice” in developing an integrated global SCPC concept. The coordination between Marketing and MM is more extensive, because of the positioning of these functions at one location. At HNA some initiatives to align the regional planning with production planning were already started with a single production plant that provided insights in the development of better SCI. The detailed AS-IS analysis at HNA and a summary of the identified gaps at HNA, contributing to the overall research, are provided in appendix A and B respectively.
3. Theoretical Framework for Internal Supply Chain Integration

In this chapter a framework is introduced for SCI of a global dispersed internal supply chain. The concept of Supply Chain Planning and Control is described in Section 3.1. The Supply Chain based Sales and Operations Planning (SC-S&OP) concept and Supply Chain Operations Planning (SCOP) form the main constructs of this framework and will be described in detail in this section. Furthermore, emphasis on the challenges and requirements for SCI are included in the framework in Section 3.2. In Section 3.3 the framework will cover the contingency of supply chain planning and control on the firm’s environment, such as the industry and market characteristics. Finally, in Section 3.4 the general applicability of the framework will be described.

3.1 Supply Chain Planning and Control
Since Anthony (1965) formally introduced hierarchical control at three levels (Strategic Planning, Management Control and Operational control) a lot of academic research is based on different levels of planning and control. De Kok and Fransoo (2003) state that hierarchical planning frameworks enable accurate modelling of consecutive planning and scheduling decisions made in manufacturing organisations. According to Fleischmann and Meyr (2003): “Hierarchical planning seeks to coordinate planning modules such that the right degree of integration can be achieved”. These planning modules are derived from the company’s tasks and they pool all decisions within the responsibility of the same planning unit. The planning horizon is shared and the timing should be simultaneously in these modules (Fleischmann and Meyr, 2003). These planning modules interact and exchange information and constraints in all directions.

Fleischmann et al. (2002) use three hierarchical levels of planning in their Supply Chain Planning (SCP) matrix: long-term, mid-term and short-term. These levels, as well as the decision functions in the SCP matrix, form a hierarchical representation of planning and control landscape of a general supply chain. Since one of the characteristics of the system is the complexity of the supply chain an abstracted framework is needed (that does not deal with every detail) for designing the planning. Fleischmann et al. (2005) argues that the framework shows decision functions, which occur in most supply chain types, but with various forms of the actual decision. A great deal of frameworks on supply chain integration is based on the SCP matrix. Therefore the SCP matrix as shown in figure 6 can be seen as paradigm in the SCM research area.
A single planning concept, like the SCP matrix, cannot cover the large variety of planning problems that arise in practice for different production layouts and market requirements (Drexl et al., 1994). Different types of production processes imply particular requirements for planning. Therefore, a production planning concept is introduced that can supplement the SCP matrix in the theoretical framework. This is the manufacturing resource planning (MRP) II model, as shown in figure 8. This model is considered particularly suited for its overview of the various types of decision support procedures and models (Bertrand et al., 1992). The MRP II model is included as it has a focus on different modules in an MRP-system, with emphasis on resource and capacity planning for production. For the purpose of creating a new planning and control concept the MRP II framework can thus provide an overview for primarily the production and procurement planning stages at the different hierarchical levels.

Figure 6: SCP matrix from Fleischmann et al. (2002)

Figure 7: MRP II production decision framework
As can be seen in figure 6, planning and control decisions are made in different parts of the supply chain and besides the strategic planning concerned with the business plan that is comprehensive, the decisions are not integrated. Fleischmann and Meyr (2003) state that planning tasks on different planning level needs a different degree of aggregation (frequency, time bucket, product, resources), the upper planning level coordinates lower planning level and that feedback from lower planning level should give instruction to the upper level. Therefore, within every hierarchical level the level of vertical integration is discussed.

**Strategic/Long term level** - Strategic or (relatively) long-term decisions have to be made only once or have to be thought over very seldom, and consider the structure of the goods flow (Fleischmann and Meyr, 2003). The Strategic/Long-term level is defining the strategy and the design of the supply chain and the decision functions in this level have a large impact on the long-term performance of an organisation (Goetschalcks and Fleischmann, 2004). The horizon of the decisions is for several years and the decisions are made by top management (Fleischmann and Meyr, 2003). Identifying the key products, markets, primary manufacturing processes and suppliers is the essence of strategic planning. Multiple decisions have to be taken which at the end form the strategic plan. In the SCP matrix of Fleischmann et al. (2002) this strategic plan is represented as an integrated decision over the whole supply chain.

At this level, decisions on procurement, production, distribution and sales have to be made. There are a number of decisions that can be identified, looking at the hierarchical models described above. This includes for procurement: *resource planning, materials program, supplier selection* and *cooperation*. *Resource planning* entails the process of establishing, measuring, and adjusting limits or levels of long-range capacity at business plan level (APICS, 2013c). The *materials program* decision considers materials needed to buy from suppliers. *Supplier selection* is a comprehensive approach for locating and sourcing key material suppliers (APICS, 2013d). *Cooperation* considers what type of strategic cooperation might be useful (Fleischmann and Meyr, 2003). For production, *plant location* and *production system* are the established decisions. *Plant location* is considering where to locate the plants and is usually taken together with the decision of the *physical distribution structure* (Fleischmann et al., 2005). The *production system* decision considers organising single production plants in terms of layout design and the resulting material flows between the machines (Fleischmann and Meyr, 2003).

Distribution is considering the *physical distribution structure* usually in cooperation with *plant locations* as mentioned above. The physical structure for distribution is decided. Finally, sales considers the *product program, long-term forecasting* and *long-term sales planning*. The *product program* together with *long-term forecasting*
and sales planning consider which products to place on what markets (Fleischmann and Meyr, 2003). Together, all the decisions of the supply chain come to the final decision that is called strategic planning. Strategic planning outputs a strategic plan that steers all levels below.

**Tactical/Mid-term Level** - Tactical decisions have to be made monthly, consider the start-up and continuance of the goods flow on mid-term (months), and are made, different from the strategic level, by middle management (Fleischmann and Meyr, 2003). The mid-term plans encompass a horizon ranging from half a year to two years (Silver et al., 1998). Tactical/mid-term decision functions consider a planning horizon that consists of weekly or monthly buckets which leads to the use of aggregated capacities (Fleischmann et al., 2005).

As discussed in the literature review, SC-S&OP can be used to integrate this level in a cross-functional manner. SC-S&OP can be seen as a periodically occurring planning process, providing links along both axes, linking the long-term strategic and business plans with the short-term operational plans vertically and the demand with supply capabilities horizontally (Ling and Goddard, 1988; Wallace, 2004).

![Figure 8: SCP matrix adapted according to Feng et al. (2008)](image)

Feng et al. (2008) define a SC-S&OP approach to integrate decisions on the tactical/mid-term level. These authors adapt the SCP matrix (figure 8) and define SC-S&OP as a monthly tactical planning process formed by breaking down the strategic long-term plans with input from various functional areas bridging the strategic plans to operations. Therefore the decision functions used in the SCP matrix are defined to be preparations and Feng et al. add the decision function Supply Chain based Sales and Operation Plan (SC-S&OP) that integrates the separate modules in the SCP matrix on the tactical level.
To be able to integrate planning processes on the tactical level with SC-S&OP, a number of planning parameters for the process have to be established (Feng et al, 2008). Decisions on the tactical level can adapt logistical control parameters like ordering method, order frequency and safety stock (Fleischmann and Meyr, 2003). Tactical parameters are rules for the decision functions at the tactical level and include boundaries due to physical constraints such as capacities or lot sizes. They control the tactical level in a central way. Considering the complexity of the considered supply chain network, the entire chain should be taken into account in order to define optimal parameters. The decision function parameter setting by de Kok and Fransoo (2003) refers to this need for this decision function as: "...a parameter setting function needs to coordinate the safety stock, leadtime, and workload parameters of the Supply Chain."

Concluding the tactical level, a number of decisions on procurement, production, distribution and sales are part of this level according to the hierarchical models. First, tactical parameters are set for the whole supply chain as explained above. For procurement, decisions that are included are: personnel planning, contracts and aggregate material requirements planning. Personnel planning considers specific personnel groups and their availability according to labour contracts (Fleischmann et al., 2005) and shows the necessary amount of needed employees on a mid-term. Contracts considers the price, the total amount, and other conditions for the materials to be delivered during the next planning horizon for suppliers (Fleischmann et al., 2005). Aggregated material requirements planning entails the planning of parts of subassemblies on an aggregated level for the mid-term. For production, aggregated production planning and capacity planning are the established decisions. Aggregate production planning is part of the process to develop the tactical plan supporting the organisation’s business plan (APICS, 2013e) and defines the production volumes for the next planning horizon. Capacity planning entails the amount of capacity needed on aggregated level. Together, the procurement and production decisions merge their preparations to come to a preliminary production plan that will be used for the SC-S&OP decision.

Distribution is considering the distribution planning that decides on the planning of transports between the warehouses and determination of the necessary stock levels. Finally, sales considers mid-term forecasting and sales planning on aggregated level. Forecasting considers the potential sales for product groups in specific regions where the products are grouped according to their production characteristics (Fleischmann et al., 2005). Sales planning gives a: “time-phased statement of expected customer orders anticipated to be received (incoming sales, not outgoing shipments) for each major product family or item” (APICS, 2013f). The distribution and sales decisions merge into a preliminary delivery plan used for the preliminary production plan and for the final SC-S&OP decision. The SC-S&OP decision aligns the
two plans and agrees to a final number for all parts of the supply chain on a mid-term horizon.

**Operational/Short-term Level** – The operational/short-term level considers decisions that iterate weekly or even daily and are concerned with the start-up and continuance of the goods flow on short-term basis (weeks, days and hours) (Fleischmann and Meyr, 2003). The supply chain operations planning (SCOP) method by de Kok and Fransoo (2003) seen in figure 9, contains decisions of both releasing materials and resources. It coordinates all release decisions in the supply chain and uses the outcomes of earlier planning decisions. SCOP overlaps mid-term as well as short-term planning by translating mid-term planning decisions into short-term execution decisions and is therefore contributing to the vertical as well as the horizontal integration of the planning landscape. For the operational level, Fransoo and de Kok (2003) relate to the decision functions considering the planning of operations and abstain from other functions in the hierarchy of Fleischmann and Meyr (2003)

![Figure 9: SCOP method according to de Kok and Fransoo (2013)](image)

The operational/short-term decision functions are divided into central control (SCOP) and production unit control (PUC). When composing a decision problem and constructing a hierarchy, the higher levels of the hierarchy need to aggregate the lower level models in the more or less independent units along the supply chain (de Kok and Fransoo, 2003). De Kok and Fransoo (2003) define the SCOP function as a centralised control being responsible for the coordination of activities along the supply chain, by making decisions on the quantities and timing of material and resource releases (considering the lead time characteristics of the supply chain). It incorporates the outcomes of earlier planning decisions and generates a material and resource release decision to be executed by the production units (PU).
PUC implies that operational decisions are taken locally (regionally) in order to optimize the process that considers the steering from SCOP in terms of requested input and output and complies with the tactical parameters. They are responsible for controlling lead time in a particular unit of the supply chain (Bertrand et al., 1990). SCOP considers PUs as black boxes with certain planned lead times. According to Fleischmann and Meyr (2003) the planning horizon of short-term planning is restricted to a few weeks (maximum a few months). de Kok and Fransoo (2003) argue that in most industries SCOP deals with a horizon up to several months with weekly time buckets. Next to the SCOP decision and PUC decisions, short-term forecasting, sales planning and order acceptance are defined. These decisions are in line with both the SCP matrix as well as the SCOP method.

Concluding this level, decisions on procurement, production, distribution and sales have to be made. For procurement, production and distribution there is one higher level SCOP decision on the operational level that Release materials and resources as described above. This basically integrates the following decisions shown in the framework of Fleischmann et al. (2002): personnel planning, material requirements planning, ordering materials, master production scheduling and warehouse replenishment. Next to the SCOP decision, the PUC considers local decisions about machine scheduling, last minute lot-size adaptations and shop floor control for production and specific transportation planning for distribution. For sales, short-term forecasting and sales planning are present to give feedback to SCOP and order acceptance. Short-term forecasting predicts future demand with statistical models and supplements this with market intelligence from marketing and sales on the short-term horizon and sales planning considers the fulfilment of customer orders on this horizon. Order acceptance controls the total amount of work accepted by the supply chain, and externalises the portion of the customer-perceived lead time that is due to varying demand that cannot be processed within the fixed and controlled lead time (de Kok and Fransoo, 2003).

### 3.2 Challenges and Requirements

In order to achieve successful cross-functional integration on both the tactical and operational level there exist various challenges and requirements besides the above described alignment of decision functions. The main challenges and requirements for cross-functional coordination in a global dispersed supply chain will follow in this section.

The stakeholders along the internal supply chain need to be engaged and educated, such that they understand the objectives, principles, the decision rights, and all related benefits both locally and globally. Stakeholders have to make decisions that may not always be best locally but are best for the greater good of the total business. For this reason it is important that cross-functional alignment activities in
any single function brings recognised additional benefits to the overall business performance (Lewis and MacLean, 2009).

All plans need to be transformed into “one number” across the different functions to support efficient information sharing. For example, if Marketing creates a sales plan in dollars per product family, while the Demand planning function forecasts in number of items on SKU level, it can lead to a misunderstanding about the numbers. However, if all plans are aligned in “one number”, all functions can understand the deviations in plans and risks and can jointly come to the best holistic plan (Lewis and MacLean, 2009).

A requirement to global coordination is a clear definition and distribution of responsibilities and accountabilities (Lewis and MacLean, 2009). In complex global supply chain structures of large firms, often multiple geographical layers in demand and supply may not always correlate with each other. This may cause difficulties when it becomes unclear who the real decision maker is. For this reason it is vital to define who is responsible and accountable for a decision.

Lewis and MacLean (2009) state that objectives of the different function must be aligned. For example, if a Sales manager's targets are linked to the profitability of a region, the manager will focus on reaching these targets, without considering the possible negative impact on other parts of the business. This may also be the case for a plant manager, who may be focused on keeping marginal production costs and utilization rates high, which may lead to longer production runs and higher stocks. Which is not necessarily better for the performance of the overall supply chain. A requirement for effective cross-functional coordination is that targets are aligned, such that they drive the best result for the overall organisation.

Another requirement proposed by Lewis and MacLean (2009) to successful coordination between functions is to maintain a medium to long-term focus, besides all the operational decisions that have to be made. Often communication between functions is concerned with short term problem solving, while less coordination takes place in the planning to prevent problems in the mid-term future. If cross-functional alignment is also focused on the mid-term, less resources are required to solve misalignment problems on a daily basis and more time is available for managers to evaluate solutions that are best for the overall business.

An important determinant of the success of cross-functional alignment in a global operating supply chain is the adaptation of the company to the local cultures of functions in the supply chain (van Hove, 2012). In a global dispersed supply chain the geography driven social and cultural differences are main challenges in implementing and operating cross-functional coordination. Organizational behaviours are not always supporting this coordination. According to van Hove there
exist four main constructive behaviours supporting effective functional coordination across geographical boundaries: Achievement, self-actualization, humanistic encouragement, and affiliation.

Organizations that are characterized by these behaviours are more likely to create an environment where open communication, transparency, conflict resolution, cross-functional coaching, and continuous improvement are encouraged (van Hove, 2012). It can take years to create the desired organizational culture and it requires executive support. An organizational culture can influence cross-functional integration directly by its change management process to accomplish better integration and by its leadership support (van Hove, 2012). Cultural issues become more important when national borders are crossed, as people have a tendency to prefer their own culture to others. A national culture can play a vital role in the way people think and behave, which makes understanding cultural preferences important.
3.3 Contingency of SCPC Design to Company Environment

The design of a supply chain and the design of the SCPC system is contingent to the supply chain’s environment, (Meyr and Stadtler, 2008). The importance of decision functions proposed in this chapter varies with respect to the functional and structural attributes of a supply chain. These attributes vary with respect to the firm’s environment such as the type of industry and market characteristics. Meyr and Stadtler describe four groups of functional and two groups of structural attributes that can describe the requirements of a supply chain and can be important for the design of a SCPC system. When developing a SCPC system these attributes that are industry and market specific need to be considered. An overview of the set of attributes is shown in Table 1.

3.4 General Applicability of the SCPC Framework

Although the strategic and tactical parameters are specific for every company, the way of controlling and planning them, and the hierarchical positioning of the decision functions can be derived from the SCPC framework and is general applicable for a supply chain design. The tactical level decisions containing SC-S&OP might be divided in multiple local SC-S&OP processes and a global SC-S&OP for alignment of the local SC-S&OP numbers. This positioning of the SC-S&OP process throughout different locations makes the tactical/mid-term decisions and their integration possible for all sorts of supply chain complexities. The need for designing the process of SC-S&OP is specific for every company, as also is true for the other processes leading to decisions in the hierarchical model. Referring to Feng et al. (2008) and their multi-site SC-S&OP model, it can be seen that the operational level could be divided between different locations of the procurement, production, distribution and sales sites. It can be concluded that the operational level does not have to be integrated on all sites of the company, if the processes are unrelated or even in different parts of the global market. If this is combined with the SCOP concept and its relation with the PU’s (already controlled locally), it can lead to multiple operational SCOP decisions and provide generalizability for a multi-site environment.
<table>
<thead>
<tr>
<th>Categories</th>
<th>Attributes</th>
</tr>
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<tbody>
<tr>
<td>Procurement type</td>
<td>Number and type of products procured</td>
</tr>
<tr>
<td></td>
<td>Sourcing type</td>
</tr>
<tr>
<td></td>
<td>Flexibility of suppliers</td>
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<tr>
<td></td>
<td>Supplier lead time and reliability</td>
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<td></td>
<td>Materials’ life cycle</td>
</tr>
<tr>
<td>Production type</td>
<td>Organization of the production process</td>
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<td></td>
<td>Repetition of operations</td>
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<td></td>
<td>Changeover characteristics</td>
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<tr>
<td></td>
<td>Bottlenecks in production</td>
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<tr>
<td></td>
<td>Working time flexibility</td>
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<tr>
<td>Distribution type</td>
<td>Distribution structure</td>
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<td></td>
<td>Pattern of delivery</td>
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<td></td>
<td>Deployment of transportation means</td>
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<td></td>
<td>Loading restrictions</td>
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<tr>
<td>Sales type</td>
<td>Relation to customers</td>
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<td></td>
<td>Availability of future demands</td>
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<td>Demand curve</td>
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<td>Products’ life cycle</td>
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<tr>
<td></td>
<td>Number of product types</td>
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<td></td>
<td>Degree of customization</td>
</tr>
<tr>
<td></td>
<td>Bill of materials (BOM)</td>
</tr>
<tr>
<td>Topography of a supply chain</td>
<td>Network structure</td>
</tr>
<tr>
<td></td>
<td>Degree of globalization</td>
</tr>
<tr>
<td></td>
<td>Location of decoupling point(s)</td>
</tr>
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<td></td>
<td>Major constraints</td>
</tr>
<tr>
<td>Integration and coordination</td>
<td>Legal position</td>
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<tr>
<td></td>
<td>Balance of power</td>
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<tr>
<td></td>
<td>Direction of coordination</td>
</tr>
<tr>
<td></td>
<td>Type of information exchanged</td>
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</tbody>
</table>
4. Case study: Integrated SCPC Concept for Hilti

The theoretical framework in Chapter 3 is applied on the business case at Hilti. Both the horizontal and vertical integration concepts of the framework are used, considering the current situation and constraints at Hilti. Figure 10 shows both the current landscape and the new concept for Hilti. First in Section 4.1 a conceptual model is presented consisting of decision functions, which are hierarchically positioned following the framework introduced in Chapter 3. In Section 4.2 emphasis is placed on the division of responsibilities in the conceptual design. This chapter concludes with an outline of the main implications of the concept for HNA in Section 4.3.

4.1 Decision Functions: Hierarchically

4.1.1 Tactical Level

From the described framework in Chapter 3, first the SC-S&OP concept of Feng et al. (2008) is used to redesign the decision functions and their coordination on the tactical level. According to this concept a preliminary delivery plan and production plan with a mid-term horizon need to be developed as a preparation for the SC-S&OP decision, resulting in a “one number” that has to be used for mid-term planning at both the supply side and the demand side of the supply chain. From the current situation depicted in figure 10 it can be concluded that required decision functions are missing to come to a SC-S&OP decision.

**Tactical parameter setting** - To be able to integrate planning processes on the tactical level with SC-S&OP, a number of control parameters for the process have to be established centrally by the tactical parameter setting function as follows from de Kok and Fransoo (2003). The tactical parameter setting at Hilti is currently divided in multiple decision functions that are controlled independently of decisions of other functions in the supply chain and changed whenever necessary. Decisions on the tactical level can however adapt logistical control parameters. The parameters that are currently set locally, but will become part of the tactical parameter setting are: MRP type selection, direct/indirect distribution, safety stock levels/positioning, lead times, and decoupling points.

**Preliminary delivery planning** - The mid-term forecasting, sales planning, and distribution planning functions are added in the new concept in order to come to the preliminary delivery plan. In the SC-S&OP model the preliminary delivery plan is described as the integration of the forecasting, distribution, and sales planning functions in one plan. In the concept for Hilti, this integration takes place by using the forecast as input for the distribution planning, which then is used as input for the sales plan.
Figure 10: Current planning and control (above) and new concept (below)
**Mid-term forecasting** - At Hilti this will entail statistical forecasting based on historical sales data and human interaction. It incorporates market intelligence and seasonality patterns. The forecast will be structured according to a pre-defined calendar, which aligns the timing of mid-term distribution and sales planning to limit unnecessary re-planning. The mid-term forecast is particularly focused on critical items in the supply chain and items that represent a high share of value. The aggregation level is on product group for a sales region. The right level of aggregation can be item specific and is dependent on the supply chain setup. The recommended horizon for the mid-term forecast is approximately 18 months, as there is an already existing rolling forecast with this horizon produced by the financial department which will be taken as a starting point.

**Distribution planning** - The mid-term forecast is input for distribution planning. This decision function aligns the distribution plan with the forecast and determines the required warehouse and transportation capacities. Distribution planning considers the transportation and storage requirements, distribution rules and other distribution related characteristics. The recommended horizon and frequency of this decision function is equal to the mid-term forecasting function.

**Mid-term sales planning** - The distribution plan and mid-term forecast are both input for mid-term sales planning. This function considers constraints such as the available sales budget and sales force to check the feasibility of the plan. In the concept for Hilti the sales planning creates an aggregated sales plan that is aligned with the mid-term forecast and distribution plan and is expressed in both a monetary value and volume. Both types of quantities are expressed to enable communication between the sales function and the other functions in the supply chain. The aggregation level is dependent on item specific supply chain characteristics. The horizon and frequency will be aligned with the previous decision functions.

As preparation for the SC-S&OP decision, the preliminary production plan represents the mid-term planning from the perspective of the production site of the supply chain. The aggregated MRP is included in the MRP II model to form the link between the mid-term demand planning and production planning. In the current situation at Hilti demand plans are communicated through the MRP function towards the production site. However, this MRP is on SKU level focuses on a short-term horizon, which is to detailed and volatile for making reliable mid-term decisions. For this reason an aggregated MRP function is added in the conceptual design for Hilti. This function transforms the sales planning, which can be seen as the preliminary delivery plan, into net requirements on which the production functions can create their
aggregated production plan, which refers to the preliminary production plan in the SC-S&OP model.

**Preliminary production planning** - In order to come to an aggregate production planning also an aggregated MRP, a capacity planning and a personnel planning function are included in the concept. Aim of the production plan is to have a planning that is feasible on the mid-term, which requires a check if enough resources and capacity is available for production. Input from Hilti here is that available materials, components and personnel are the limiting factors in the mid-term production planning that have to be considered in the mid-term production plan. Both decision functions are also part of the SCP matrix, which is part of the framework used to design the concept for Hilti. The decision functions forming the preliminary production plan and their relations will now be described in more detail.

**Aggregate material requirements planning** - The mid-term sales plan is input for aggregate material requirements planning. The sales plan is transformed into net requirements and purchase volumes together with information about current stock levels, lead times and scheduled receipts. In this decision the timing is considered according to a pre-defined calendar. The aggregation levels need to be chosen in accordance to the product specific supply chain characteristics. A monthly frequency and the same 18-month horizon are determined for the implementation design.

**Capacity planning** - The aggregate net requirements that result from aggregate materials requirements planning are subsequently used in the capacity planning decision. Besides the net requirements also available raw materials and components are input for this decision. The output of the capacity planning decision is a set of constraints that have to be respected to come to a feasible production plan. The level of aggregation, frequency and horizon of this decision are equal to the aggregate material requirements planning function.

**Personnel planning** - In parallel with the capacity planning decision a personnel planning decision is made. In this function the aggregate net requirements are input to determine the quantity of full-time equivalents (FTE) available, the shift model for the production, and the constraints regarding personnel capacity. In the decision the legal constraints and the personnel capacity on the mid-term are taken into account. Again, the level of aggregation, frequency and horizon of this decision are equal to the aggregate material requirements planning function.

**Aggregate production planning** - The next tactical decision function is aggregate production planning. The net requirements, capacity restrictions and personnel restrictions are input for this decision. The available raw materials and components are considered, together with the personnel shift model. The output of the
aggregated production planning consists of the production quantities and constraints. In the adapted concept for Hilti the product specific supply chain characteristics determine the level of aggregation. Also for this decision function the level of aggregation, frequency and horizon is determined to be equal to the aggregated material requirements planning function.

**SC-S&OP** - Following the SC-S&OP model of Feng et al. (2008) the mid-term sales plan and aggregated production plan serve as preparation for SC-S&OP in the conceptual design for Hilti. The frequency of the proposed SC-S&OP meeting is quarterly with the purpose to come to a “One Number”, representing the latest estimate. This frequency is chosen in order to reach alignment with the financial planning, which is also organized quarterly, and is determined by senior management during the workshops. These meetings are determined to be divided per plants. Every plant will have a SC-S&OP meeting where all markets/regions will be aggregated as demand. The aggregation level and type of the SC-S&OP decision will be a translation of the sales plan and aggregated production plan levels and type in order to be able to make valued decisions.

A best-practice example that can be used as reference for Hilti in organizing the SC-S&OP meeting, is the concept developed, and partially used at HNA. The meeting, which HNA calls a “S&OP” meeting, is a new initiative that is still in its test phase. Only one business area is organizing these monthly meetings currently at HNA. The meeting is organized for managers in the plant, the BU and the MO (HNA). This includes the plant MM; the BU MM and Product Manager; the MO team leader of Logistics services, and MO warehouse management. However, not all these people are always attending currently, which is critical for successful SC-S&OP. The issues that are on the agenda of this meeting are concerned with mid-term planning related to production, supply, replenishment and distribution. One key objective of the meeting is to improve communication between the different silo’s and to achieve alignment to HNAs business requirements. Another key objective is to build trust that the HNA future requirements are well founded. This communication and trust is required in the plants to react proactively on demand forecasts. Finally, a key objective of this “S&OP” meeting is to achieve excellent product availability.

**4.1.2 Operational Level**
A number of operational decisions are currently made decentralised, while a centralised approach could overcome much of the silo problems identified at Hilti. The specification of the SCOP model in the theoretical framework developed by de Kok and Fransoo (2003) is used on the operational level to cross-functionally integrate the planning and control. Decision function that are currently made decentralised, but will become part of the SCOP decision include: MRP, Warehouse order release, Plant order release, Production planning, Material ordering,
Warehouse order management, and Plant order management. Next to the SCOP function, a short-term forecasting, sales planning and order acceptance function are included in the concept for Hilti. This is accordance with the model of de Kok and Fransoo.

**SCOP** - The determined input for the SCOP decision is the “one number”, set by the SC-S&OP meeting described in the previous section on tactical level. As output, there will be a weekly plan for procurement, production and distribution where the PUs are free to optimize in the boundaries of the set lead times. This output shows the timing and quantities in the form of a plan at item level for all locations. The horizon of the SCOP function will ideally be the longest critical lead time. Since the range of the product portfolio is fairly large this horizon will be split to the longest critical lead time within a business unit. This way, for example, chemical anchors do not suffer under the availability of steel and electric tools have no liability on the availability of chemicals. This implicitly means that the horizon can differ for all business units. However, as long as there are no communalities between the business units, from a planning perspective this will not form any complications. When two or more business units share a raw material the longest critical lead time of all the business units will become leading again.

**Short-term forecasting** – This function will be adapted following a predefined calendar in order to align all markets in their way of working (WOW). The determined output is a forecast (on item level) that will benefit the historical data for the future and should therefore not be adapted in the way it is currently done (sales planning and forecasting combined).

**Short-term sales planning** - will be concerned with foreseeing important changes (on item level) as last-minute events or important new market possibilities (e.g. new large clients). Forecasting and sales planning will provide information to the order acceptance decision, which will have a feedback loop for exception management to the SCOP decision.

**Order acceptance** - This order acceptance will remain as defined in the theoretical framework and will be the only possibility to feedback to SCOP for making a trade-off within the possibilities to change the SCOP plan differing from the original received “one number”.

**4.1.3 Cross-level alignment**

With the decision functions and responsibilities clear the actual cross-level alignment can be discussed. Several fields of interest have been identified that need attention when aligning the two levels. These are the alignment through different frequencies, aggregation levels and targets.
**Frequency** - Both levels have a different frequency; monthly for the tactical level and weekly for the operational level. In order to cope with this a calendar has to be developed in such a way alignment becomes a natural flow of actions or way of working. The calendar will take the needs of both levels into account and will give all contributors of the planning process clear guidelines on how to participate in the preparations, meetings and planning decisions.

**Aggregation level** – An important aspect of planning on the different levels is the level of aggregation. On the tactical level the aggregation level is a lot higher then on the operational level. This is because the calculations and decisions on the tactical level are more rough-cut and high levels of detail would unnecessarily add to the complexity of these calculations. On an operational level, the rough-cut figures are no longer useful since detailed (item level) production plans and schedules are needed in order to plan procurement, production and distribution (item-location). Also, sometimes it will be easier to talk in monetary values on the tactical level where on the operational level always item or item-location numbers are required.

Therefore, to be able to align the levels first the correct levels of aggregation have to be decided for the different constructs (e.g. demand forecasting unit, stock keeping unit, family types and resources).

Concerning the families, this will need special attention since the existing product groups are handled differently in the MO/region, HAG (BU) and Plants. In order to be able to aggregate families clear decisions have to be taken so that disaggregation makes sense for the production locations.

The development of aggregation/disaggregation logic in form of algorithms is also of high priority. To be able to translate the different levels of aggregation into the required format algorithms are key in aligning the tactical and operational decision functions.

**Targets** – As mentioned before, the potential of integrated planning can only be realized by recognizing the connections and inter-relationships between different parts of the supply chain and ensuring a good fit between its design and operations and the company's competitive strategy. We have described the design and operation but part of the strategy is also of great importance. Targets, which are translated into key performance indicators (KPI) at Hilti, are key examples of the company's internal strategy. The current KPIs will have to be reassessed in order to make alignment possible between the two levels as at the moment are strongly focusing on local improvement only.

Also important to note, is that since the responsibilities of the supply chain team will lie in procurement, production and distribution their KPIs will have to be equally diverse insuring a full supply chain focus. Moreover these (new) KPIs will have to be
shared with other departments, which often will be local departments such as plants or MO/regions, in order to make connections and inter-relationships between different parts of the supply chain possible. Therefore, they can be a driving force in the reassessment of the local KPIs, suggested before.

**Engagement rules** – Next to these three fields of interest engagement rules have to be developed to guide all the new processes. Engagement rules are general rules of the game. These rules have to be developed and have to guide at least the following topics:

- Service level requirement and agreement
- Prioritization (e.g. priorities based on profitability)
- Exception management
- Stock positioning

**4.2 Responsibilities**

Combining the decision function diagram with swim lanes will not only include the timing of the decision, but also the responsibility for the decision. Now the decision functions for the Hilti integrated planning and control concept have been elaborated above, they can be extended by determining responsibilities. These responsibilities will define the roles for the swim lanes that are used for the concept (shown in Appendix D). As Oliva and Watson (2011) argue, even if goals or incentives are not aligned, better integration takes place if the process is well developed with clear responsibilities.

In order to come to these roles that are responsible for the decision functions, input from Hilti was gathered through the RAPID (Recommend-Agree-Perform-Input-Decide) tool (developed by Bain and Company (2013)), which is a Hilti company standard was used. This tool, represented in Appendix E helps to develop clear decision making guidelines (Rogers and Blenko, 2006) and shows the complete perspective of accountabilities. This input is determined the following final roles for departments responsible for the decision functions:

**Market/region Sales and Marketing** – These are the current sales and marketing departments in Hilti, which are decentralised to the markets in MOs or regions. They will be responsible for *sales planning* on the tactical, as well as on the operational level as described in the previous sections. Close-to-market information is necessary and putting this responsibility at this team will provide better cross-functional integration at Hilti. They will be responsible for the final number in the preparations of distribution and sales for the SC-S&OP meetings in their market/region.
Market/region Demand Management – The current MM in the markets/regions is combining forecasting and sales planning as mentioned before. They are also concerned with the warehouse replenishment of the warehouses they control. As this warehouse replenishment will become a part of the SCOP decision, this will slim down the responsibilities that are done by the teams in the markers/regions. Forecasting will be performed close-to-the market and separated from sales planning. MM will get the responsibility and transform to a Demand Management (DM) department.

Global Logistics Material Management – Under GL MM, a central team that is responsible for the entire supply chain except the sales functions on tactical level (distribution planning, aggregate material requirements planning, capacity planning, personnel planning and aggregate production planning) and operational level (SCOP and order acceptance) will be formed. Instead of the dispersed decision functions belonging to distribution as-is now, the central team will be responsible for the complete distribution network. This central team will be the Supply Chain Specialists Team (SCST) and should be a 6 to 7 person team that is highly competent and educated in supply chain management. It will reconcile market/region needs with production capacities and has in independent role in this balancing. Main tasks of the team within the SCOP function will be:

- Weekly revert market/region needs into a feasible production plan at item level
- Manage exceptions from both plant as market/region needs
- Manage the order release activities

The supply specialist team will be the main contact point for the plants as well as for the markets/regions.

Business Unit Management – This role currently exists at Hilti and is responsible for Global Manufacturing (GM), which in turn is responsible for the plants, Global Logistics (GL), as well as the sales functions. Therefore it is the team that should be responsible for the tactical parameter setting for the whole supply chain (receiving input from the separate stakeholders) and SC-S&OP (also receiving input from the separate stakeholders).

Plant Management – This role will provide input (e.g. constraints) for the SC-S&OP, tactical parameter setting and will have responsibility for the PUC decision functions. As they are represented by the BU Management in the SC-S&OP meetings, they will not have responsibility for this.

Concluding, as has been indicated before, the biggest change in the new concept is that a lot of responsibilities in decision making are shifting from the silos to a supply network.
chain based team. This team of supply chain specialists is currently not in place but will get a lot of the responsibilities.

4.3 Implications for Hilti North America
After having described the supply chain wide conceptual design, in this section the implications of the new design for HNA are elaborated. This enables a more focused and detailed description of the conceptual design for HNA.

4.3.1 Tactical Level
As HNA is concerned with the sales and distribution functions of the supply chain, on the tactical level the new concept will have in particular implications for the forecasting, distribution planning and sales planning at HNA. These three functions will be executed in a clear sequential order, with a mid-term focus, and with a fixed calendar dictating the timing of the execution to make sure this order is maintained.

A mid-term forecasting function will be introduced in addition to the existing short-term forecast. This forecast will be maintained in SAP-APO separately from the short-term forecast and will reflect the expected future sales, without considering distribution and sales constraints.

A central distribution planning function will be created, which uses the mid-term forecast and makes a tactical planning that is feasible in regards to the HNA specific distribution constraints. Main distribution constraints are the warehouse and transport capacity. Also adjustment of these capacities to better fit the mid-term forecast is part of the distribution planning in the concept.

Another implication is that sales constraints will be included in the tactical planning, which will happen during mid-term sales planning with the input of distribution planning and mid-term forecasting. This function considers constraints such as the available sales budget and sales force to check the feasibility of the plan. If it is desirable and feasible, then the decision can be made during sales planning to adjust the sales budget and sales force to optimally benefit from market potential. The outcome of the sales planning function is the final sales number, which is the result of all HNAs planning functions on the tactical level.

4.3.2 Operational Level
On the operational level the concept has implications for the short-term forecasting, the short-term sales planning and the warehouse replenishment decision functions at HNA. The short term forecasting and short-term sales planning decision functions will be adapted and will be maintained according to a calendar that is aligned with the SCOP calendar. The warehouse replenishment function will become part of the central SCOP function.
The short-term forecast will be created on an aggregated level, instead of on the current item/location level. If the forecast is maintained at a higher level than the item/location, the number of forecasts to manage can be considerably reduced. The IT system will be adapted such that it can calculate the aggregate forecast using different models (e.g. constant, trend, seasonal) and automatically select the model that is most accurate. The materials manager will focus on reviewing the aggregate forecast, instead of reviewing on the item/location level forecast like in the current situation. This will increase the efficiency of the short-term forecasting process. Subsequently the forecast will be disaggregated to the item/location level according to a disaggregation rule. This item/location level is the required input for the SCOP decision in order to come to a warehouse replenishment plan for each location.

The warehouse replenishment decision function at HNA consisting of: purchase order release, deployment release, and exception management will become an element of the central SCOP function. These decisions will no longer be made separately from the material and resource release decisions upstream in the supply chain, creating more cross-functional alignment. The SCOP function will have a weekly frequency, which implies that purchase and deployment orders for replenishment of HNAs warehouses will be released weekly, instead of daily. This creates more stability and freedom for the operational planning in production plants and other PUs.

Short-term sales planning at HNA will have input from the short-term forecasting function in the new concept. On the short-term the sales planning will be concerned with fulfillment of customer orders. For example, in case of shortages the sales planning can prioritize customers to serve the most important customers. Important new changes in sales quantities on the short-term will be included in the planning and will become input for order acceptance.
5. Implementation Plan

In this chapter the implementation plan is described. The technical aspects described in the previous chapter are not the only drivers to successful implementation. Environmental, human aspects are of equally importance in achieving this. For this reason Section 5.1 shows the analysis of the company’s environment in which the implementation takes place. Then the action plan of implementation is described in Section 5.2. The different phases of the implementation are presented with corresponding responsibilities and communication plan. This section also elaborates on the specific implementation actions that concern HNA.

5.1 Environment

In order to analyse the implementation environment thoroughly, in subsequent order a force field analysis, stakeholder analysis, and leadership style analysis are conducted.

5.1.1 Force Field Analysis

A number of forces will be driving or restraining the projects development. They are caused by factors or are influencers that are often hard to control. By identifying them in a force field analysis especially the restraining forces can be handled before they can influence the project in to large of a scale. The driving and restraining forces are shown in figure 11.

![Figure 11: Force field](image)

**Driving forces** – Efficiency is the first driving force. By implementing the SCPC concept and following the design the efficiency of especially material managers can
improve a lot. If the workforce and management recognize this potential efficiency can be a great driver as Hilti has a strong lean culture that constantly searches for better efficiency. Closely related to efficiency is quality. It refers to the quality of the information, which will be far more accurate, but also to performance indicators such as product availability. As both information and availability are often frustrating the KPIs, which can be a big driver as well. Inventory levels are expected to decline since the integrated planning concept ensures less nervousness and higher accuracy in the entire supply chain. This eventually will lead to higher customer satisfaction. And since the company vision is aimed towards the customer this force can influence the workforce in all layers of the organization. It also has the potential to win commitment from the workforce since it makes the goal of the project more tangible for the workforce. Ultimately the already high commitment of the highest management of both Global Logistics and Global Manufacturing and the support of the IT department can be seen as a great driving force for the future implementation plan.

**Restraining forces** - Costs are almost always a restraining force in change management. Although the project has high commitment there are many initiatives at Hilti that require funding and financial gain is often an important decision tool. For the SCPC concept it is hard to give accurate number of financial gain since the implementation plan will indirectly influence a lot of factors. If the financial gain cannot be made clear the costs of the project might be a serious threat. Also the company culture can be dangerous, since the culture exists of a lot of nationalities and local cultures, which are not all in line with the headquarters company culture. Furthermore, the long time span of the project can really restrain the workforce from committing to the project. This force is mitigated partly by the sub-projects in the implementation plan. But real results will be hard to show in the first years since the SCOP team has be build up gradually. This brings us to the last restraining force, competence. Momentarily Hilti does not have the right competence in-house to form the SCOP team without risking to loose vital knowledge in other area’s. Therefore new and highly ambitious employees have to be hired which can be difficult in the current market. Highly educated supply chain specialists are scarce and it might be hard to find a team of these people in a short amount of time.

**5.1.2 Stakeholder Analysis**

First, the main stakeholders of the change effort were identified. Afterwards the other stakeholders are described. An overview of the stakeholders with their expected attitude towards the change plan is shown in table 2.
Table 2: Stakeholder analysis for the design of implementation

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Predisposition to Change:</th>
<th>Commitment</th>
<th>Aware</th>
<th>Interested</th>
<th>Want change</th>
<th>Desire action</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL senior</td>
<td>Innovator</td>
<td>Committed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>MM senior</td>
<td>Early adaptor</td>
<td>Committed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>WM senior</td>
<td>Early adaptor</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TM senior</td>
<td>Early adaptor</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>GM senior</td>
<td>Early adaptor</td>
<td>Committed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sales/Marketing senior</td>
<td>Early majority</td>
<td>Supportive</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>MM middle</td>
<td>Early adaptor</td>
<td>Committed/Supportive</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>WM middle</td>
<td>Early adaptor</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TM middle</td>
<td>Early adaptor</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>MM operations</td>
<td>Early majority</td>
<td>Committed/Supportive</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>WM operations</td>
<td>Early majority</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TM operations</td>
<td>Early majority</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TU Operations</td>
<td>Early majority</td>
<td>Supportive</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

The formal decision maker that can authorize the change is the Head of GL (here, GL senior management). This stakeholder is the initiator of the HIPP project and sees a lot of added value for Hilti with the use of SCI by changing the landscape of SCP. This positive attitude is driven by the efficiency increase; transparency; and removal of the silos in decision making that are foreseen by the senior management as a result of the project. With the clearly defined tactical level and SC-S&OP, more decisions will be the responsibility of middle management, affecting in Hilti also the responsibilities of senior management as they have a multi-entity structure in their organization.

Together with the senior management of GL, the divisions WM, TM and MM (under the responsibility of GL) will be influenced in a great extent. The senior management of WM, TM and MM is therefore also a stakeholder. Senior management of MM is involved from the beginning of the project and have shown great support to the project as well. The driving factor for this was more trust and transparency in the supply chain, leading to a more reliable product flow. Senior management of WM and TM have not been included so far, and might have a slightly resistant attitude towards the change. The combination of these senior managements implies the involvement of the senior management of the logistic regions and HAG (and might in some cases even be one person). As a supplement to this, the senior management of the sales/marketing regions is a stakeholder for implementation of the decision
power on the sales plans. These are expected to have a positive attitude towards the project as they will gain decision power on the latest estimate of the sales plan and also will get a (expected) more reliable lead time to the customer. Finally, senior management of GM has to be involved as a lot of responsibilities will be taken away from their department. Their attitude is leaning towards the positive despite the loss of responsibility, because of the gain in more stable production plans. Also, their concerns are mitigated by the stay of the PUC responsibility.

As mentioned, in the new hierarchical structure existing decisions and responsibilities will be shifted towards middle management. These stakeholders have been involved in the HIPP project from the start and all have shown a great attitude towards the change as it is believed to set clearer communications lines and responsibilities. For the GM side, more trust is needed of the numbers coming from the markets whereas for the markets, more reliability throughout the chain for the lead time to the customer is important.

In addition the operational force of GL MM, logistic regions MM, HAG MM, plant MM as well as all the WM and TM departments are stakeholders. With the implementation of the SCOP function a central team will be created, taking over responsibilities from the local MM teams. The negative attitude towards this change might become visible in these stakeholders, as there is a possibility that a lot of their jobs might become redundant. Especially, as the central team will need employees with high education and SCP experience. For the employees that will remain, a shift of responsibilities and the formation of tactical decisions might require adaptations to the WOW. This is known to be a human factor that can bring negative attitude as this often gets more attention than potential benefits of the new WOW. For successful implementation of the developed concept the shift in decision making and responsibilities has to be accepted, and full cooperation is required. Finally the operational force in the warehouses, in transportation and on the plants’ shop floors will have to adapt to getting input from a different party, the central team. This is not seen as bringing a negative attitude towards the change but the change has to be communicated in a proper way.

5.1.3 Leadership Style and Change Leaders
Since full implementation of the SCPC concept can take up to 8-10 years, leadership is going to be very important. Preferably leaders will be part of the change management as long as possible and there will be limited to no changes in high positions, and particularly among change leaders a core group of forerunners is preferred.

Especially for these forerunners, the leadership style will be important. Using the model of Vroom-Yetton-Jago a style has been determined that fits the
implementation plan best. The underlying assumption of the Vroom-Yetton-Jago decision model is that no single leadership style or decision-making process fits all situations. Analysing the situation and evaluating the problem based on time, team buy-in, and decision quality can help make a conclusion about which style fits the situation best. The model defines a very logical approach for selecting a leadership style to adopt and is useful for managers and leaders who are trying to balance the benefits of participative management with the need to make decisions effectively.

Since we are dealing with a complete chain and thus with different structures, visions and cultures, the decisions model is based upon a dynamic environment. The model uses seven structured questions that all direct to a certain leadership style to adapt. The ‘team’ consist of all Hilti material managers and the ‘leader’ consists of the Hilti managers present in the steering board. Appendix F shows the clarification of the questions. Figure 12 shows the model for Hilti.

As the model above shows the consultative type of leadership will fit the change best. According to the model the C2 type of leadership means; “Leader shares problem to relevant followers as a group and seeks their ideas and suggestions and makes decision alone. Here followers meet each other, and through discussions they understand other alternatives. But the leader’s decision may or may not reflect his followers’ influence. So, here followers’ involvement is at the level of helping as a group in decision-making.” This means decisions are made by the steering board, but not without consulting the material management operational levels that will be affected. Part of this consultation has already taken place as part of the As-Is analysis.
of the Master Thesis but during the change many more decisions will have to be taken were further consultation is advised according the Vroom-Yetton-Jago model.

**Change Leaders** – From the stakeholder analysis we can subtract the main change leaders or change agents. As mentioned before they stay in this role as long as possible to ensure continuity and transparency during the implementation plan. They are the faces of the implementation plan and will have to be able to answer all questions regarding the project. They will be the internal ambassadors and will make sure the project holds its high focus and commitment during the implementation. In the responsibility chart we further elaborate on the specific tasks of the change agent.

**5.2 Action Planning of Implementation**

The proposed change style of the implementation is primarily incremental, rather than radical. The changes should not be implemented at once, but as sequential sub-changes to gradually move from the current state to the desired state. This approach will most likely experience the least resistance and has the lowest risk of failure. Most of the changes imply adjustments or repositioning of existing functions and will not require a redesign from scratch. However, the SCOP function can only function if it is implemented as a whole, which makes incremental change difficult and will require a more radical approach.

**5.2.1 Project Plan Phase Planning**

In order to develop the project plan, the implementation of the Hilti SCPC concept is structured into four phases represented in Figure 13. As can be seen in Table 3 all of these phases exist of separate projects each with a milestone that has to be achieved before the next phase can start. Some phases entail the execution of multiple projects simultaneously, as can be seen in the Gantt chart (Figure 14).

*Figure 13: Phased implementation of the Hilti SCPC concept*
<table>
<thead>
<tr>
<th>Phase</th>
<th>Project</th>
<th>Content of the Project</th>
<th>Milestone</th>
</tr>
</thead>
</table>
| 1     | (Workflow) Calendar Development | • Alignment of workflow timing  
• Suggestion timing S&OP  
• Snapshots taken at certain times | A calendar aligning the WOW throughout the entire Hilti SC for all operational and tactical decisions |
| 2     | SCS Team | • Defined tasks (releasing material and resources)  
• Tool kit development  
• Defining supply chain tasks (procurement/production/distribution) | A SCST responsible for all operational decision functions for procurement, production and distribution |
| 3a    | SCOP Algorithm | • Algorithm development  
• System update (algorithm)  
• Cooperate with SC Aggregation & Disaggregation project | An algorithm taking the SCOP decision with all needed inputs, providing outputs for all controlled functions of the |
| 3b    | Supply Chain Aggregation & Dis-Aggregation | • Analyse all parts of supply chain for levels of aggregation  
• Optimal “one number” design with translations into different parts of supply chain  
• Cooperate with SCOP Algorithm project | “One number” with its belonging translation in aggregation/disaggregation |
| 4a    | SCOP WOW Update | • System update (roles)  
• SCOP team tasks update  
• Replace toolkit by system transactions  
• Cooperate with S&OP project for receiving “one number” | WOW workflow with detailed description of processes |
| 4b    | S&OP | • Design S&OP process  
• Define roles  
• Implement S&OP process  
• Develop toolkit or system support  
• Cooperate with SCOP WOW Update project | Workflow based on the calendar; responsibilities for tactical decision functions added to SCST and specified roles for the other stakeholders |
The phases described in the table above will all be reflected on before the start of the following project. This will be complemented with the measuring and evaluation of the implementation at the completion of all phases. Based on this a reflection will take place and adaptations or further projects will be created to ensure smooth working with the Hilti SCPC concept.

![Gantt Chart of implementation](image)

**Figure 14: Gantt Chart of implementation**

5.2.2 Responsibility Chart
The action plan requires a clear division of responsibilities, which is shown in table 4. In each department specific people have to be selected and assigned to the responsibility that is reflected in this chart. Besides these people, the earlier described change leaders will have an involvement during each step of the action plan. Every project will have a project leader who will have main responsibility for the progress, milestones and deliverables of the sub-project. Depending on the project this will most likely be a GL employee.
Coding:
R = Responsible (not necessary authority)
A = Approval (right to veto)
S = Support (put resources toward)
I = Inform (to be consulted before action)

Table 4: Responsibility chart of action plan

<table>
<thead>
<tr>
<th>Change action</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GL</td>
</tr>
<tr>
<td>(Workflow) Calendar Development</td>
<td>S/I</td>
</tr>
<tr>
<td>SCS Team</td>
<td>S/I</td>
</tr>
<tr>
<td>SCOP Algorithm</td>
<td>S/I</td>
</tr>
<tr>
<td>Supply Chain Aggregation &amp; Disaggregation</td>
<td>S/I</td>
</tr>
<tr>
<td>SCOP WOW Update</td>
<td>S/I</td>
</tr>
<tr>
<td>S&amp;OP</td>
<td>S/I</td>
</tr>
</tbody>
</table>

5.2.3 Communication Plan

Good communication is key to keep commitment and support from the environment. The head of Global Logistics currently gives an update of the latest developments via a video message. Incorporating the latest news regarding the implementation in this video message would be a good way to keep employees involved even if they are not directly influenced. Next to this video message, a news update via mail or on message boards in the canteen and entrance hall could keep awareness up to a healthy level. It will prevent that actual changes will come as a surprise and gives employees the idea they are part of the change. Table 5 shows specific recommended communication plans for all phases. The video messages and updates are not placed in the table since they should iterate every month and give a relevant update if applicable.
### Table 5: Communication plan

<table>
<thead>
<tr>
<th>Phase</th>
<th>Communication</th>
<th>Type</th>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIPP</td>
<td>Master Thesis (3x)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HIPP Communication Package (As-IS, GAP, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 1</td>
<td>Calendar training</td>
<td>Presentation</td>
<td>Project team</td>
<td>Logistics employees</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>Handbook</td>
<td>Project team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calendar framework</td>
<td>Milestone</td>
<td>Project team</td>
<td>Logistics employees</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Introduction of team</td>
<td>Meeting/newsletter</td>
<td>SCOP team</td>
<td>Colleagues of SCOP team</td>
</tr>
<tr>
<td></td>
<td>Official start of team</td>
<td>Reception</td>
<td>SCOP team</td>
<td>Logistics employees</td>
</tr>
<tr>
<td>Phase 3a</td>
<td>Algorithm requirements</td>
<td>Documentation</td>
<td>Project team</td>
<td>IT department</td>
</tr>
<tr>
<td>Phase 3b</td>
<td>Requirements GM</td>
<td>Questionnaire</td>
<td>All Plants</td>
<td>Project team</td>
</tr>
<tr>
<td></td>
<td>Requirement regions</td>
<td>Questionnaire</td>
<td>All regions</td>
<td>Project team</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>Handbook</td>
<td>Project team</td>
<td></td>
</tr>
<tr>
<td>Phase 4a</td>
<td>Documentation</td>
<td>Handbook</td>
<td>SCOP team</td>
<td>Logistics employees</td>
</tr>
<tr>
<td>Phase 4b</td>
<td>Documentation</td>
<td>Handbook</td>
<td>Project team</td>
<td>Logistics employees</td>
</tr>
</tbody>
</table>
5.2.3 Implications for HNA
To follow the phased implementation plan provided in Section 5.2.1, at HNA the MM and Marketing functions need to take a number of actions. The timing of these actions should be in line with the Gannt Chart in figure 14, to support the global implementation of the concepts.

First of all the “cookbook” at HNA describing the demand planning process needs to be adjusted. A deadline should be part of this “cookbook”, after which no more adjustments are possible in the forecast. This should be timed in such a way that it is in line with the procurement, production, and sales planning activities depending on it.

Second, to develop a mid-term forecasting and sales planning function at HNA, an aggregation level for these functions need to be determined. As the right aggregation level is crucial for the forecast accuracy and stability, a project should be started at HNA to determine this level. If this is combined with a disaggregation rule, the mid-term forecasts can be translated into short-term forecasts, making forecasting for each item/location combination redundant. When this level is determined, a project can be started at HNA to develop the mid-term forecasting and sales planning function as described in the conceptual model. To get full support from the MM and Marketing team the communication plan, shown in table 5, can be followed and additional training can be provided.

Third, when the SCS team takes over the warehouse order release decision, HNA MM should transfer this responsibility in phases towards the SCS team. For full commitment and support of the MM team it is important to clearly communicate the benefits of this responsibility-shift towards the team.
6. Conclusions and Recommendations
This master thesis studied how the planning and control of an internal global dispersed supply chain can be integrated. In a case study at Hilti, these findings were applied to develop a solution for integration of the internal Hilti supply chain. In this chapter the conclusions and recommendations for further research based on our findings will be outlined. In Section 6.1 the research questions will be answered, followed by the concluding implications for HNA in Section 6.2. Finally, Sections 6.3 concludes with further recommendations.

6.1 Answering the Research Questions
RQ1: How can the supply chain planning and control of an integrated supply chain best be organized internally?

1.1: What options and requirements do exist?

Hierarchical planning can coordinate planning functions such that the right degree of integration can be achieved. Both cross-functional and cross-level alignments play a crucial role.

Cross-functional alignment:
Tactical - *In order to control the decisions on the tactical level, a parameter setting function can coordinate centrally the safety stock, leadtime, and workload parameters.* The distribution and sales decisions are merged into a preliminary delivery plan and the procurement and production decisions are merged into a preliminary production plan. The *SC-S&OP decision* aligns the two plans and agrees to a final number for all parts of the supply chain on a mid-term horizon.

Operational - The operational/short-term decision functions are divided into central control (SCOP) and production unit control (PUC). The SCOP function contains decisions of both releasing materials and resources in the supply chain. PUC implies that operational decisions are taken locally to optimize a process, considering the central steering from SCOP and compliance with the tactical parameters.

Cross-level alignment: This can be achieved when the upper planning level coordinates the lower planning level and feedback from the lower planning level provides instructions to the upper level. Aggregation and disaggregation in planning is required for cross-level coordination.

1.2: What are main challenges?
   - Alignment of the objectives of the different function.
   - Transformation of all plans into “one number” across the different functions to support efficient information sharing.
• A clear definition and distribution of responsibilities and accountabilities.
• Engagement and education of stakeholders along the internal supply chain.
• Maintaining a medium to long-term focus, besides all the operational decision making.
• Adaptation of the company to the local cultures of functions in the supply chain.

1.3: To what extend is the design of the SCPC system contingent on the firm’s environment (type of industry, market turbulence)?

The importance of planning and control functions varies with respect to the functional and structural attributes of a supply chain. These attributes depend on the firm’s environment such as the type of industry and market characteristics.

RQ2: Given Hilti’s situation and current planning and control landscape what is the best solution for internal supply chain integration?

2.1: What way can the internal supply chain planning and control system of Hilti be integrated?

Various control parameters for the process have to be established centrally by the tactical parameter setting function. The mid-term forecasting, sales planning, and distribution planning functions are included in the system in order to come to the preliminary delivery plan. In addition, an aggregated MRP, a capacity planning, a personnel planning, and an aggregate production planning function are included in the system to come to a preliminary production plan. A preliminary delivery plan and production plan with a mid-term horizon form preparations for the SC-S&OP decision. The SC-S&OP decision is made during a quarterly held meeting, resulting in determination of “one number” for all tactical decisions along the supply chain. The “one number” is input for the central SCOP decision on the operational level. The output of the SCOP function is a weekly plan for procurement, production and distribution where the local PUs are free to optimize in the boundaries of the set lead times. Besides the SCOP function, a short-term forecasting, short-term sales planning, and order acceptance are included on the operation level. In the SCPC system for Hilti, the determination of planning frequency, aggregation levels, targets, and engagement rules form extra cross-level alignment of decision functions.
2.2: What way can the new supply chain planning and control design be implemented at Hilti?

The change and implementation plan consists of five different phases. All of these phases exist of separate projects each with a milestone that has to be achieved before the next phase can start. The first phase is the calendar development, aligning the way of work throughout the entire Hilti supply chain for all operational and tactical decisions. The next phase is the implementation of a SCS Team responsible for all operational decision functions for procurement, production and distribution. Then in parallel a SCOP algorithm and supply chain aggregation/disaggregation method will be created. Finally, in parallel the SCOP way of work and the S&OP process will be designed and implemented.

6.2 Concluding Implications for HNA
Integrating the decision functions at HNA in the proposed supply chain wide SCPC design requires a number of changes in this specific region. The effects of these changes will be visible in the form of more transparency and alignment in the material flow, which eventually results in better lead time reliability to the customer and lower inventories in the HNA region.

A key implication is that distribution and sales requirements at HNA will be considered in a mid-term planning that is balanced with the supply possibilities. This balancing will take place in a SC-S&OP meeting, in which HNA will provide input about the distribution and sales requirements in their distribution network. Moreover, a mid-term sales planning and forecasting function will be required, to provide the necessary input for the SC-S&OP decision. For this mid-term planning, the development of an aggregation/disaggregation method is proposed. The integration of decision functions also requires that short-term/mid-term sales planning and forecasting follow a predefined timing according to a calendar. In addition, the warehouse replenishment will become the responsibility of the central Supply Chain Specialist Team placed in the SCOP function. The operational material flow along the entire supply chain will be controlled by this central function.

6.3 Recommendations for Further Research
This research has proposed conceptual steps towards a more integrated planning and control at Hilti. As the project’s scope was limited and the results are mainly conceptual, several recommendations can be made for further research directions:

• Investigation of operational improvement of the PU’s. In order to get understanding of the problem and planning structure the production facilities were analysed on a detailed level. However, in the eventual concept the
operational excellence of the PU’s is not treated. The proposed concepts should greatly improve the capabilities of the manufacturing sites and once the SCOP team is functional, operational excellence at the PU’s could be an interesting field of research for further improvement;

- Further investigation of the organization of Sales to cover the complete range of Hilti’s functional decisions. The communication lines and dependencies of MM with sales and marketing were included in this research. For further research more emphasis should be put on the influence of sales/marketing and their way of work for input of integrated decisions;
- Quantification of the effects of the proposed concepts by means of a pilot. By using a pilot study, quick and tangible results can be retrieved in the current situation. These can be used to make adaptations when necessary and show the potential of the solution.
- At HNA MM: starting a pilot to forecast on an aggregated level. In this pilot multiple different aggregation groups should be tested to see which one performs best. The quantitative results of this pilot can also be used in other market organisations to improve their demand planning process.

Next to the applicability for Hilti, this research was aimed at providing added value to the field of research. A theoretical framework is provided, consisting of leading paradigms in the field of supply chain management and models that might be applied universal. This leads to the following recommendations for further research:

- The general applicability of the theoretical framework. Although this point was mentioned in chapter 3, more research could contribute to the validation of the framework at different companies. This would provide more case studies that could prove the generalizability of these concepts. These case studies could be set up at other industries or end-to-end supply chains that are not controlled internally;
- The mathematical implications of the models in the framework. Further research on the contents of the proposed framework will provide the field of research more insights in its applicability to other supply chains.
Bibliography


Appendix A: AS-IS Planning and Control Landscape HNA

Part of the research objective is to identify the current planning processes at Hilti and their relationships, including cross-functional processes that influence the planning. The identification is performed during the As-Is analysis of the planning processes; the findings of the As-Is analysis at market region Hilti North America (HNA) will be described in this report. The analysis is based on process documentation and semi-structured interviews. In table 1.1 an overview of the decision functions extracted from a meta-analysis of literature is depicted. This table has served as reference model to cover all decision functions performed at Hilti during the interviews.

Table A. 1: Extracted planning functions

<table>
<thead>
<tr>
<th>Planning function</th>
<th>Operational</th>
<th>Tactical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HAG</td>
<td>Market region</td>
</tr>
<tr>
<td>Demand planning</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Order release</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Distribution planning</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Inventory management</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Inventory positioning</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Production planning</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Production scheduling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity planning</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Procurement planning</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

The logistical planning processes at HNA are primarily aimed to achieve high customer satisfaction by fulfillment of customer orders within the delivery lead time, under minimal inventory and transportation costs. Because of the long lead times from supplier/plant to the customer, customer demand needs to be fulfilled from stock. Planning is required to have the right product in stock, in the right quantity, at the right location, and at the right moment in time. Planning at HNA includes planning of demand, to determine the amount of goods that need to be shipped at lead time for replenishment of the central warehouses.

The demand plans are shared with plants and HAG, such that they can plan the required capacity and component materials for production. Based on the demand plan the release of purchase orders needs to be planned to receive goods from suppliers/plants/warehouses outside the HNA network on time. It also includes safety stock planning to achieve the right service level with minimal stock levels. Furthermore, deployment needs to be planned based on safety stocks and actual stock levels to replenish downstream stock locations from upstream warehouses in
order to achieve high product availability. Figure A.1 shows the high level planning processes at HNA in a business process model.

Central information systems are used along Hilti’s supply chain in order to support all planning processes. There are three main systems that are also reflected in figure A.1.: the Business Intelligence (BI) system, the SAP APO system and the SAP R/3 system. The BI system extracts the data from both the SAP R/3 and SAP APO system. The APO and R/3 systems transfer data real life. The APO system is the SAP planning system, whereas the R/3 system is used for actual execution.

Figure A. 1: High level planning processes HNA

Decision functions

The decision functions that have been identified during the interviews and their relations are illustrated in figure 4.1. This structure is chosen to capture all planning
tasks performed at HNA as illustrated in figure A.2. This structure is also chosen to make comparison possible with the framework to identify the current gaps at HNA. The definition, importance, and relation of the decision functions will be described in detail per function. Some decision functions are also represented in a process model to add more clarity to the description of the situation.

**Figure A. 2: Decision functions HNA**

**Demand planning:** is defined here as the forecast that is made by the SAP/APO system and the human interaction leading to different values. The main focus of the demand planning function is to forecast how many items need to be purchased for the replenishment of HNA’s distribution network and when these purchase orders need to be released to minimize the stock levels at the forecasting locations. The demand planning process is the responsibility of MM and follows a monthly cycle at HNA; as illustrated in figure A.3. In this cycle the history adjustment, forecast adjustment, forecast accuracy measurement, and suspect forecast adjustment tasks are manual and structured in different weeks. Another representation of the demand planning process at HNA is shown in figure A.4.

**Figure A. 3: Demand planning process HNA**
History adjustment: In the first week of the cycle, the history is reviewed and if required adjusted by the MM in the SAP/APO system. The purpose of this review is to find and adjust extreme high and low values in the sales history that are potentially non-recurring.

Statistical forecasting: During the first weekend in the cycle the statistical forecast is calculated in the SAP/APO system. The rolling planning horizon of this forecast is eighteen months, with time buckets of one month. There are various forecast models available in this system that can be selected depending on the demand pattern.

Forecast adjustment: After the statistical forecast is calculated by the APO system the MM reviews the forecast in the second week. The purpose of this review is to find forecasts that are too high or low and correct them. The MM can correct the forecast by changing the forecast model, entering a manual value that overrides the statistical forecast and increasing the forecast for events and promotions.

Forecast accuracy measurement: After the forecast is reviewed and possibly adjusted, the active forecast in APO will be stored in the BI system for accuracy measurement. The accuracy is measured during the weekend after forecast review week. For this calculation the two months ahead forecast is compared with the actual demand.

Suspect forecast review: After the active forecasts have been stored for accuracy measurement, a new check for deviating forecasts is performed by the MM team leader. This is a management review of the forecast. The purpose of this process is to filter out the bad forecasts that are missed during the forecast review week.

Sales planning: at HNA is primarily focused on aligning the forecast with the sales targets. The reason for this is that the forecast made by MM drives the supply decisions for items that need to be sold by marketing/sales. If the forecast for the supply of items is not aligned with the sales numbers expected by marketing/sales, then it is likely that either the sales targets will not be achieved or items will become obsolete. The sales plan at HNA is made by marketing/sales and is a sales target in dollars for each item based on the expected sales during the year. This sales value is split into monthly values and communicated to MM. MM aligns the sales plan with the forecast and incorporates the sales plan into the forecast. This process is called Sales Forecast Integration (SFI).
Figure A. 4: Model of demand planning process at HNA

*SFI:* There are two different types of cross functional meetings on a monthly basis to align the sales plan with other decision functions. One meeting is called SFI and the other one S&OP. The SFI is an internal HNA meeting where the PMs and MMs align the sales plan with the forecast. The main purpose of this meeting is for the MM to acquire market/sales information and for the PM to acquire supply information.

*“S&OP” initiative:* The other type of meeting, which HNA calls a “Sales and Operations Planning” (S&OP) meeting, is a new initiative that is still in its test phase. Only the ET&A BA is organizing these monthly meetings. The meeting is organized for managers in the plant, the BU and HNA. The issues that are on the agenda of this meeting are on an operational level to solve short to mid-term problems in the supply, replenishment and distribution on item level. One key objective is to improve communication and alignment to HNAs business requirements. Another key objective is to build trust that the HNA future requirements are well-founded. Finally, a key objective of the “S&OP” meeting is to achieve high product availability.

**Distribution Planning:** is defined here as the planning tasks concerned with transportation, warehousing, stock levels, and materials handling to support distribution (APICS, 2013). Distribution planning consists of inventory management and capacity planning. The forecast is used as input for the distribution planning to determine safety stocks at NDCs and DCs. The forecast accuracy is an important variable to determine the safety stock level. The main outputs of the distribution planning functions are the decisions: which replenishment strategy to use; which safety stock method and level to use; and where to position stock. These decisions
are then input for the MRP, the material ordering, and the warehouse replenishment decision functions. These functions will be described in the next sections.

Safety stock method: In general NDCs are replenished based on forecasted demand and a statistically calculated safety stock. The target of HNA is to use safety stock methods that calculate an optimal value for each item-location combination.

Safety stock adjustment: The Purpose of this process is to review SKU’s by exception, that potentially have an invalid safety stock level and to take corrective actions if needed. This function is represented in figure A.5.

Stock positioning: This is the assignment of stock to different warehouses. Main driver for the stock positioning decision is the KPI Customer Order Perfect (COP). This KPI measures if a customer order is completely fulfilled by the primarily located warehouse. This enables a short customer lead time, high product availability and is a method to manage logistic costs. To achieve a high COP most items (except sporadic items) are stocked at all NDCs and DCs.

Material Requirements Planning (MRP): calculates time-phased plans of secondary demands for components and parts based on a time series of primary demands (usually finished products). The material requirements are calculated by the SAP/APO system for all stock points in Hilti’s supply chain. In the HNA distribution network the material requirements are calculated for the replenishment of NDCs, DCs, HCs, and Sales Vans. The output of the MRP is the net requirements quantity. At HNA this is the input for the warehouse replenishment and material ordering decision function.
**Warehouse replenishment:** is the decision function that releases the orders for replenishment of the NDCs, DCs, HCs and Sales Vans. For the replenishment from Hilti plants, and warehouses outside the HNA distribution network this is a purchase order release. Inside the network warehouse replenishment is a deployment order release.

Input for the warehouse replenishment decision is the net requirements quantity, which is the output of the MRP decision function. Based on the net requirements the purchase order release decision can be made manually by the HNA MM, manually by the plant MM, or automatically by the SAP/R3 system. For the deployment order release decision the SAP/APO system makes a deployment calculation with the net requirements as input. This deployment calculation is subsequently input for the automatic deployment order release.

**Purchase order release:** There are three different procedures for purchase order releases: manual by HNA MM, Manual by plant MM and automatic. After an order has been released a reservation order will be created automatically in the HAG R/3 system along with a customer order and production order, if it is a MTO item. The HAG MM can “hold” reservations in a “waiting room” in SAP on an exception basis. After the goods issue a production order, delivery and invoice is created. The order process ends with the goods receipt in the NDC at HNA. A model of the purchase order release decision is shown in figure A.6.

![Diagram of the purchase order release process at HNA](image-url)
**Purchase order management:** When APO detects NDC replenishment issues, the system provides an alert. The purpose of these alerts is to inform MM of situations where action is needed to ensure that product availability for customers is maximized and inventory and logistics expenses are minimized.

**Deployment order release:** After the APO net requirements calculation APO automatically calculates and releases the deployment; this is a daily process. Not all stock in the NDCs and DCs is available for deployment. A share of the stock is needed to fulfill customer demand. At the NDC the average weekly customer demand of an item is calculated and deducted from the available stock for deployment.

**Limited stock allocation:** In case of limited stock the APO system deploys orders according to a fair share method. According to this method the locations are deployed based on their share of total demand. An intervention is required to deploy stock that is available for deployment to locations that are scheduled for deployment in the current day.

**Material ordering:** This process is here defined as the procurement of materials and products from external suppliers. In general this is the responsibility of the HAG BUs and not part of HNA’s tasks. One exception in this procedure is the procurement of “national items”. These items are directly ordered by HNA from suppliers via a purchase order, bypassing HAG and the MO replenishment process (material reservation).

**Order acceptance:** the “Available To Promise” (ATP) decision function checks available items in the supply chain in order to give a customer a promised delivery lead time. If the warehouse replenishment function releases orders for the distribution of items, this becomes input for the ATP function to determine available stock. The ATP is calculated based on this availability information. The accepted orders form input for the MRP function to determine the new net requirements.

For incoming customer orders there is an ATP check that checks the availability of the item at the primary stocking location. If the item is not available at that location, the lead time of delivery from the upstream location in the HNA network is included in the ATP calculation. If the product is not available in the HNA network another ATP check needs to be run to check the future availability based on planned replenishment of the NDC.
Appendix B: Integrated Planning Gaps HNA

This section elaborates on the planning gaps identified at HNA. In accordance to the supply chain wide planning gaps, a distinction here can be made between the hierarchical gaps and the cross-functional gaps.

3.2.2a Hierarchical Planning

Structure – At HNA the missing division between the tactical and operational level implies that there is no distinction between mid-term and short-term forecasting. In the framework the forecasting is structured in such a way that there is a mid-term forecast on an aggregated level aimed at tactical decision making and a short-term disaggregated forecast aimed at operational decision making. In the current situation there is one forecast in APO created on the item/location level with a planning horizon of 18 months. Due to the lack of aggregation, this forecast is not accurate or stable enough on the mid-term to base tactical decisions on. Furthermore, as described in the literature review of Mertens (2013) can aggregation reduce the complexity of forecasting. In the present state the forecasting on item/location level leads to inefficiency and complexity.

Decision making – The inconsistent or missing tactical decision making is manifested at HNA in the distribution planning and tactical parameter setting. The tactical distribution planning decisions are made on the operational level or missing. E.g. the decisions where to position stock and how much warehouse and transport capacity is required are missing on the mid-term. There is only an operational short-term stock positioning decision on item level based on a decision rule that takes the monthly sales quantity into account. The warehouse and transport capacity decisions are made ad hoc on the operational level. As distribution decisions and the resulting constraints have consequences for the mid-term SC planning, these decisions should also be made on the tactical level with a mid-term horizon.

The tactical parameter setting is missing in the present situation. In HNA safety stocks are set by the HNA MM, but changes in decoupling point, lead times and lot sizes for replenishment from outside HNAs distribution network is the result of decisions made by plant MM, HAG MM or Global Logistics. These decisions are mutually dependant, but are made independently from each other, which results in sub-optimal decisions.

Communication –In the framework, communication between the two levels takes place by aggregation and disaggregation in the MRP. As a logical consequence of the missing tactical level, this communication is not present in the current situation. The MRP for HNA is created on item/location level. There is no aggregated MRP for tactical decision making that is translated into a disaggregated MRP, on which the
operational decisions can be made. Also the feedback loop from the operational level to the tactical level is missing. Without communication between the tactical and operational level the decision on these levels will be poor aligned, since these decisions will be based on different information.

**IT support** – An IT system is missing that supports tactical decision making in order to make distribution planning and tactical parameter setting possible. Currently the system is only supporting operational decision making, without making a distinction between mid-term and short-term forecasting and without supporting different levels of aggregation in MRP.

### 3.2.2b Cross-functional Planning

**Structure** – The vertical structure in the framework differs from the situation in HNA in that some decisions are made in a different sequence. At HNA the sales plan and forecast are made in parallel and aligned afterwards. This is subsequently input for the distribution planning decisions. In the framework the forecast is input for the distribution planning which is input for the sales plan. Another gap is that at HNA the warehouse replenishment decision is structured separately from the other operational decisions upstream and is not an integral part of the SCOP function.

**Decision making** – In the current situation Marketing creates a sales plan once a year, without including the MM forecast. There is alignment between the sales plan and the forecast, but this is mainly focused on the short-term and does not consider the tactical parameter setting or distribution planning. A preliminary delivery plan is missing at HNA that is based on mid-term forecasted demand, incorporates the mid-term distribution planning, and takes into account the future mid-term sales constraints. Without this preliminary delivery plan there is a lack of integration between the sales and distribution functions on the tactical level, which is a prerequisite for further integration with procurement and production by means of SC-S&OP.

The replenishment of warehouses in the HNA network is a decision that is currently made regionally by HNA MM. The release of resources and materials upstream in the supply chain are not considered in the warehouse replenishment decision. In the framework the central SCOP function would consider all operational planning required to steer the PUs along the supply chain at the same. The current decentralized approach leads to local optimization of the warehouse replenishment process at HNA. The net requirements on which the warehouse replenishment decision is based, is currently calculated daily. In the SCOP function this is a weekly calculation. The daily calculation and warehouse replenishment decision leads to nervousness, since it can result in unnecessary daily re-planning.
Communication – The decisions made at HNA are primarily communicated to upstream locations via the MRP. If a decision leads to a different net requirement, this will become visible at the procurement and production side in the MRP. To build trust that the MRP plan for HNA is well-founded and to receive information about supply issues, monthly meetings are organized with plant MM and HAG MM. The main difference with the SC-S&OP concept is that a preliminary delivery plan and production plan is missing that can be communicated during the meeting. The result is that the meeting is focused on short-term problem solving at item level, instead of tactical alignment on an aggregated level.

IT support – For incoming customer orders an ATP check exists that checks the availability of the item at the primary stocking location. If the product is not available in the HNA network another ATP check needs to be run to check the replenishment of the NDC. In the IT system there is not a single ATP check for all stock points along the supply chain.
Appendix C: Interview Questions

Interview Questions – Name Employee – Date
Can you give an introduction of the function Function Name?

Can you give provide your responsibilities as a Function Name?

- What are your monthly tasks?

Per task (Appendix)
1. Why is this task initiated and what is the purpose of the task?
2. When and where is the task performed?
3. With what system is the task performed?
4. Describe the activities (steps) in this task.
5. Who is participating in the task, activity?
6. What is the input (message, data, etc.) needed for the task, activity?
7. What are the conditions needed for the task, activity?
8. What are the linkages/dependencies of the task, activity?
9. What is the output (message, data, etc.) produced by the task, activity?
10. Which results (decision) does the task provide?

- What are your weekly tasks?

Per task (Appendix)
1. Why is this task initiated and what is the purpose of the task?
2. When and where is the task performed?
3. With what system is the task performed?
4. Describe the activities (steps) in this task.
5. Who is participating in the task, activity?
6. What is the input (message, data, etc.) needed for the task, activity?
7. What are the conditions needed for the task, activity?
8. What are the linkages/dependencies of the task, activity?
9. What is the output (message, data, etc.) produced by the task, activity?
10. Which results (decision) does the task provide?

- What are your daily tasks?
Per task (Appendix)
1. Why is this task initiated and what is the purpose of the task?
2. When and where is the task performed?
3. With what system is the task performed?
4. Describe the activities (steps) in this task.
5. Who is participating in the task, activity?
6. What is the input (message, data, etc.) needed for the task, activity?
7. What are the conditions needed for the task, activity?
8. What are the linkages/dependencies of the task, activity?
9. What is the output (message, data, etc.) produced by the task, activity?
10. Which results (decision) does the task provide?

- What are your event-based tasks?

Can you provide your accountabilities as a Function Name?
- What are the targets the Department Name department is measured on (KPIs)?

Can you provide your accountabilities as a Function Name?
- What are the targets the Department Name team is measured on (KPIs)?
• What are the targets the Function Name is personally measured on (KPIs)?
• Are you measured on all your responsibilities?

Can you mention suggestions to improve your contribution as a Function Name?
Appendix D: Responsibility Chart

Figure D.1: Responsibility chart
Appendix E: RAPID Model

Figure E. 1: RAPID model
### Appendix F: Vroom-Yetton-Yago

#### Table F. 1: Vroom-Yetton-Yago

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the quality of the decision important?</td>
<td>The first question concerns a quality requirement; it asks the leader whether a decision with a low or moderate quality is a complication. Since this is a very important decision which affects both the quality and efficiency of daily operations and with possibly large associated costs, the quality and reasoning behind this decision has to be of high quality. A lot of resources may be involved in making this decision and quality is key in the Hilti culture.</td>
</tr>
<tr>
<td>2. Is team commitment important to the decision?</td>
<td>This question deals with a commitment requirement. In a change project it is important that there is sufficient commitment from the workforce to implement the changes. In our case the steering board team consists of a company-wide delegation. Every single individual in this steering board is touched by the implementation plan and the team consists of their workforce. The commitment of the workforce is of high importance since there will be a lot of operational changes to their daily tasks.</td>
</tr>
<tr>
<td>3. Do you have enough info to make the decision on your own?</td>
<td>The third question answers to leadership information; do the leaders have enough information to change a company-wide platform? The steering board consists of all division of the company that are affected. They have good knowledge about what is happening and the missing knowledge has been provided by the HIPP project. Decision making can therefore be done by the steering board without further questioning.</td>
</tr>
<tr>
<td>4. Is the problem well-structured?</td>
<td>This question deals with the problem structure; is it well defined, clear, organized, time limited and so on. In our case the answer to this question not so important since the model is not guiding us past this question. However, we are dealing with a very clear problem, including a clear and straightforward solution. The Hilti SCPC concept is a custom made solution for the entire supply chain. Part of the implementation plan is further development of the concept but all within a clearly defined structure that can guide the rest of the implementation.</td>
</tr>
<tr>
<td>5. If you made the decision yourself, would the team support it?</td>
<td>Here the likelihood of team commitment is discussed; it does not deal with the actual decision but with the probability of support when deciding without consulting the team. Although the steering board has secured commitment from the higher management, team support is vital for the implementation plan. Hilti’s culture of continuous improvement has the downside of high change and sometimes failing projects. In the recent past a similar project has failed which will make the workforce resilient to support it out of the blue. The workforce has to be informed that representatives have input to the decision making.</td>
</tr>
<tr>
<td>6. Does the team share organizational goals?</td>
<td>The sixth question concerns the goal congruence of the team, do all members of the team share common values or do they have personal or departmental goals that frustrate organizational goals. Hilti is a highly competitive company, both the vision and company culture are aimed at improving processes, people and therewith ultimately improving customer satisfaction. KPIs are often not aligned and however the company’s vision is shared by all, the main drivers for the team are their personal goals which are sometimes frustrating the overall goals.</td>
</tr>
<tr>
<td>7. Is conflict amongst the team about the decision likely?</td>
<td>The last question deals with subordinate conflicts; what are the relationships within the management team. Overall Hilti has a hierarchical culture but through several meetings the higher, intermediate and lower management can communicate reasonably. The setup of the steering board tries to overcome any conflict but going from strong silo thinking to corporate thinking can bring conflict within the management team if they keep “protecting” their own workforce.</td>
</tr>
</tbody>
</table>
Appendix G: Business Process Model of current SCPC at Hilti

Figure G. 1: Business process model current planning and control at Hilti