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Automation of Supply Processes

A study at Ericsson AB

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Abstract

In the Information and Communication Technology (ICT) industry, the pressure to accelerate the deployment of 5G technology has created a new competitive environment for businesses. This technology not only enables lower latency, but also higher number of connected devices, higher amounts of shared data, and faster. The growing demand from customers is pressuring every stage of the supply chain to become more efficient. In this industry, achieving a short time-to-market is vital to stay ahead of competitors and position the company as a trend-setter in the eyes of customers. Therefore, it has become necessary to overall shorten lead times and deliver products in a faster way.

This study was performed in collaboration with Ericsson AB, more specifically in the Ericsson Outbound Supply EMEA. Recent escalations from customers have shown that Ericsson's ways of working to handle customer purchase orders are not being efficient. In many cases, it is taking longer to process the order than the lead times agreed on the contract with the customer. As a result, this study investigates how automation technologies can improve end-to-end order flows, how these can affect Ericsson as an organisation and its workforce, as well as which factors must be taken into consideration when implementing automation. In order to support the investigation, an analysis of the issues most frequently affecting hardware deliveries to customers was also conducted through the Spiderweb program. The latter is an internal improvement initiative of Ericsson Supply, focused on improving Ericsson's order handling flows for the Market Area Europe and Latin America.

The study was based on the following research questions: *How can automation technologies help to improve Supply's performance? How does automation impact the company as an organisation*, *its culture and workforce? How can the improvement methodology followed in the Spiderweb drive automation discoveries?* Qualitative data was primarily collected through meetings with Spiderweb program drivers and 11 interviews held with different stakeholders at Ericsson Supply.

Conclusively, this study indicates that the four critical factors that will require further developments for automation in Supply to become a reality are: its culture; the establishment of a data-driven organisation; the coordination of different processes and communication between dependent stakeholders; and the technical implementation of automation technology and other tools used locally. It is also concluded that the full potential of automation will only be realised if accompanied by a corresponding development of the workforce, and a clear communication of the strategy from top management. Lastly, the main recommendation to Supply regards the need to standardise order handling processes and simplify order flows, prior to any automation implementation in Supply.

Keywords: Supply Chain Management, Supply Chain 4.0, Digitalization of Logistics, Information sharing in Supply Chains, Business automation, Automation software, Back-end automation.

Sammanfattning

Inom informations- och kommunikationsteknologinäringen (IKT) har trycket för att påskynda implementeringen av 5G-teknik skapat en ny konkurrensmiljö för företagen. Denna teknik möjliggör inte bara lägre latens, utan också större antal anslutna enheter, större mängder delad data och snabbare. Den växande efterfrågan från kunderna pressar varje steg i leveranskedjan att bli effektivare. I denna bransch är det viktigt att uppnå en kort tid till marknaden för att ligga före konkurrenterna och positionera företaget som trendmässigt i kunders ögon. Därför har det blivit nödvändigt att övergripande förkorta ledtiderna och leverera produkter på ett snabbare sätt.

Denna studie utfördes i samarbete med Ericsson AB, mer specifikt i Ericsson Outbound Supply EMEA. Nya upptrappningar från kunder har visat att Ericssons sätt att arbeta för att hantera kundköporder inte är effektiva. I många fall tar det längre tid att behandla beställningen än de ledtider som avtalats med kunden. I denna studie undersöks hur automatiseringstekniker kan förbättra ordningsflödena från början till slut, hur dessa kan påverka Ericsson som organisation och dess arbetskraft, samt vilka faktorer som måste beaktas vid implementering av automatisering. För att stödja utredningen genomfördes också en analys av de problem som oftast påverkar hårdvaruleveranser till kunder genom Spiderweb-programmet. Det senare är ett internt förbättringsinitiativ från Ericsson Supply, fokuserat på att förbättra Ericssons orderhanteringsflöden för marknadsområdet Europa och Latinamerika.

Studien baserades på följande forskningsfrågor: Hur kan automatiseringsteknologier bidra till att förbättra Supply's prestanda? Hur påverkar automatisering företaget som organisation, dess kultur och arbetskraft? Hur kan förbättringsmetodiken följas i Spiderweb-enhetens automatiseringsupptäckter? Kvalitativ data samlades främst genom möten med Spiderweb-programdrivare och 11 intervjuer med olika intressenter på Ericsson Supply.

Sammanfattningsvis indikerar denna studie att de fyra kritiska faktorerna som kommer att kräva ytterligare utveckling för att automatisering i Supply ska bli verklighet är: dess kultur; inrättande av en datadriven organisation; samordning av olika processer och kommunikation mellan beroende intressenter; och teknisk implementering av automatiseringsteknologi och andra verktyg som används lokalt. Det dras också slutsatsen att automatiseringspotentialen fullt ut kommer att realiseras om den åtföljs av en motsvarande utveckling av arbetskraften och en tydlig kommunikation av strategin från toppledningen. Slutligen beaktar huvudrekommendationen till Supply behovet av att standardisera orderhanteringsprocesser och förenkla orderflöden innan automatiseringsimplementering i Supply startar.

Nyckelord: Supply Chain Management, Supply Chain 4.0, Digitalization of Logistics, Information sharing in Supply Chains, Business automation, Automation software, Back-end automation.

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Contents

Nomenclature

3PP – Third Party Providers
AI – Artificial Intelligence
ASP – Authorized Service Provider
BNEW – Business area Networks
CBE – Customer Business Execution (Ericsson team responsible for the finance-related tasks between the receival of a CPO and the release of internal sales orders).
CPO – Customer Purchase Order
EAB – Ericsson AB
EDI – Electronic Data Interchange. It is the electronically communication of commercial information between entities internal or external to a company.
EMEA – Europe, Middle East and Africa
ERP – Enterprise Resource Planning
ICT – Information and Communication Technology
IT – Information Technology
KPI – Key Performance Indicator
LC – Local Company
LSP – Logistics Service Provider
LT – Lead Time
MELA – Market area Europe and Latin America
OECD – Organisation for Economic Cooperation and Development
PO – Purchase Order
POD – Proof of Delivery
PSF – Product Sales Flow
QTC – Quote to Cash
RPA – Robotic Process Automation
SAP – designates the ERP and data management programs developed by the homonymous German software company.
SC – Supply Chain
SCRM – Supply Chain Risk Management
SIPP - Stock Item Product Portfolio
SO – Sales Order
S&OP – Sales and Operations Planning

1. Introduction

1.1 Background

Globalization and digitalization are currently the key drivers of global change. Globalization has decreased the relevance of physical distance as a barrier to global trade, offering opportunities for companies to simultaneously grow revenues and decrease costs, but also increased the risk in the development of supply chains. These risks include supply disruptions and delays, demand fluctuations, price fluctuations, and exchange-rate fluctuations. Therefore, a global supply chain must develop an appropriate flexibility to deal with these risks, as referred by Chopra and Meindl [1]. On the other hand, digitalization has profoundly altered the way people communicate and interact with their surroundings [2]. This has enabled communication inside and between organisations to become faster and more efficient, in a world permeated with digital technology. As referred to Yoo et al.: “the propagation of digital tools has allowed firms to build a platform not just of products but of digital capabilities throughout the organisation to support its different functions, for example, intricate information systems such as ERP systems” [3].

The combination of the two aforementioned key drivers has led to the fast proliferation of a concept extremely popular in every aspect of an industry, yet, not a novel concept by any means: *Industry 4.0*. The World Economic Forum (WEF) characterized the fourth industrial revolution by the convergence of breakthrough technologies that are transforming production processes and business models across different industries. Business leaders can no longer focus on the development of trends in their own sectors alone, but need to understand potential transformations and disruptions in the entire world of suppliers, customers and adjacent markets. Thus, related to the *Industry 4.0* appeared another concept: *Supply Chain 4.0*. [4]

Today’s markets are characterised by strong competition and a fast change of customers’ preferences that have forced organisations in current economies to center themselves on supply chains, i.e. operating as members of a supply chain, instead of individual enterprises, according to Baghalian et al. [5]. This has led to the disruption of entire industries and changed the way companies do business across all stages of the value chain: how they develop, market, produce, sell and deliver products and services to the end-customer [6]. The performance of a supply chain depends on the efforts of numerous connected and interdependent stakeholders, such as manufacturers, material suppliers, LSPs and technology providers, as pointed out by WEF [7]. Therefore, the existence of many stakeholders and decentralized tasks demands for a high level of visibility, integration and coordination of all entities, leading to a need for sharing accurate data among all tiers of the supply chain, to respond rapidly to customers’ demands.

With digitalization as the driver, the availability of real-time information has exploded in most supply chains, resulting in the advent of tools and software primarily focused on improving strategy and planning decisions. Significant opportunities still exist to design systems that enable: the automation of supply chain processes, such as order management tasks, and the generation of rapid insights based on real-time data to support supply chain staff, such as in transportation and warehousing. These will allow to make smarter and faster decisions that are revisited frequently [1].

WEF states that “the technologies generated by the Fourth Industrial Revolution – from big data analytics, the Internet of Things (IoT) and advanced robotics, to 3D printing, machine learning and artificial intelligence – can take supply chain visibility, coordination and performance to new levels” [7].

1.2 Scope

Ericsson Supply serves customers in 180 countries grouped in five different Market Areas: North America; Europe and Latin America; Middle East and Africa; North East Asia; and South East Asia, Oceania, and India. These Market Areas act as the interface between the company and all customers, working with the Customer Units – organisations responsible for developing and maintaining specific portfolios of products, solutions and services for specific customer accounts and according to their requirements. Ericsson’s customers include traditional telecommunications service providers and companies in industries such as utilities, transportation and public safety.

This study was developed within the unit Group Supply EMEA, part of the Business Area Networks (BNEW) at Ericsson in Kista (figure 1). The extent of this thesis is directly related to the Spiderweb Program, which is further explained in chapter 3. The region in focus is the Market Area Europe and Latin America (MELA). This region was chosen due to its: advanced technological infrastructure, enabler of a potentially easier path for the adoption of supply automation processes, and the importance of doing so to key internal stakeholders at Ericsson local companies and specific customer accounts in this market area.

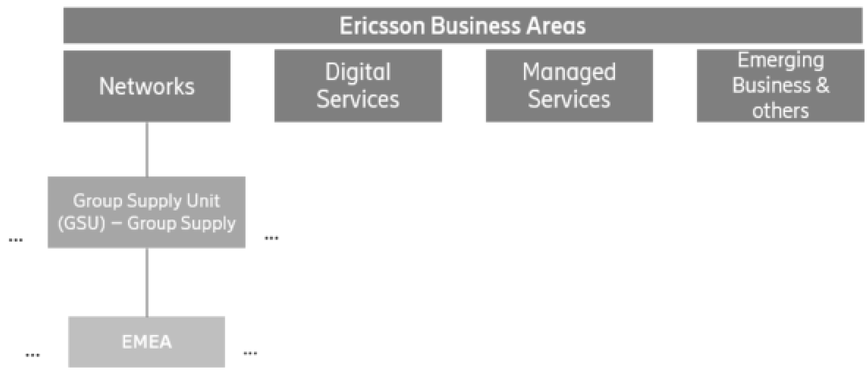

Figure 1 - framing of the project within Ericsson's organisation.

1.3 Problem Description

Over the lifetime of a supply chain network, the only constant is uncertainty, with companies experiencing fluctuations in demand, prices or exchange rates in an increasingly competitive global environment. Hence, companies must develop supply chain strategies to deal with the above-mentioned disruptions. Tomlin suggests some tactics to manage supply disruption risks: business insurance (financial mitigation); inventory build-up, multiple-supplier or multiple-location sourcing (operational mitigation); rerouting of transportation and customer demand management (operational contingency) [8]. Supply chains are constantly under pressure to do more with less, to reduce costs while boosting performance. These pressures arise from customer demand and expectations, but also internally to deliver products in a faster and cheaper way.

For Ericsson, one of the leading companies in the Information and Communication Technology (ICT) industry, the pressure to accelerate the deployment of 5G technology has created a new environment for the business. This technology will not only enable lower latency, but also higher number of connected devices, higher amounts of shared data, and faster. The growing demand from customers is pressuring every stage of the supply chain to become more efficient. In this industry, achieving a short time-to-market is vital to stay ahead of competitors and position the company as a trend-setter in the eyes of customers. Therefore, the need to overall shorten lead times and deliver products in a faster way has become necessary. As a result, Ericsson Outbound Supply has defined the “Wanted Position 2020+” as a set of three main objectives to be achieved in the upcoming years to increase Supply’s responsiveness:

- “Zero- touch” end-to-end order flow through automation
- Real time visibility and traceability of order handling processes with reliable data
- Stable and reliable hardware and software delivery lead time, exceeding customer expectations

Recent escalations from Customer Units have shown that Ericsson’s ways of working to handle customer purchase orders are not being efficient. In many cases, it is taking longer to process the order than the lead times agreed on the contract with the customer. As a result, this study focuses on how automation technologies can help improve end-to-end supply performance, in order to meet customers’ expectations and the three internal goals for 2020. In February 2019, Börje Ekholm, the CEO at Ericsson emphasized the challenge of improving customer experience:

> *A year ago, we launched the challenger mindset and our “Quest for Easy” to create maximum value for our customers (…) Ease in doing business is all about improving customer experience. We are addressing how we can become faster in responding to customers, making sure we have the right insights about each customer to fully understand their needs.*

1.4 Objective and Research Questions

The aim of this study is to investigate how can automation technologies affect Ericsson as an organisation and its workforce, how can these technologies improve end-to-end order flows, as well as which factors should be taken into consideration when implementing automation. The ultimate objective is to achieve lead time reductions that enable delivering customer orders within the contractual lead time. In order to support the investigation, an analysis of the issues most frequently affecting hardware deliveries to customers was also conducted through the Spiderweb program. The following research questions are investigated:

RQ1: How can automation technologies help to improve Supply's performance?

- Sub-RQ1.1: What are the issues currently affecting Supply's performance?
- Sub-RQ1.2: What are the critical factors in process automation?

RQ2: How does automation impact the company as an organisation, its culture and workforce?

RQ3: How can the improvement methodology followed in the Spiderweb drive automation discoveries?

1.5 Delimitations

This study focuses solely on the supply chain stages related to order management, supply chain preparation, outbound supply and local logistics (figure 2). That is, the tasks carried out between receiving a customer purchase order (CPO) and the actual delivery of the ordered items at the agreed destination, triggering a proof-of-delivery (POD) or goods receipt (GR), depending on the type of financial flow in question. All software products or other Ericsson services, such as site installation or managed services, were excluded from the scope, with only hardware delivery being considered. Therefore, areas such as supply hub stock levels and inventory replenishment strategies, sourcing, forecasting of customer demand, material planning or sales were not directly analysed.

Regarding the automation technologies, technical aspects such as the programming required for the actual implementation of the mentioned automation technologies are not considered in this study. A more holistic business overview and qualitative analysis of the topic is presented.

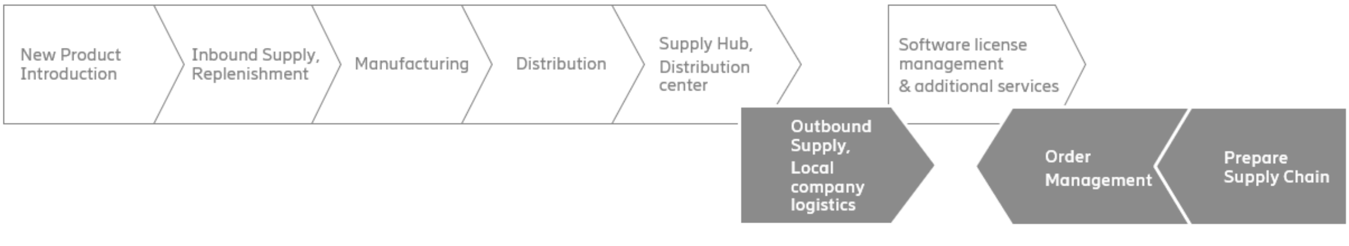

Figure 2 - Supply Chain planning delimitations.

2. Research Methodology

2.1 Literature Review

Initially, a preliminary literature review was conducted following an exploratory approach to identify scientific sources that could provide insights into the state-of-art and limitations in academia related to the topic under study. In this initial stage, a review of internal Ericsson information sources and tools was also done. The literature review to retrieve relevant scientific knowledge was based on searching for the following words: Supply Chain Management, Supply Chain 4.0, Supply Chain disruptions, Digitalization of Logistics, Information sharing in Supply Chains, Business automation, Automation software, Back-end automation. The search engines used to look for scientific articles were *Web of Science, KTH Diva, KTH Biblioteket, SpringerLink* and *Research Gate*. Each cited source was reviewed for written language (English), peer review and number of citations, to achieve the highest level of relevance. Additional considered sources include relevant white papers and studies from acknowledged entities such as the World Economic Forum (WEF), SCM World by Gartner or McKinsey&Company, with the recommended literature from the course *ME2053 Logistics and Supply Management* also being revisited.

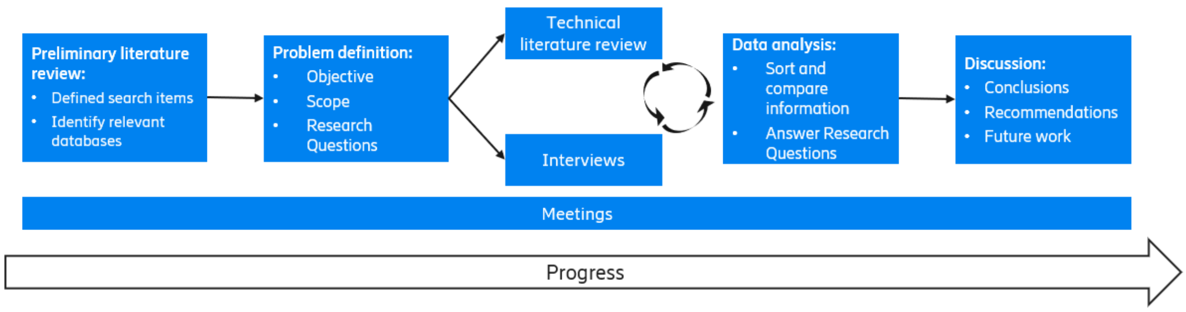

Figure 3 - Research progression.

2.2 Data collection and analysis

In order to answer the research questions, qualitative data was primarily collected through meetings with Spiderweb program drivers and one-on-one interviews with multiple stakeholders at Ericsson Supply. The aim of the interviews in an early stage was to become acquainted with the terminology used internally, and to acquire a better understanding of ways of working and specific processes. These included finding how some processes are manually handled by the accountable people and to understand which tools and systems are currently involved in the end-to-end processes. The interviews were mainly conducted in an unstructured or semi-structured way, depending on the topic in question. In a later stage, and to ensure reliability of the relevant collected information, the interviewees were once again contacted, to examine if any changes had occurred after they had been first interviewed.

Throughout this research, eleven people with different knowhow were individually interviewed to obtain different perspectives of the topics under study. According to Eisenhardt and Graebner, the issue of bias in interview data can be mitigated by using numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives: different hierarchical levels, functional areas and geographies [9]. The selection of interviewees was primarily supported by advice from the supervisor at Ericsson, Peter Lindberg, and by some interviewees themselves who pointed out the most knowledgeable people to approach within the company, for a deeper understanding of certain areas. Depending on the background of the interviewee and purpose of the interview, the duration of these events varied from 30 minutes up to 2,5 hours. The table below presents an overview of the one-on-one performed interviews.

Table 1 - Performed interviews with area experts.

Interview	Date	Position	Duration
I1	22/01	Strategic Product Manager eCommerce	1,5h
I2	24/01	Supply Delivery Manager	2,5h
I3	25/01	Supply Delivery Manager for embargo countries	2h
I4	15/02	Process Manager for Logistics & Planning	1h
I5	18/03	Head of Group Supply EMEA	30min
I6	20/03	Line Manager Supply	1h
I7	21/03	HR Business Partner	30min
I8	21/03	Change Lead	1,5h
I9	22/03	Change Management Consultant	2h
I10	26/03	Global Supply Chain Architect	30min
I11	15/04	HR Business Partner	1h

In addition to the interviews, informal meetings were held on a weekly basis with the supervisors, and with central and local drivers of the Spiderweb Program. These informal meetings were structured by having a pre-defined topic to be openly discussed by the attendants or by having the local drivers studying the status of the improvements defined in their local action plans. Furthermore, the attendance of a seminar at KTH given by an external consultant, that focused on people change management, was also an important event to gain a wider understanding of the topic from an outside perspective. The insights gathered in the seminar, and in a subsequent contact with the speaker via email, contributed to the research related to organisational, cultural and workforce changes, as well as with suggestions of literature related to the topic in question, further analysed after the seminar.

During the data collection stage, all new information was continuously analysed, sorted and compared with existing information. The study was mainly based on qualitative data. This type of data can be less precise and more vulnerable to the influence of its context but can still have a high degree of validity if the data is collected systematically and methodically, as stated by Collins and Hussey. When using qualitative data, the Collins and Hussey also emphasize the need to collect background information and clearly contextualise it. Therefore, data triangulation was used to compare the background information, empirical data, and the findings from literature sources. [10]

3. The *Spiderweb* program

The project was carried out having as a starting point the involvement in the Spiderweb program (commonly referred to as simply “the Spiderweb”). This program is an internal improvement project of Ericsson Supply, focused on improving Ericsson’s order handling flows for the Market Area Europe and Latin America. This project analyses eleven customer accounts out of which six accounts are more thoroughly studied (the six main accounts are shown in table 2). Each account was chosen from a different customer unit within MELA. The Spiderweb also aims to identify what the bottlenecks and “time thieves” in the order handling processes are by retrieving measurable data to benchmark customers and customer units. The end goal of the program was to deliver the ordered hardware faster and in a simplified way to customers, lastly looking into the possible automation of processes within the order handling flow.

3.1 Motivation to run the program

The justifications behind the need to conduct the Spiderweb program fall mainly on the non-optimised lead-times, negatively impacting Ericsson’s profitability and the relationship with customers. Furthermore, other identified motivations are: the need to demystify customers’ perception that Ericsson is very complex internally and lacks overall orchestration across processes and organisations (i.e. unclear end-to-end ownership of processes); to reduce the complexity and mistakes in processes interfacing multiple organisations from Sales to Delivery, enabling faster process handling; and to reduce tasks’ dependency on manual handovers, manual work and tools only used locally. Overall, the Spiderweb is about improving internal efficiency, to eventually obtain better cost margins in a bottom-up approach, looking into specific local accounts and, later, raising some of the findings to Ericsson centrally.

Table 2 - Contractual lead time per account in the Spiderweb Program's scope.

Account	Country	Contractual LT (days)
Claro	Brazil	X8
Entel	Chile	X6
Telcel	Mexico	X6
Telefonica	Uruguay	X0
Telia	Sweden	X5
Vodafone	Netherlands	X9

The lead times represented in the table above for each account concern the case when the client places an order for products that have been forecasted and are part of the customer’s Stock Item Product Portfolio (SIPP). SIPP is defined by the account supply responsible and Ericsson Supply, usually consisting of products ordered frequently and/or in large volumes by a customer. In the case of a sales order containing at least one non-forecasted or non-SIPP product, the contractual lead time will increase significantly, since Ericsson cannot guarantee that the ordered products will be in stock. A sales order can comprise multiple items. Yet, it only takes one non-forecasted and/or non-SIPP item for the sales order to be considered non-forecasted and/or non-SIPP accordingly.

As a result, it should be in the interest of the customer to provide enough information and to closely work with its Ericsson account manager and account supply responsible, to be able to have more accurate forecasts of products and build the SIPP that better meets the customer needs; ultimately leading to faster order deliveries.

3.2 Program methodologies

Goldbst and Martichenko stated: "If a company is ever to have aspirations of delivering on customer promises at anything close to real time, then lead-time management, speed and flexibility are critical" [11]. To decrease lead times, the processes performed to fulfil an order must be scrutinized and more importantly, must be questioned. Therefore, in the Spiderweb Program, an inductive reasoning approach was adopted: from the analysis of the identified issues from six accounts in MELA, generalizations were made that resulted in actions being taken not only on a local setting, but on a central scope as well. These central actions were considered for processes common to many accounts within the Market Area, thus, improving the order flow of accounts that were not as thoroughly analysed as the accounts in table 2.

With the increasingly competitive environment, companies have long embraced Lean and Six Sigma methodologies to drive cost reductions and process improvements. Goldbst and Martichenko define Lean as "the elimination of waste and the increase of speed and flow", in an oversimplified way, with seven different waste types being categorized; whereas Six Sigma "is a management methodology that attempts to understand and eliminate the negative effects of variation in processes". The core principle of Six Sigma is variation reduction: process variation needs to be acknowledged and reduced, to be able to conduct improvement initiatives that will ensure better accuracy and reliability of processes according to customer expectations. [11]

Therefore, Lean Six Sigma is "the elimination of wastes through disciplined efforts to understand and reduce variation, while increasing speed and flow in the supply chain" [11]. During the Spiderweb program, a Lean Six Sigma approach was followed with the intent of maximizing customer value while minimizing waste. The backbone of Six Sigma-based projects is the *DMAIC* model, *Define-Measure-Analyse-Improve-Control*, to reduce variation in processes, which was used in the following way:

1. ***Define*** *– What problem needs to be solved?*
   Method: central preparation and analysis. Definition of the scope of the assignment, planning of the activities and pre-Spiderweb data analysis. Preparation of the local team and knowledge sharing from local team to central team. Kick-off meeting with local stakeholders (local sponsors and workshop participants from the different units involved in the order flow).
    a. Definition of the purpose and scope of the program;
    b. Thorough understanding of the detailed order flow from customer purchase order to delivery;
2. ***Measure*** *and benchmark – What are the capabilities of the processes? How to measure them?*

Methods: retrieve lead time measurements from *Tableau* dashboards (further explained in chapter 5.5) or *Excel* log sheets, for the different accounts.

Moreover, As-is mapping at the local Ericsson company or via skype, using swim lane diagrams to map process workflows. This type of diagram allows to distinguish responsibilities and accountability of each event in different horizontal lanes that represent the multiple involved business groups or departments. In this diagram, the connections and handoffs between the different tasks or process steps are also represented, highlighting the bottlenecks and other inefficiencies in the flow. [12]

   a. Establish KPIs: set targets for the end-to-end lead time and segmented lead times (further explained in chapter 4.3);
   b. Establish measurements based on the contractual lead time for each account;

3. ***Analyse** – When and where do the issues occur?*

   Method: root-cause analysis (Ishikawa diagrams) using the "5 Whys" technique. This technique is used by focusing on a problem and asking five times "Why?", as it is believed that this number will lead to uncovering the root cause of an issue. [13]

   a. Identify bottlenecks/issues in the order flow and its causes;
   b. Support with data;
   c. Evaluate best practices and critical cases;

4. ***Improve** – How can process capability be improved?*

   Method: creation and implementation of individual Action Plans for each local account. The actions are defined by comparing the current performance measurements of an account with the lead time targets for the same account. That is, by analysing the performance gaps, create actions to achieve the defined targets for the account.

   a. For each issue, develop and implement solutions that address the root-causes, and define the accountable person for each action;
   b. Use data to evaluate the created solutions;
   c. Continuous improvement (*Kaizen*);
   d. Study of automation viability;

5. ***Control** – How to sustain the gains?*

   Methods: *Tableau* dashboard with key lead time measurements, and a "Maturity ladder" creation to provide a self-diagnose tool of the current maturity level of each process of an account.

   a. Standardise work methodologies;
   b. Analyse lead time measurements evolution.

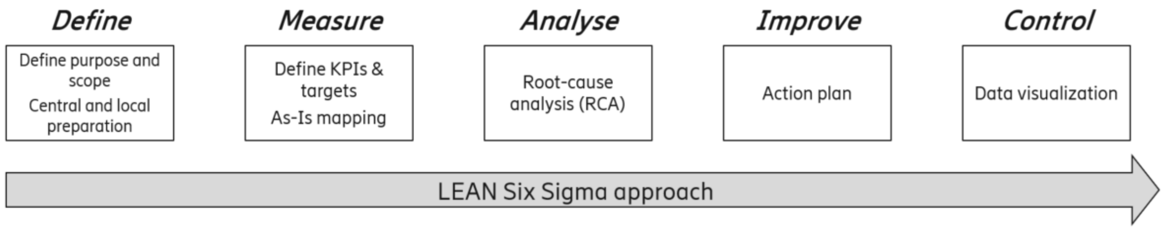

Figure 4 - Sequence of main methodologies followed during Spiderweb (adapted from Ericsson's internal documents).

Note: for the As-is mapping **(Measure)** and root-cause analysis **(Analyse)**, workshops were conducted at the local companies together with the local driver for each account in the Spiderweb scope. The relevant stakeholders involved in the workshops were primarily the workshop "leaders", local drivers, sponsors and people from the areas of Pre-sales, Sales, CBE (Finance) and Supply.

3.3 Identification of issues

The identification of issues and their roots in each account's order flow was possible by doing root-cause analysis (Ishikawa diagrams) and using the "5 whys" technique (which dates to the Toyota Production System, principle 14), via workshops conducted locally or Skype meetings, together with relevant stakeholders from the Local Company [13]. This was followed by a classification of the issues in each account in two ways: by *Improvement area* (see Appendix 1) and by placement within the matrix in figure 5.

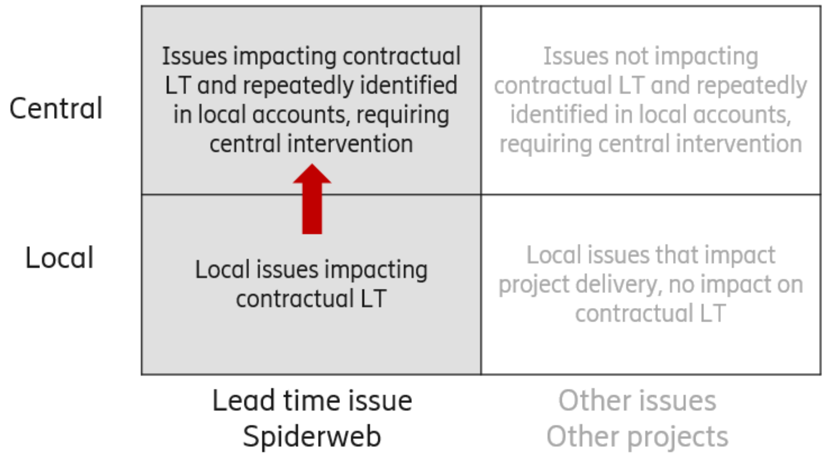

Figure 5 - Classification of issues by Central vs Local and Lead time issue vs other issue.

The Spiderweb scope was initially defined as only regarding issues affecting the contractual lead times of the local customer accounts. Nonetheless, other project delivery-related issues were also identified to be addressed in other ongoing or future Supply improvement initiatives. These are not comprised in the scope of the thesis.

After identifying and mapping the issues per account and improvement area, a consolidation of all accounts together was carried out together with the Spiderweb team. This allowed the identification of local issues, related to the same improvement areas, that were recurrent in all or most of the accounts (list of improvement areas is provided in Appendix 1). The analysis targeted evaluating if the status of an issue could be elevated from "Local" to "Central" involvement, hence, requiring central solutions to be developed, i.e. EAB intervention (represented by the arrow in figure 5). Afterwards, local issues were filtered and analysed by improvement area, and summarized in a list of general findings related to the entire MELA region. Each one of the findings was characterised in terms of improvement area, impacted segmented lead time(s) and solution area. The solution areas were divided into *local solution*, *MELA/global solution*, *Check list* and *Good Practice*. This step in the Spiderweb program was vital to identify the issues requiring EAB involvement (*MELA/global solution*) that could be considered for the Automation study. Apart from the *local solution* area, the *Check list*, *Good Practice* and *MELA/global solutions* will be further developed in future Supply initiatives.

4. Supply Chain configuration

4.1 Ericsson supply chain setup

A supply chain represents all business processes and applied technologies that support the flow of physical goods from suppliers to manufacturers and distribution channels serving customers [1]. The good functioning of supply chains requires interorganisational communication among a diverse set of stakeholders including suppliers, manufacturers, retailers, logistics service providers, transportation carriers and customs agencies. Some of the standard entities involved in Ericsson Supply order flow are:

- Manufacturing: Ericsson Supply Site (ESS); Electronics Manufacturing Services (EMS); External suppliers (3PP) of material and components - approximately 200 suppliers.
- Supply Chain management: Cross-organisational with handovers between different legal entities – EAB, Ericsson local company Supply, Authorized Service Providers (ASP), Customer.
- Outbound logistics: Supply hubs - locations: Sweden, Düsseldorf, Dubai, Pune, Nanjing, Singapore, Dallas, Guadalajara, São José dos Campos; Procurement centres (previously called Regional Order desks) - locations: Tallinn, Sofia, Gurgaon, Nanjing, Mexico; local LSPs.
- Local Supply: Local warehouses (over 500 worldwide); Distribution centres; Customer Unit Supply; country customs.

Ericsson's Supply global presence is based on a worldwide distribution of both Ericsson-owned facilities and external partners' sites, in order to optimise: lead times, distribution, flexibility and pro-active supply chain risk mitigation.

Supply strategy and objectives

The core of Ericsson's strategy is an increased focus on customers to become the trusted partner for 5G global deliveries with increased end-to-end operations transparency. To achieve this, Ericsson Supply has set digitalization and automation as the top priority in the upcoming years. The year 2019 has been defined as the year to accelerate the automation journey throughout the entire organisation, by scaling the already implemented bots and onboard new technologies. The main targets for the group to achieve in 2019 are: delivery performance of 85%; end-to-end inventory of 65 days; and supply cost vs cost of sale of 15,2%. Other relevant performance indicators have also been specified: SIPP adherence of 80%; average lead time reduction of 50%; supply process adherence of 80%. In order to achieve these objectives, four strategic capabilities were established for every Supply area, with specific projects targeting each one of the following:

- **Visibility**: end-to-end visibility across functions to enable proactive decision making based on real time data, driven by analytics tools and the use of IoT. Full transparency of demand, supply capabilities and user insights;

- **Segmentation**: differentiation of supply chains based on time, cost and service to enable handling shorter life cycles, increased demand volumes and product variants – flexible supply chain network and agile production;
- **Fundamentals**: to release the full potential of digitalization and automation initiatives process adherence must be secured (see chapter 5.2), with special emphasis on Master Data quality, common ways of working across the entire organisation, and strong and supportive leadership;
- **Automation**: the key to power overall efficiencies by removing manual, rule-based, repetitive and error-prone processes and, finally, drive the goal of "zero-touch" in transactional flows (as mentioned in chapter 1.3).

4.2 Standard supply flow

A generic supply chain scenario comprises three types of flow: (1) order flow - the information flow that starts from the customer all the way back to component suppliers-; (2) physical flow - the flow of products and components starting with component suppliers or manufacturers towards the delivery of the final product to the end customer; (3) financial flow - the exchange of financial instruments between different entities, both internal and external to Ericsson, within the supply flow. The information shared between different supply chain stakeholders may be transferred verbally, manually (i.e. on paper), digitally (e.g. via email) and, more recently, in an automated way (e.g. via EDI) or through digital platforms [7].

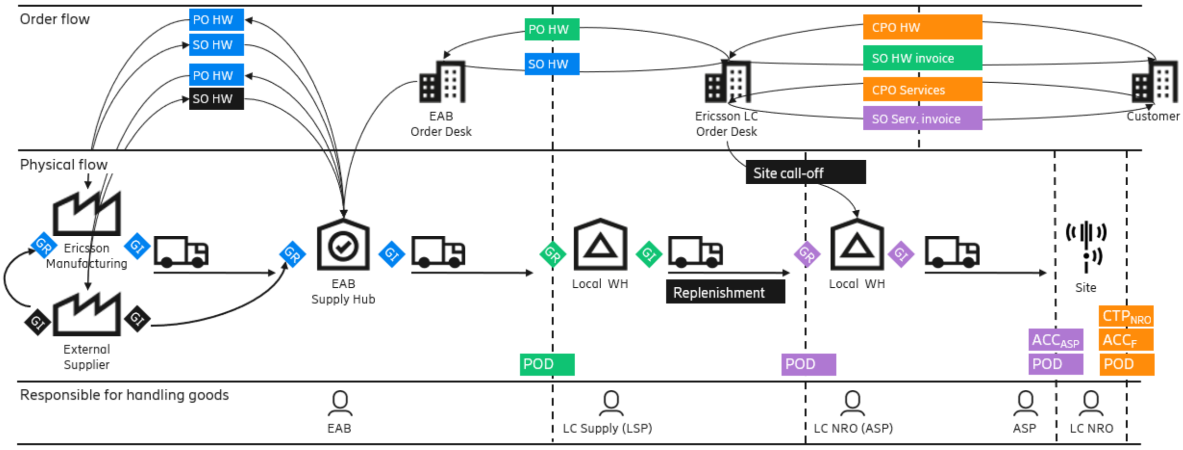

Figure 6 – Dimensions and events in generic supply chain scenarios (Ericsson internal document).

In Ericsson's Operational Model (EOM), an internal flow classification is also introduced, distinguishing market types by contract ownership, as stated:

- Flow markets - contract owned by the local company. Common in western countries or countries with a stable economic conjuncture;

- Split markets – hardware/software contract owned by EAB and service contract by the local company. It can be seen as a combination of Flow and Direct market scenarios. Common in countries with unstable economic environments;
- Direct markets – contract owned by EAB. Common in countries with very unstable economic and political environments, which can lead to having a branch office in that location or in a neighbour country, instead of a local Ericsson company.

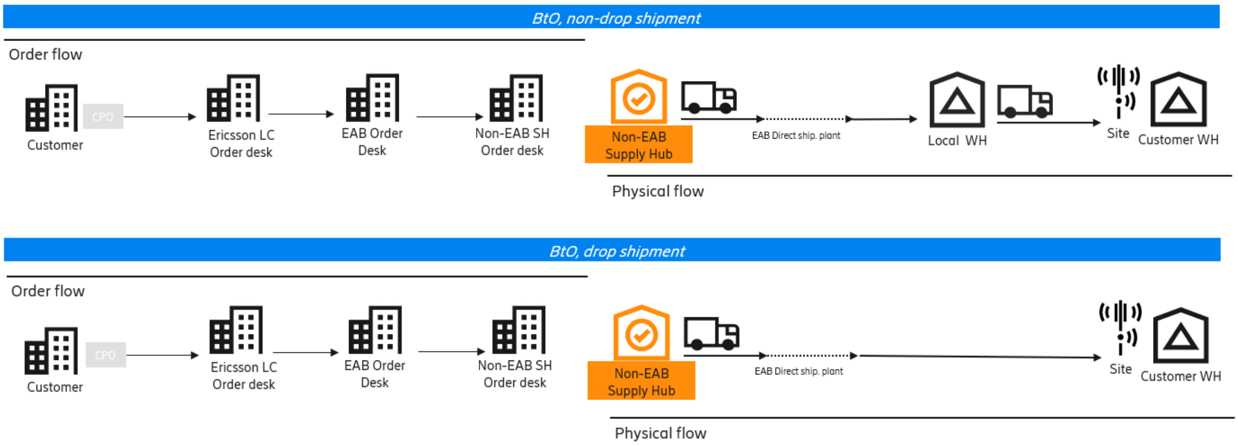

Figure 7 - two examples of a Flow Market flow, adapted from Ericsson's internal documents. More examples of flows can be seen in Appendix 2.

The shipment variants can be seen in the figure above: drop shipment (direct delivery to customer warehouse) and non-drop shipment (delivery to LSP or ASP managed warehouse).

Ericsson's adopted ERP system is SAP, with a myriad of tools being used everywhere in the company. One of these tools is SAP ONE, which is crucial to manage financial business functions. Via the ONE Value Contract it is possible to follow up the financial aspects of customer contracts in SAP ONE. This includes fixed contracts and frame agreements. Whereas the former refers to a mutual formal agreement between Ericsson and the customer, with pre-defined prices for products and/or services, and orders being booked on a contract level. On the other hand, frame agreements refer to an agreement between Ericsson and the customer, where the customer commits to buy specific products and/or services, but no orders are booked on contract level. In the latter, the contract is not "activated" until Ericsson receives a customer purchase order. At Ericsson, the word *scenario* is used to describe the system procedures to perform in SAP ONE, to complete an end-to-end order process. The financial flow scenarios in SAP ONE comprised in Spiderweb's accounts in focus are:

- QTC – "Quote to cash", scenario for project management-intensive customer projects. It is used whenever there is a requirement for project management to fulfil the order of a certain number of sites to be deployed (site-based orders), i.e. a network rollout. Network-based ordering requires the creation and planning of a project structure after receiving the customer purchase order.

Before the creation of sales order for the material needed to deploy each ordered site, the project rollout is planned using Work Breakdown Structure (WBS) with multiple sites associated. A QTC flow may also include services (e.g. installation on site or network management, the latter is part of the Business Area Managed Services). The project is closed once all ordered sites have been installed, although the client can be invoiced prior to the completion of all sites.

- PSF – "Product Sales Flow", scenario for routine and non-complex orders (in any combination of hardware, software and services), requiring 100% clarification of the order (product-based orders, also called "box delivery"). With PSF, invoicing the customer is only done when 100% of the hardware has been delivered. Moreover, in this financial flow, the planned and actual cost of the order is set product-wise, whereas in a QTC flow, it is set project-wise.

Note: other common financial flow scenarios are QTC-M and PSF-M, with "M" standing for manufacturing. These will not be further explained, as none of the accounts reviewed in the Spiderweb program had any of these flow scenarios.

Table 2 - Characterisation of the studied accounts regarding type of financial flow and market type.

Spiderweb account	SAP financial flow	Market
Claro Brazil	PSF	Flow
Entel Chile	QTC	Flow
Telcel Mexico	QTC	Flow
Telefonica Uruguay	PSF	Direct
Telia Sweden	PSF	Flow
Vodafone Netherlands	PSF	Flow

4.3 Order handling lead times

As mentioned in chapter 4.1, Business Area Networks (BNEW) has set the target of reducing fifty percent of order handling lead times for the present year for ten Supply customer accounts worldwide. With the Spiderweb being one of the main initiatives to reduce lead times in MELA, the main KPI of the program is the lead time from the moment the customer places a purchase order, until it is delivered. Nevertheless, there are other factors that must be used as supporting measurements to evaluate Supply's relationship with the customer account and the Supply Hub concept adherence. Hence, the main KPI is supported in the program's context by the percentage of site material forecast and the percentage of SIPP orders on account level.

The following lead times measurements descriptions were based on the mapping of the hardware order flow for Vodafone Netherlands, and later used for all accounts with a **PSF flow**:

1. Total LT - must follow the total LT agreed in the contract with the customer, so the starting point can differ from customer to customer. The triggering task is generally the CPO sent by the client to the local entity, the finishing point being the receival of a POD at EAB and status update of the delivery on SAP system;
2. Local Sales Order registration LT – starts with the receival of a CPO at the local company and ends with the creation of the internal Sales Order to the local Supply (CBE is responsible for this);
3. Local Purchase Order creation LT – starts with the internal Sales Order creation (end point of the previous LT measurement), ending with a Purchase Order of the desired items being sent to each supplier;
4. EAB HW Purchase Order creation LT – starts with the receival of a Purchase Order at the local Supply, ending with a Purchase Order being sent to a Supply Hub;
5. Ericsson local company Hardware Delivery LT – begins with the receival of a Purchase Order from Supply, finishing with the materials ready for shipment (RFS), after pick and pack of the materials. The target lead time for hardware in a Supply Hub is two weeks. Yet, this will depend if the ordered products are forecasted and/or in SIPP;
6. EAB Transport Planning LT (RFS-GI) – starts when the materials are ready for shipment (RFS status) and ends with goods issue (GI) by the LSP Transportation;
7. EAB Transportation LT (GI-POD, the actual physical transport lead time) – lead time between goods issue by the LSP Transportation and the receival of a POD at EAB.

The following terminology can also be used to describe the segmented lead times on a high-level for a PSF flow:

- Admin LT: (2) + (3) + (4);
- Material Supply LT and Pick & Pack LT: (5);
- Transport planning and loading LT: (6);
- Outbound transportation LT: (7).

The definition of the relevant segmented lead times in a **QTC flow** scenario is less clear, since the contractual lead time is set as a time frame for the entire project to be finished, for example: the customer requests a one-year end-to-end lead time to deploy 100 sites. Therefore, the end of the project only occurs with site installation, which comprises activities that are outside the scope of Spiderweb. Presented below is the understanding of lead time definitions for a QTC scenario by Spiderweb's team:

1. Customer PO to SO: starts with the receival of a CPO at Ericsson and ends with the creation of the internal Sales Order to the local company Supply (CBE is responsible for this step);
2. SO to local PO: starts with the receival of a Sales Order, ending with the creation of POs to EAB. At this stage, there is often some waiting time between activities, since the project structuring has to be done using the Work Breakdown Structure method to plan the deployment of the different sites within the contractual time frame.
3. Local PO to Goods Receipt (GR): this segmented lead times comprises the segments (4), (5), (6) and (7) defined for the PSF flow. PO-GR is an iterative segment of the order handling process as it is done for every site or group of sites.

4. End-to-end LT: the starting point is the receival of the CPO sent by the client to the local company, being the finish point the Goods Receipt (physical products are ready to be sent to the customer's local warehouse or ASP warehouse).

4.4 Common flow deviations

Grimson and Pike developed a model to determine the factors that lead to deviations in S&OP processes, as well as the maturity assessment of which stage an organisation is at (see Appendix 4). The model suggests five categories: (1) Meetings and collaboration; (2) Organisation; (3) Measurements; (4) Information Technology; (5) Plan integration. The first two categories regard the human aspect in operations processes, with emphasis on how meetings are conducted, who engages in the meetings and how the team is organised. The third category represents the quantitative assessment the company's performance and profitability generated from its operations. Concerning information technology, this dimension assesses the IT infrastructure and the level of tool adoption and integration of the various business operations, whereas the last category measures the integration and planning of the different processes. None of these dimensions should be isolated from each other, as an issue in one factor will possibly affect another. [14]

Deviations in processes and in the overall flow at Ericsson have its main origin in the global character of the company. With its central organisation in Sweden and local companies spread worldwide, Ericsson has adopted ways of working that differ location and customer-wise, hindering the standardisation of processes. Currently, customers' ordering habits vary from one to another, which prevents having common ways of working in every process and leads to multiple changes and adjustments of information in one or multiple steps of the end-to-end flow.

The interaction with the customer starts by setting the contract through the account manager. Although contracts are theoretically binding, in some observed regions (some accounts in Latin America and Africa) the contracts are not expected to be strictly followed by both parties. It is rather a close relationship and verbal agreements between the local company and the customer that end up being the guidelines in how to process the customer's orders. In this case, written contracts have little meaning when it comes to lead times, as sometimes there is no actual contractually agreed lead time. In other cases, it is sometimes the customer delaying giving "green lights" in certain processes that require its approval, because either Ericsson has asked for an extension of the lead time since it knew it would not be met, or because it is not a good timing for the customer. Consequently, often increasing the lead time by weeks.

By establishing a parallel between Grimson and Pike model and the studied the findings from the analysis conducted in the Spiderweb program, it is possible to identify causes for deviations in each category, and infer that these impact lead times differently (direct or indirect impact):

(1), (2): MELA is a large region that comprises local companies operating in very culturally different countries. This has resulted in miscommunication, delays caused by different time zones and a multitude of local ways of working.

(3): In the case of some local companies, KPI measurements and data analytics are rarely used to base decisions. In other cases, the measurements are simply stored in multiple spreadsheets and consolidated manually, resulting in error-prone information. Furthermore, and even in cases where data analytics are locally in place, there are often misinterpretations of the data. This is a result of the utilization of different terminologies from the ones used centrally, or due to a subjective evaluation of the results to show a "better picture" than the reality shows if all data is considered.

(4): All local companies must use SAP to interface different business areas. Yet, different local companies have different levels of IT adoption throughout the end-to-end processes. This usually depends on the customer's maturity and business volume. For example: in the case of a small customer that places two purchase orders per year, it will not be cost efficient for the customer to use EDI, as it is a costly technology. In other situations, local companies have developed or are using tools that are specific to that location but might serve similar purposes of tools implemented centrally. With more systems locally, the company's IT-architecture becomes complex and more difficult to integrate all tools and information centrally.

(5): The inexistence of clear accountability for the end-to-end flow and detached collaboration in handovers of processes causes excessive time being spent editing data in the currently used information systems. This also results in a lot of change management activities taking place during the flow – increasing significantly the lead time to fulfil an order.

Other areas that are not comprised in Grimson and Pike framework, and that have proved to be determinant on why and how process deviations occur, are the external supply chain actors and a customer or country's geopolitical and financial situations. The former regards stakeholders such as suppliers, LSPs, ASPs or customs. The ways of working of these stakeholders will differ location-wise, with contracts being set locally for LSPs and ASPs, and with the legal requirements at customs clearance depending on a country's specific regulations. Regarding the latter, a country's political and financial conjuncture may determine if a certain customer is required to pay Ericsson through letters of credit (only used in Split or Direct market flows) or if the customer must be imposed a credit block. A credit block is set in SAP when Ericsson wants to limit the customer's order volumes to not exceed a certain credit limit [15].

An example of a more extreme case of how a country's political situation can affect all actors in a supply chain is the embargoed country's case. These are countries where diplomatic and/or economic sanctions are in place, requiring special workflows that strictly follow the restrictive measures imposed by governing bodies, or risk civil and criminal penalties for the entire Ericsson organisation. [16]

4.5 Supply chain risks

According to Baghalian et al., the success of a company is highly correlated with the success of the adopted risk management strategies in its supply chain [5]. Ho et al. considered supply chain risk as "the likelihood and impact of unexpected macro and/or micro level events that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities" [17]. As a company's supply chain includes more and more external partners, it also becomes more vulnerable to unforeseen risks that may arise from the vulnerabilities of its partners and lack of shared insights between different stakeholders.

A literature review showed that a multitude of classifications and models have been created by many authors to categorise these risks. For instance, Chopra and Sodhi divided these risks into nine categories: (a) Disruptions; (b) Delays; (c) Systems; (d) Forecast; (e) Intellectual property; (f) Procurement; (g) Receivables; (h) Inventory; (i) Capacity [18]. On the other hand, Waters considers three comprehensive types of risks: (a) Internal risks, which arise from operations within the organisation; (b) Supply chain risks, external to the organisations, but internal to the supply chain; (c) External risks, external to the supply chain, (e.g. legislation or natural disasters) [19]. To be able to quickly address any of the afore mentioned issue categories, Ericsson is working towards building the appropriate logistics flexibility by improving inventory management at the Supply Hubs, integrating business planning activities and supply orchestration, and strongly pushing ambitious lead time reduction initiatives. Ho et al. present a thorough analysis of the different risk classifications, definitions, risk factors compilation and risk mitigation approaches that can be further analysed [17].

As defined by Tang, supply chain risk management is "the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity" [20]. Snoeck et al. defined two types of decisions that a decision maker can take to manage disruption risks: [21]

- *Operational decisions* - decisions taking place immediately after a disruption starts to minimize its impact – e.g.: by using different supplier options for the same stock material;
- *Strategic decisions* – preventive decisions made before a disruption occurs, associated with investments that make the supply chain network design (SCND) more resilient to disruptions – e.g.: the Transport Management System (TMS) initiative currently being developed in Supply to better track and trace goods transported by Ericsson, through the implementation of devices to improve the real-time visibility of the physical flow of ordered products (the IoT concept).

Ericsson Supply's strategy to initiate an internal automation journey with the development and implementation of such technologies can be classified as both an operational and strategic decision. *Operational decision* as in the analysis of issues already identified in Ericsson Supply's processes that must be fixed. For example, in the Spiderweb analysis, numerous issues were identified and, subsequently, some considered for an automation-related solution. The *strategic decision* classification can be seen when using automation to improve processes' efficiency, prevent Supply issues and build robustness to possible risks.

5. Automation of processes

5.1 Definition

Grosz et al. defined Automation as the process of introducing technologies to automatically execute a task previously performed by a human, or impossible to perform by a human, by following a fixed set of rules [22]. An overview of automation technologies resulted in the categorization of three enablers of automation: robotics, artificial intelligence (AI) and machine learning (ML), with the latter being considered a subcategory of AI. According to Groover, automated systems typically consist of three building blocks: [23]

1. Power source: the most versatile and common being electricity. A power source performs two types of actions: (1) processing an operation or a set of data, and (2) transfer and positioning, referring to the movement of data among various processing units to deliver an output.
2. Feedback controls: systems that monitor the output of an action comparing to the input values.
3. Machine programming: refers to a set of well-defined programmed instructions that should be followed to achieve the desired output.

Automation can be classified in a plethora of categories. Leask et al. suggested the categorisation of automation into three broad types: [24]

1. Systems that DO.
   Examples: Speech-to-text; Robotic Process Automation (RPA); Data collection and preparation.
2. Systems that THINK.
   Examples: Natural Language Processing; Smart APIs.
3. Systems that LEARN.
   Examples: AI; Sentiment Analysis; Machine Learning.

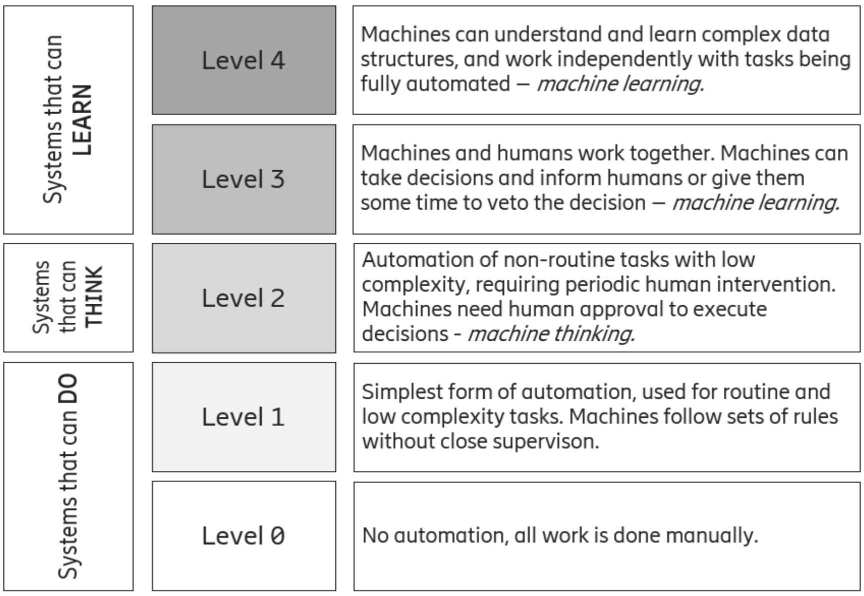

Figure 8 - General business automation ranking, adapted from Leask et al. [24].

Systems that can DO are considered the simplest automation level, whereas *systems that can LEARN* the most advanced. They all have in common the goal of automating repetitive manual work. Despite most of the systems, given in the examples above, having existed for many decades, only now are they becoming part of companies' operations. Some of the most obvious benefits associated with business automation are: reduced costs, reduced process lead times, increased production rate, and improved customer service quality.

5.2 Process Adherence (SLPA)

Supply Logistics Process Adherence (SLPA), previously named "Mandatory fundamentals", defines basic practices and business principles that should be followed on a daily operations basis. Process adherence takes place when a person, group or organisation understands and follows the purpose, scope and goals of a process in a consistent way, ensuring process compliance. SLPA is divided into sixteen different areas that were established to ensure: the right quality of the company's supply operations, the efficient use of tools and processes developed at Ericsson, and to secure an overall compliance with local and international laws related to finance, trade and code of conduct.

The fundamentals comprising SLPA are part of the strategic capabilities (alongside end-to-end visibility, process automation, and supply segmentation) that Ericsson Supply wants to achieve in a near future and, when followed, should lead to meeting the Supply Group targets for the year 2019 (check chapter 4.1). Process adherence in all its different areas must be secured, to guarantee a smooth transition to an end-to-end process automation scenario. SLPA must be considered a pre-requisite to make "zero-touch" flow in Supply a reality.

All the SLPA areas directly or indirectly affect the KPIs (lead time measurements) defined for the Spiderweb Program: from customer purchase order to proof of delivery. The areas directly related to the Spiderweb's scope are listed: (1) Master data; (2) Production; (4) Order entry; (5) Order planning; (7) Goods receipt; (8) Local control of material; (10) Goods issue; (11) Last mile logistics control; (12) Transportation; (16) Automation. Ericsson's internal documents disclose more information regarding the best practices to follow, the defined targets, and the internal documentation supporting each area. The Spiderweb step of developing the Action Plan for each considered local account, intends to mitigate flow-related issues by following process SLPA best practices.

5.3 Pre-requisites for automation

It can often be difficult to reflect the company's adopted automation strategy to the selection of the right business processes to automate. According to Streif et al., the initial goal of an automation assessment is to enable simple, low risk and quick wins, then eventually move towards more complex processes. The ultimate objective, however, is to achieve fundamental process improvements across all user journeys. To make progress towards both goals at once, an assessment must evaluate and quantify the company's existing automation potential in terms of activities and tasks, finding opportunities to incorporate advances in the short term while building towards larger, longer-term changes to overall systems and solutions. [25]

Leask et al. suggested that a common mistake is to start by choosing high-volume tasks or operations with costly deployment. The authors also stated the key characteristics to look for when selecting the right process to be automated: manual error-prone processes; rule-based standardised processes; structured digital data, this being numerical or textual data; high volume data or processes. [24]

When choosing a process to automate, the trade-off between the scale of the process, the risk for the organisation, its business importance, process complexity, data privacy and the required effort, both in terms of time and cost, are some of the parameters that must be closely analysed. In industries related to advanced technology development, as the networks and telecommunication industry, speed of execution is of uttermost importance to stay ahead of fast-moving competitors. Hence, and according to Deloitte LLP, many organisations are adopting a lean hybrid agile implementation approach, typically involving six steps: process identification, qualification, plan, develop, deploy and operate (or maintain) [26].

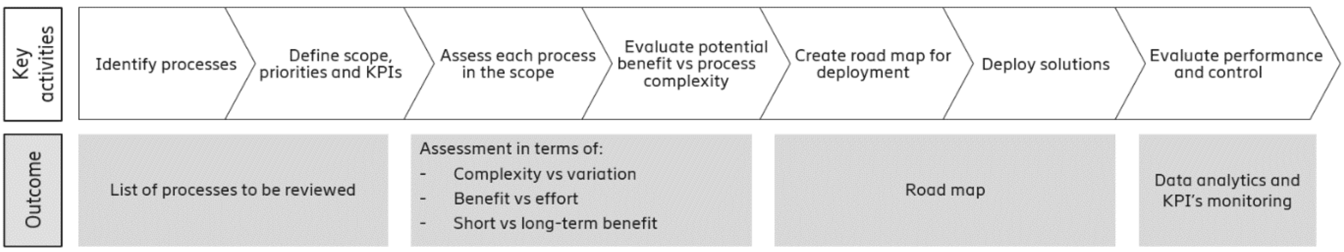

Figure 9 - Steps to follow in an automation discovery (adapted from Ericsson internal documents).

In order to determine which tasks are suitable for automation, a literature review of task classifications was conducted. A plethora of classifications have been established by many authors. McKinsey Global Institute stated seven activity types: (1) Predictable physical; (2) Process data; (3) Collect data; (4) Unpredictable physical; (5) Interface with stakeholders; (6) Expertise; (7) Manage and develop others. The authors also defined five groups of capability requirements to perform an activity: sensory perception, cognitive capabilities, natural language processing, social and emotional capabilities, and physical capabilities. [27]

Whereas Leask et al., classifies tasks in a 2x2 matrix, considering two key parameters: the degree of complexity of a task and the degree of variation (figure 10) [24].

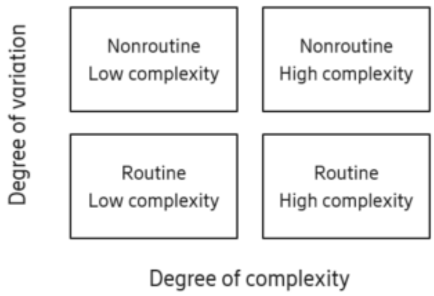

Figure 10 - Task classification according to level of complexity and variation.

- Degree of **complexity** of a process: High complexity in a business process refers to when the output cannot be achieved by simple rule-based tasks, and/or involving many exceptions or overlaps during execution. The number of handoffs, roadblocks and changes required later in the flow are also indicators of complexity in a process or in the flow between two adjacent processes. A low complexity process, on the other hand, is one that is straightforward, with no deviations or exceptions, and with low business impact. The business impact of a process should be evaluated by analysing the effect of the implementation potentially failing.
- Degree of **variation** of a process: this parameter distinguishes between routine and nonroutine tasks, based on the repetitiveness of an individual's work. Routine entails a process without or with small deviations, which can be translated into a clear set of rules and performed with little social interaction. Non-routine, on the other hand, means the process involves significant people management (negotiation skills and teambuilding), critical reasoning and decision-making abilities.

After an analysis of the processes under study, following the classification previously introduced, the next step must include an assessment of the required efforts and possible resulting benefits (figure 11). Whereas "efforts" imply all resources - financial, technological, time and personnel involved - required to complete the automation implementation and to maintain the system; the term "benefits" refers to all potential gains - process time reduction, financial gains, increased employee and customer satisfaction, and, ultimately, increased business volumes.

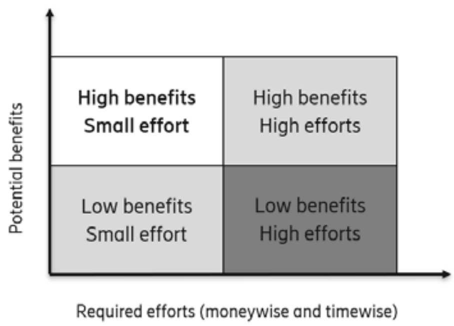

Figure 11 - Potential benefits vs required efforts matrix.

Lastly, the automation of a business process should be framed in the strategy of the company. A report from Deloitte states that from 2016 to 2018 the main priorities for executives of companies implementing automation solutions shifted from a pure cost reduction focus to the following three priorities: increase productivity, improve customer experience and deliver automation at a significant scale. The benefits and efforts required to automate a task should be weight in according to the company's both short and long-term vision. Some businesses may risk long-term financial gains by seeking automation in the short-run, while ignoring greater macro effects in the organisation as a whole. Following the classification of automation technologies introduced in chapter 5.1, short-term target the implementation of level 1 systems (e.g. RPA), midterm solutions target level 2 systems, whereas long-term solutions focus on level 3 to 5 systems for continuous improvements (e.g. Machine Learning). [26]

5.4 Critical factors in process automation

McKinsey Global Institute explains that even though automation technologies are progressing at a fast pace, the journey from technical automation potential to full adoption at companies is, nonetheless, likely to take decades as different interdependent businesses will implement technologies at different rates. The authors also state five factors that will affect the timing of an automation journey: (1) Technical feasibility of the solution; (2) Cost of developing and deploying the solution; (3) Labour market dynamics (supply, demand and costs of human labour); (4) Overall economic benefits with the automated solution; and (5) Regulatory and social acceptance. [27]

Despite the technical aspects of an automation implementation being decisive for its success, Leask et al. developed a "formula" to achieve a successful automation strategy less focused on the technicalities and more on the resources and organisation aspects, consisting of: [24]

- Identify any resistance to change
    - Assess the organisation's readiness to change.
    - The relevance of automation for the organisation should be continuously reinforced through all communication channels.
    - Establish new relationships between key stakeholders to facilitate a smooth transition and support new initiatives.
- Alignment of strategic objectives and management support
    - Senior management should ensure the alignment between the automation initiatives and the organisation's overall strategic goals.
    - Automation targets should be clearly stated and periodically reviewed, with actions being decided based on relevant data analytics.
- Clear communication of plans
    - Top-priority objectives should be clear to all relevant stakeholders.
    - Objectives must be SMART: specific, measurable, achievable, realistic and time-framed.

    - Involved parties must agree on the scope, size, nature of work, timelines and key success parameters before engagement starts.
- Right team
    - A cross-functional team is required for the success of the initiatives, including: automation experts, technology architects, process architects, process managers, change leaders and business analysts.
- Budget and resource availability
    - The total cost vs benefit must be estimated, prior to starting an automation initiative, as well as the resources that will be required from start to finish.

Supply chain coordination improves if all stages of the chain take actions that are aligned and synchronized. Hence, requiring each stage of the supply chain to share information and take into account the impact of its actions on other following stages. A lack of coordination occurs either because different stages of the supply chain have conflicting objectives or because information moving between stages is delayed and distorted. Different owners for each supply chain stage and poor communication between these are often the cause of having conflicting objectives, according to Chopra and Meindl [1]. For the automation of a process to be viable, it is mandatory that the immediate predecessor and successor processes, as well as process owners are aligned in terms of: information shared, tools used, handoff agreements, and common goals.

5.5 Information system and data management

The software needs in the operations execution level differ from the software requirements at the corporate level. It is vital to use the appropriate software technologies, to logically model the hierarchical layers where data is imbedded to ease business process execution and to accommodate the automation of these, as stated by Berge [28]. A well-established corporate IT-infrastructure is a pre-requisite to be able to link automation systems and realize its full potential. Ericsson has numerous implemented systems and tools for different purposes and stakeholders at every level of the organisation. Any automation that might be considered has to be integrated in the SAP system or interact with it and with the affected parts of the organisation's IT architecture. In Supply, the flexibility and capability of functions along many points of the supply chain can be increased through tailored IT applications that show real-time forecasts and demand information, inventory management, and transport progress [29].

The most relevant system, that is vital to so many functions, is SAP and its add-on tools (ERP, Extended Warehouse Management, Vendor Invoice Management, Transport Management System, SAP ONE, among others). Cotteleer and Bendoly define enterprise resource planning systems as applications of "software products that support the wide array of work processes on which firms rely to conduct their day-to-day processes" [30]. This system brings together various types of data from different business activities (Sales, Finance, Supply, Sourcing, HR, etc.). The possibility of integrating Ericsson's SAP system with its supply chain partners', not only in outbound logistics but also inbound, makes way for a more agile organisation covering the entire spectrum of its supply chain.

Data analytics

In order to extract some useful findings from the data created in the IT tools from Supply's daily operations, system data must be turned into information and information into knowledge. Knowledge is gathered when there is a desire to improve a process. Therefore, attempts to improve internal practices must be made to critically examine what the company or business area is doing. Performance excellence will only happen in an organisation that is able to embrace all the relevant available data to base decisions. Data-driven decisions are most effective when three types of data are considered simultaneously (see figure 12): historical, real time, and future or deterministic. [11]

Ericsson Supply has already started to instil a data-driven culture where management decisions are no longer subjectively based on intuition, rather on facts deriving from information extracted from the company's SAP systems. Initiatives such as the Live Customer Order book implemented in EMEA, which provides Customer Units with information regarding order status, are helping to move away from Excel spreadsheets into dashboards with live updates from SAP. This also means that hundreds of man hours spent doing manual reports will be saved. Two of the IT tools available at Ericsson are helping to transition towards a more data-focus organisation:

- **Tableau** – it is an analytics visualization tool used to support complex computations and to blend large amounts of transactional data produced by daily operations in the SAP system. Tableau's interface allows the user to quickly create interactive dashboards. The main purpose of these easy to read dashboards is to deliver real-time analytics insights that cannot simply be derived from looking at a spreadsheet.
  Tableau in the Spiderweb: a comprehensive dashboard with the KPIs metrics and supporting measurements were created for Supply globally and made available to the local teams involved in the Spiderweb Program (only the accounts with a PSF flow). The dashboard shows the segmented lead times for fully delivered hardware sales orders. This allows to keep track of Supply's past and current performance and to verify local lead time improvements, filtering the results per customer account.

- **QPR ProcessAnalyser** – it is a process mining tool that turns transactional data coming from various systems (ERP, BPM, etc.) into visual process insights. By using QPR, it is possible to retrieve statistics on what happened in a certain process, when it happened, in what order, by whom, where and why. QPR provides continuous process performance monitoring in the form of data-driven insights on the "As-is" state of processes, benchmark performance and analyse the root-cause behind process variations and long lead times. These allow to speed up the discoveries of potential automation opportunities and reduce the time between the discovery and resolution of an issue.
  Note: this tool was being implemented in Supply during the time that this study was being conducted. Nevertheless, it was not used in any step of the Spiderweb program.

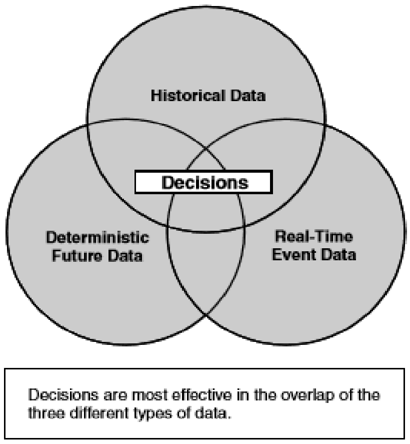

Figure 12 - Data balancing [11].

The combination of data analytics tools with automation technologies provides new ways to effectively measure and monitor process performance in every step of the supply chain. However, this is only possible if master data quality (correct, complete and consistent data) is secured. Most business processes rely on the availability and accuracy of master data in the information systems [31]. According to Gartner, master data is "the consistent and uniform set of identifiers and extended attributes that describes the core entities of the enterprise including customers, suppliers, sites and chart of accounts" [32]. Master data is the first area of the Supply Logistics Process Adherence (see chapter 5.2), and it is the responsibility of all system users to report any incorrect master data that may be found at any point in a process.

As master data has become more and more dispersed throughout the organisation's information systems, Master data management (MDM) has become an imperative in enterprises. MDM includes cleaning, updating, governance, tracking and control of all master data in the systems, and it is critical for data-driven operational decisions [33]. For a seamless adoption of automation technologies, MDM must be continuously carried out in all information systems.

5.6 Automation technologies

In this subchapter, the most promising automation technologies that can improve business process execution are briefly presented, highlighting its capabilities, requirements and key characteristics. It should be noted that some of the following introduced technologies have already been implemented at Ericsson Supply, with others being introduced to raise awareness to the potential benefits of such implementations.

Prior to the beginning of Supply's automation journey, the only implemented tools that provided a basic level of simple task automation were Visual Basic for Applications (VBA) and Winshuttle. The latter consists of a software product that enables the transfer of large amounts of data from Microsoft Excel to the SAP system without having to program scripts or to manually insert data.

This tool is still used today by some Supply groups (e.g.: Supply Delivery Managers) as it provides benefits such as mass data entries in a controlled way, decreasing manual data input and updates, hence, improving data quality.

The automation journey at Ericsson Supply started roughly two and a half years ago with a pilot project to study the feasibility of having automatic creation of purchase orders. It later evolved into a proof-of-concept, supported by a team from a recognized consulting firm, that resulted in the adoption of RPA technology with some bots being deployed. As of the start of the thesis project, fourteen bots had already been deployed to support the Regional Order Desk (ROD) operations in MELA, automating local PO creation.

Robotic Process Automation (RPA)

When one hears the word robot it usually brings up to mind the image of a machine or an industrial robotic arm working on a shop floor of a factory. However, the term RPA refers to a software robot that interacts with other installed applications in a similar way to how people do. That is, it operates on top of user interfaces (UI) of web-applications or ERP systems in the same way a human employee would work [26]. An automation software consists of sets of rules or computer instructions programmed to carry out repetitive tasks that are rule-based, yet, not having the capability of making decisions or learning. RPA is the current state of automation; however, it is also a basic technology. To expand bots' capabilities and potential increase its robustness, RPA (Systems that DO) can be integrated with AI and Machine Learning (Systems that LEARN), helping to interpret changing interfaces and scenarios [34].

Two types of RPA automation can be considered: unattended and attended automation. The first concerns automation without or with as little as possible human intervention, where actions are triggered by the bots themselves, being capable of running around the clock, all year round. Unattended automation is most commonly used in back-office scenarios where large amounts of data are being gathered, sorted, analysed, and distributed amongst key players in an organisation. On the other hand, attended automation relies on the cooperation with employees, with the trigger of specific actions or commands being an employee. As a result, attended automation solutions must be user-friendly for employees to quickly move between multiple interfaces. [35]

As stated by Leask et al.: "today's successful RPA initiatives can provide a foundation for tomorrow's cognitive automation. It will also help win the trust of senior management by demonstrating that the organisation is moving in the right direction" [34]. However, there are some drawbacks associated with the RPA. These reside on the technology not actually fixing issues, rather only touching the surface; it does not optimise a process, rather makes it faster by replacing human manual work. Moreover, and according to Williams, if programmed incorrectly or if the input data lacks quality (e.g. wrong master data), incorrect results or no results will be delivered [36]. On the other hand, RPA can be quickly set up and easily altered, requiring a non-invasive integration, with no changes to the backbone systems.

Artifical Intelligence (AI)

The term AI dates back to 1956, when it was introduced by a Stanford computer science professor, John McCarthy. Even though there is not a universally agreed definition for AI, Nilsson provided a useful one: "Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately with foresight of its environment" [38]. In other words, the ability of machines to perform cognitive functions associated with humans, such as perceiving, reasoning, learning, interacting with the environment, and problem solving [39].

According to a study by Stanford University, the field of AI is a continual effort to push the boundaries of machine intelligence to make as close as possible to human intelligence [22]. AI comprises a combination of technology components – sensing, processing and learning components – to be able to understand the real world (see figure 13) [40]. SCM World by Gartner claims that by using AI technology companies will be able to plan their supply chain in a much more frequent, granular and predictive way [41]. However, the speed of change derived by improved planning capability can become meaningless, if companies are not able to develop greater operational agility.

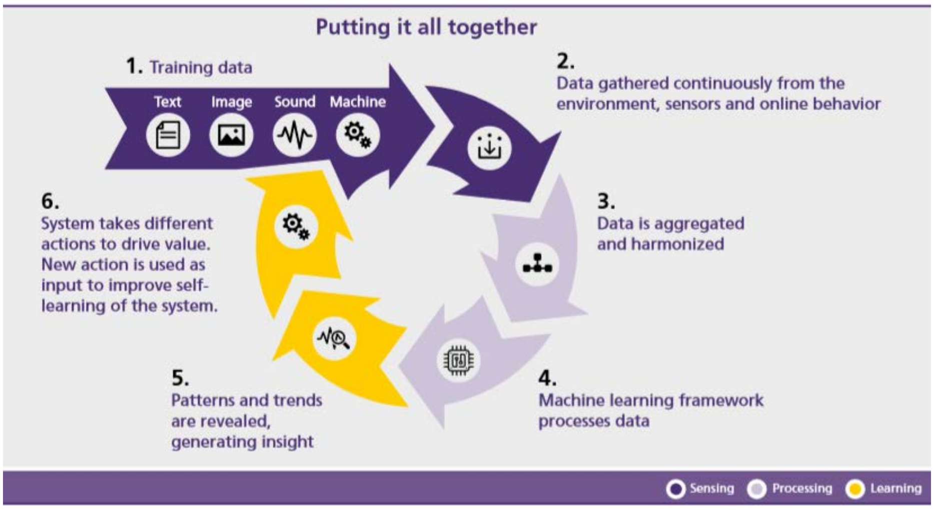

Figure 13 - A full AI learning cycle [40].

Other two terms that are important to better understand AI are Machine Learning (a subset of AI), and Deep Learning (a subset of Machine Learning).

Machine learning (ML)

It is the practice of teaching a computer how to detect patterns and make connections by analysing massive volumes of data [37]. ML relies on statistical methods to numerically calculate an optimised model based on the training data provided. Instead of receiving explicit programming instructions, by applying the learned numerical model to new data this will lead to predictions or action recommendations that are statistically closer to the training examples.

ML focus on predictive analytics to deliver insights and anticipate what will happen, and prescriptive analytics to provide recommendations on what to do to achieve goals. McKinsey Analytics provided a succinct and clear definition of the main types of ML: [39]

- Supervised learning

  It concerns algorithms that use feedback from humans to train data and learn the relationship between given inputs and given outputs. The algorithm is trained on the data to find the connection between the input variables and the output. When the algorithm is sufficiently accurate, it is applied to new data. This type of ML can be used when the classification of the input data and the behaviour to predict are known.

- Unsupervised learning

  It takes place when the ML-enabled system uses an algorithm to explore unlabelled input data without being given an explicit guidance from humans (e.g. explore data to identify patterns). The algorithm identifies groups of data that exhibit similar behaviour. This type of ML can be used when the classification of the data is not known, with the aim of finding patterns and classifying the data for the user.

- Reinforcement learning

  It uses an algorithm to learn to perform a task simply by trying to maximize the rewards it receives for its actions. The algorithm optimises for the best series of actions by correcting itself over time. This type of ML can be used when there is not a lot of training data, and it is not possible to define an ideal end state. The only way to learn about the environment is to interact with it and amass data from the environmental responses given to the system.

Deep learning

It is a type of ML that can process a wider range of data resources, requires less data pre-processing by humans, and can often produce more accurate results than traditional machine-learning approaches (although it requires a larger amount of data to do so). In deep learning, interconnected layers of software-based calculators known as “neurons” form a neural network. The network can withstand vast amounts of input data and process them through multiple layers that learn increasingly complex features of the data at each layer. The network can then decide about the data, learn if its decision is correct, and use what it has learned to make conclusions about new data. For example, once it has learnt how to look for an object, it can identify the object in a new image.

Cognitive technologies

An intelligent agent, a practical implementation of AI and ML, is software that is able to make decisions and operate autonomously in a complex environment. The term cognitive technology refers to a diverse set of techniques, tools and platforms that enable the implementation of intelligent agents. The purpose of intelligent agents is to perform actions and communicate solutions based on two technology pillars: machine learning (previously explained) and machine reasoning.

The second generates conclusions from symbolic knowledge representation, using logical induction and deduction [42]. Popular cognitive technologies include Speech processing and Natural Language Processing (NLP). These comprise the understanding and generation of natural language, requiring lexical, grammatical, semantic and pragmatic knowledge [43]. They are often associated with automatic speech recognition, a very active area of machine perception. Speech processing regards the leverage of tools for speech to text conversion, and vice-versa. Whereas NPL analyses natural language data for insights and query response, with research now moving towards developing systems that are able to interact with people via dialog, instead of simply reacting to standardised requests [22].

According to SAP News Centre, it is the integration of different automation technologies (RPA, Artificial Intelligence, automation in SAP, cognitive automation) in different layers and for different use-cases that enables a holistic automation implementation at a company.

6. Challenges of automation

6.1 Technical challenges

The improvement of one process does not eliminate the need for the improvement of another. An iconic representation of this idea is the O-ring[1] production function studied by Kremer [44]. In this model, failure of one step in the chain of production leads the entire production process to fail. Autor used the O-ring model to establish an analogy with automation: "when automation or computerization makes some steps in a work process more reliable, cheaper, or faster, this increases the value of the remaining human links in the production chain" [45]. The higher the automation level in a certain flow, the more important the remaining human activities related to the same flow will be. Deloitte surveyed 478 executives from various industries, including telecommunications, who identified the major technical challenges to scale the implementation of automation (by bots) at a company: [26]

- Process fragmentation *(32% of the respondents)*

This issue is typically caused by multiple processes and variations that result in increased complexity and reduced leverage from individual automations. To overcome this, organisations should be process and value led. That is, adopting an end-to-end flow approach that emphasizes high value business opportunities, rather than considering automation a mere implementation of technology. According to the survey, only nineteen percent of organisations are focusing on RPA alone, most are combining RPA with process re-engineering and cognitive technologies.

- Lack of a clear vision *(17% of the respondents)*

Many organisations have neither defined clear specific quantifiable goals nor a vision for automation. Without these, securing support from senior leaders to build the capabilities required to scale automation will be ineffective. Organisations should go beyond small task automation and think large scale process standardisation to extend the potential gains.

- Lack of IT readiness *(17% of the respondents)*

IT support is critical to deploying substantial scalable solutions. IT teams need to learn and adapt, as the pace of automation deployment accelerates rapidly.

Another issue that is transversal to any considered automation technology is the cyber security level of the system. There are three basic elements comprised in information system security: Confidentiality, Integrity and Availability (the C-I-A triad), as defined by Krutz. *Confidentiality* refers to the protection of files and other data instances from being, intentionally or unintentionally, disclosed without authorization. *Integrity* of data concerns the unauthorized interception and modification of data in a system or data source. Lastly, *Availability* is a measure of the ability to access a system or a computational resource by the user.

[1] Note that the O-Ring production function refers to the 1986 accident of Space Shuttle Challenger, which crashed due to an inexpensive O-ring seal that failed after hardening and cracking the night before take-off.

Additional relevant elements in system security are: *identification* (of users, processes, data sources and systems); *authentication* (the act of verifying an identity); *authorization* (granted after identification and authentication are completed); and *accountability* (responsibility for actions, information and processes). [46]

Companies build distinct system architectures using the applications that best suit their business needs. Therefore, different companies will have different policies regarding IT-security and different requirements in what concerns safety, reliability and compliance [28]. Information security is a mandatory concern for any initiative that impacts the IT-infrastructure of the company. In this case, the introduction of automation technologies in the systems require a variety of approaches to mitigate IT-related risks, such as: internal policies and standards; access control mechanisms; identification and authentication procedures; malware detection, isolation and elimination; among others suggested by Krutz [46]. When introducing a bot or any other automation technology, the vulnerability of the entire information system structure increases if IT-security considerations are disregarded during the implementation phase. Therefore, the integration of automation demands for the reconsideration of user permissions, system accessibility and, eventually, higher investment in security software and initiatives, as more and more business processes become automated.

6.2 Organisational change

The ability to quickly adapt and change to new conjunctures is emerging as a distinguishing factor of organisational competence. Companies that participated in Mercer's Global Talent Trends Study cited Automation as the second reason for "Organisation redesign", coming shortly after "Achieving greater efficiency" [47]. Organisation leaders recognize that technology can bring many benefits to a company, but usually they lag in recognizing these benefits and the changes that will be required to achieve them. Making changes at the organisational level is more and more dependent on the agility and resilience of the company's structure.

According to Goran et al., shortcomings in organisational culture are one of the main barriers to a company's success in the digital age. A McKinsey&Company survey of global executives highlighted culture as the most significant barrier to digital effectiveness and three deficiencies associated with this: functional and departmental silos, a fear of taking risks, and difficulty forming and acting on a single view of the customer (figure 14). [48]

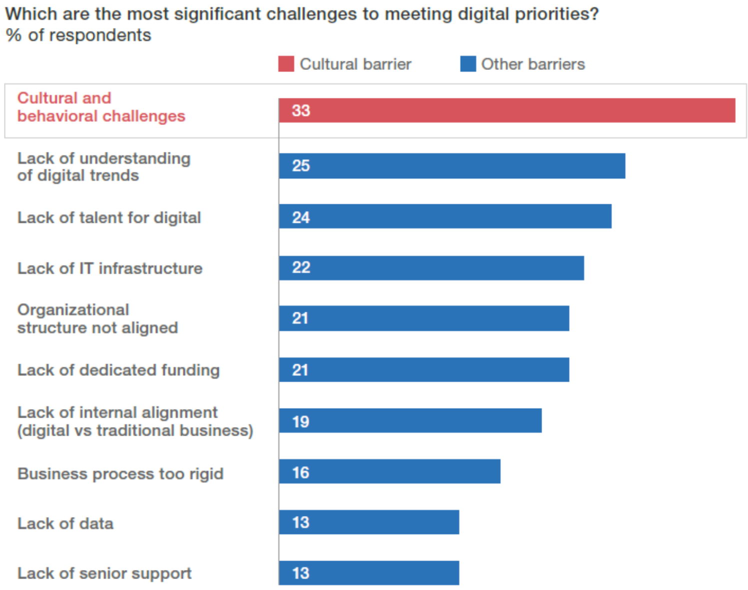

Figure 14 - 2016 McKinsey&Company Digital Survey [48]

Automation of processes will require an alignment of ways of working, removal of silos and strict data management, to be successful. Additionally, companies that support digital strategies are more willing to take risks, hence making their culture more focused on customer responsiveness, and pushing for better cooperation across business areas. Despite experimentation with new technologies having become crucial to be able to compete in an increasingly digitalized world, taking this risk can also be fearsome as the cost of failure can be high. This is due to the fact that companies are more exposed to customer and public scrutiny than ever before. Therefore, key questions to ask executives facing an automation journey are: what risk level are you willing to take? How are you preparing to face potential disruptions? And does your organisation have the right people, skills and mind-sets to face these? A possible way to prevent these risks and reduce the risk of experimentation is to foment a customer-centric culture to anticipate patters in customer behaviours, and by working closely with customers in the development of innovative technologies and tools. [48]

Managers and senior leadership

A survey of directors, CEOs, and senior executives conducted by North Carolina State University, in collaboration with the management consulting firm Protiviti Inc., found that digital transformation is their number one concern in 2019, up from the tenth place in 2018 [49]. The success of an organisational change derived from an automation journey is intimately related to how internal leaders communicate. They must raise awareness for the importance of the needed changes to achieve the latest company strategy or new goals in sight. A study by the SAP Centre for Business Insight indicates that what sets leaders apart from the rest of the organisation is that they have to internalize the need to transform how they think and what they do, prior to creating a digital mindset across the organisation. This study highlights the four traits that characterise a digital transformation leader within an organisation: [50]

- Focus on true transformation: they consider transformation an opportunity to reinvent business models, and they prioritize that over comparing themselves to their competition;
- Transform customer-facing functions first: they view the customer experience as the gateway to a successful digital transformation;
- Invest in next-generation technology: high level of investment in cloud computing, Big Data and analytics, IoT, Machine Learning and AI;
- Be talent driven: they invest heavily in recruiting and training, and in tearing down frustrating process roadblocks, to improve employee engagement and prepare for new technologies.

Furthermore, organisational change is about educating senior managers to be transformation leaders across the organisation. Embarking on initiatives that concern experimenting automation technologies is also about seeing these technologies as integrated parts of the company's future business practices, rather than mere available tools. One of the biggest challenges with organisational changes is to define a strategy to enforce the message throughout the organisation. The defined strategy must ensure that everyone understands and acknowledges the need for the internal change. Leaders might adopt a top-down strategy by redesigning the company's operating model and driving company-wide initiatives from the central organisation to incrementally spread to the local offices. Or a bottom-up approach by starting with local implementations and local changes, with an end-to-end view of customers or specific markets, and later broadening the scope and raising actions to the central organisation level – in an inductive way. The latter was the strategy used in the Spiderweb program: from the analysis of individual local accounts, conclusions were drawn to the MELA region, leading to some improvement actions to be taken on a region-wide scope and driven from Ericsson AB centrally.

Alongside the definition of a clear strategy, managers must create a unified digital culture, to repeatedly apply changes across the entire organisation. This is to be done instead of making disconnected adjustments to the culture, resources and internal politics, so as to avoid falling in the silo-approach to changes, that so often happens. In many cases, ownership of processes and information is fragmented and deliberately not shared, as the popular saying goes: "information is power". According to Schaubroeck et al., senior leaders must reinforce accountability by assigning strong managers that are capable of coordinating end-to-end processes and lead communicative teams [51]. Together with defining a group of transformation leaders to fight cultural resistance and help connect teams end-to-end. Executives must be proactive in shaping the organisation's structure and culture, both centrally and locally, otherwise risking changing too slowly to keep up with competition as digitalization permeates the entire industry, as stated by Goran et al. [48].

Knowledge sharing – breaking down silos

Knowledge is the most valuable resource in the success of a business, but often not recognized as such in an organisation. “Islands of knowledge”, also called “silos”, is a phenomenon that have long affected cross-functional collaboration in many companies and considered by some a structural issue rather than a cultural one. The closed mentality of workers who are reluctant to cooperate or share information across functions and areas can be destructive to a digital culture. The two primary symptoms of a siloed organisation, according to Goran et al., are inadequate information sharing, and insufficient accountability or coordination of enterprise-wide initiatives, or the tendency for employees to believe that an issue is not their responsibility, but rather someone else’s. Data sharing across teams plays a vital role and, if not done, it is the most obviously spotted symptom of a siloed culture. The second stated symptom, although less often directly associated with the “disease”, can be fought by increasing the rotation of managers and employees across siloed business units. This type of rotation should be done in different organisation levels, helping to create a more consistent understanding between functions, and informal networks as employees build relationships in different departments. [48]

Academics are now talking about the concept of “knowledge chain” as to represent an organisation’s knowledge resources and how different knowledge activities can yield competitive advantage, if properly executed [52]. (The model can be viewed in Appendix 3). When employees lack information regarding the wider context of something that concerns their work, it is less probable that they will be able to identify a disruption risk or an automation opportunity when facing it. Goldsbt and Martichenko outline ten possible reasons why knowledge is not properly shared in many organisations: [11]

1. No formal knowledge-sharing infrastructure;
2. No incentives for individuals to share knowledge;
3. No accountability for individuals to share knowledge;
4. No time to share knowledge;
5. No awareness on what knowledge should be shared;
6. No training on how to share knowledge;
7. No departmental or interdivisional communication;
8. Defensiveness resulting in knowledge “hoarding”;
9. No tools in place for sharing knowledge;
10. No commitment to “get it done”.

Consequently, organisations targeting to break the siloed mindset must have mechanisms (whether digital, structural or process) to ensure that information and knowledge is shared between employees. This will create a sense of belonging and direction as individuals and as a team striving towards common objectives [11]. These will help to understand the different organisation priorities and to lead employees to realize their role in achieving the company’s strategy. Introducing a culture of continuous improvement throughout the company will encourage people to openly share best practices, methods and tools that have proved to be valuable.

Cross-functional involvement

If in the past automation was seen as a responsibility of IT teams, it is now a multidisciplinary area that must involve all affected stakeholders and process owners to develop a better understanding of the technology. As stated by SCM World by Gartner, the practice of individual supply chain functions developing their own digital roadmap in isolation is still very common [53]. The launch of separate uncoordinated and unbalanced automation investments leads to pockets of local business improvements, which will not result in end-to-end improvements. The Gartner also suggests that organisations targeting a "zero-touch" supply flow will have to view automation holistically. That is, automation related investments must be balanced and levelled across the entire supply chain, within and across functions. [41]

In a report by Deloitte, it is suggested that in order to increase stakeholder support from different units, organisations must use a set of formal and informal initiatives, during and after implementation, such as: [26]

1. Introduction of technology sessions. For example: "build a bot" sessions on RPA technology.
2. Daily groups to share development progress and question process owners.
3. Weekly status meetings to raise and monitor risks and issues against the estimated plan.
4. Monthly steering committees for governance, take decisions and to track progress and performance of the adopted automation technologies.
5. Wider regular communication across all company channels to show progress and impact of the ongoing initiatives.

Leaders and managers must promote initiatives that make people work horizontally, i.e. work cross-functionally with transparency, and collaborating both in and across Market areas and business areas. Waste is regularly created in organisations, when duplicated efforts are in place in different parts of the company, regarding similar issues. Although this redundancy might not be easily avoided, communication between people working with similar cases could lead to a joint effort to create better methods and processes. A tactic recommended by Schaubroeck et al. is for leaders to set stretch goals that no individual function or business could meet on its own, forcing employees to collaborate [51]. Cultural changes within corporations will always be slower and more intricate than the technological changes, which makes it even more critical for executives to take a proactive attitude on culture. As specified by Goran et al., leaders will not achieve the speed and agility they need unless they build organisations that perform well across functions and business units, embrace risk, and focus on customers [48].

Lastly, completing a digital transformation does not necessarily mean that an organisation has reached an end state, rather that the initial cross-functional and cross-departmental transformation projects have finished.

6.3 People change management

The first industrial revolution incited ethical issues related to labour rights and working conditions. The fourth industrial revolution has raised these issues once again. The advent of automation and other computer-assisted technologies have brought many concerns about the future of jobs and wages that have spread to companies across the world. In December 2013, activists chanted outside Amazon's headquarters in South Lake Union: *we are people, not robots*. Similar protests happened in November 2017 in South Korea, when Hyundai announced the desire to introduce more automation and reduce assembly-line workforce size. In 1930, John Maynard Keynes wrote that: "we are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment" [54]. In 2016, a European Parliament motion stated that: "the development of robotics and AI may result in a large part of the work now done by humans being taken over by robots, so raising concerns about the future of employment and the viability of social security systems" [55]. These concerns are more present than ever before, with the increasing automation of low and medium-skilled jobs. A study by consulting firm Mercer states that: "Work and human work have become two distinct concepts. Companies simply cannot thrive without taking advantage of the best and newest technology" [47].

According to Wright and Schultz, the key stakeholders in the automation of business processes are: labour markets, firms, customers and governments; the technological advances in automation will affect all stakeholders in different ways [56]. Freeman defines stakeholder as "any group or individual who can affect or is affected by the achievement of the firm's objectives" [57]. Regarding labour markets as a stakeholder in job automation, the three factors that will define the immediacy and likelihood of professions being disrupted by automation: (1) routine; (2) skills; (3) social interaction. It is expected that routine-based jobs, with low social interaction and low skills required will be the first impacted by automation. Meanwhile, jobs that require non-routine, high social interaction and high skills will benefit from automation. [56]

A possible result of the shift in labour needs was stated by Wright and Schultz: "As automation becomes cheaper than labour, companies from developed countries will return to their home country, as outsourcing will have fewer economic advantages" [56]. In what concerns companies, these are posed to be the stakeholders benefiting the most from automation, especially large firms who have the capital to adopt the technology in an early stage. In a report by Marsh&McLennan companies, it is stated that there is an increasing need for companies to adopt strategies and transform their business models to realize the opportunities of a digital revolution [6]. At the same time as they are being challenged to define their workforce for the future. On the other hand, consumers will be given increasing purchasing power by being offered lower prices, due to lower production costs, combined with increasing consumer demand. Nevertheless, companies have started experiencing the impact of the negative scrutiny of the other stakeholders: employees, governments and customers. It will be governments' role to include automation in the political agenda, in order to: minimize disruptions, reduce social inequalities that may arise from polarization of jobs by skill-level, and create regulation to oversee automation practices. As of now, no regulation exists related to automation.

In a 2017 study, Mercer and Oliver Wyman state that business leaders at a company should address the following four questions to assess the implications of a digital revolution on their workforce: [6]

1. **What changes will impact my workforce?**
   Identify the trends impacting the workforce, set a vision for the future workforce and align leadership with this vision.
2. **What will my future workforce look like?**
   Map the current and define the future workforce under different scenarios, by identifying future talent gaps, the skills that will be required and workforce size needed.
3. **What strategies are needed to bridge from the current state to the future workforce?**
   Specify the strategies to deliver the future workforce and implement platforms to help transitioning.
4. **How do we deliver the workforce transformation?**
   Roll out and manage transformation strategies, establishing clear governance of the transformation.

Some claim that automation may result in workforce disruptions, that will change how individuals work and the availability of jobs. With companies and policymakers still lacking a structured approach to assess and navigate the ethical quandaries that will arise as businesses increasingly adopt automation [56]. Whereas other researches, who support business automation, claim that it may displace workers temporarily, but it has historically created more jobs than the ones displaced. Furthermore, these advocates say that automation will complement workforce, instead of replacing it, increasing workers' productivity and making jobs more rewarding by reducing routine-based tasks. Using automation can allow the company to redirected human resources towards more value-adding work. [24]

Nonetheless, the rapid growth of business automation will require an adequate preparation of all stakeholders, in order to minimize disruptions with the inevitable labour displacements that may derive. Those already employed will need the skills to adapt to an automation-driven work environment. This will require the training and education of Ericsson's current workforce, so that its employees are able to realize the company's direction and culture.

Hence, the automation journey must be an educational journey that is supported by increasing proliferation of formal means. These may include company sponsored educational opportunities via internal (e.g. Ericsson Academy) and external (e.g. Coursera, Edx) platforms to share knowledge, skills, learning processes, and strategies. However, Purvis et al. alerted that in order to gain the value-adding potential of organisational knowledge, the launch of IT-enabled knowledge platforms is not sufficient. Instead, the knowledge platforms should be integrated into the ongoing work processes in organisations [58]. Another important means of training employees is via external entities such as professional associations or external consultants. This provides an unrestrained influence by viewing the company's business practices from the outsider perspective on "the way things should be", rather than "the way things are". This ultimately nurtures the questioning of the company's processes, ways of working and, eventually, its fundamental principles. Yet, it must be recognized that the knowledge gained with training sessions will only translate into performance improvements, if opportunities arise for one to apply the newly acquired skills, as noted by Goldsbt and Martichenko [11].

Moreover, competence and leadership are key assets that need to cope with accelerated change and technology shift. A Mercer study on human resources trends elaborates that talent strategies and structures should be as flexible as organisations' business strategies and structures. According to this study, the surveyed companies claimed that the HR's top four talent management priorities for 2018 were: (1) Developing leaders for succession; (2) Building skills across the workforce; (3) Attracting top talent externally; and (4) Supporting employee's career growth. [47]

<u>Some predictions regarding workforce changes in numbers:</u>

- In Sweden, 80% of the citizens studied feel positive about automation and AI because they trust their government and companies will take care of them [43]*;*
- Arntz et al. estimate that only 7% of jobs in Sweden are at high risk of being automated, compared to an average of 9% for all OECD countries (figure 15). The authors explain that the risk of automation must not be equated with employment losses in these countries, since macroeconomic adjustment mechanisms may result in increased labour demand in certain industries. [59]

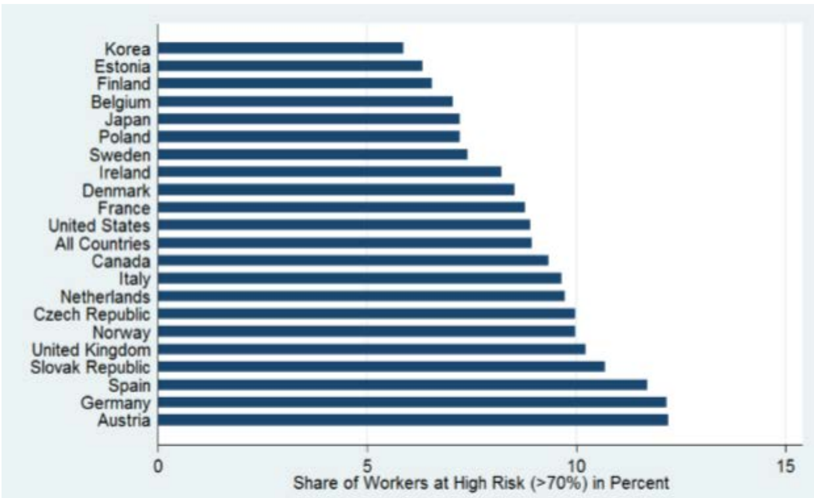

Figure 15 - Share of workers with high automation risk by OECD country [59].

7. Discussion

7.1 Automation technologies to improve Supply's performance (RQ1)

To answer the first research question, two sub-research questions were defined to provide a full picture of what currently impacts Supply lead times and the main factors to consider when analysing a possible automation implementation. The first sub-research question is directly related to the findings from the Spiderweb program, following the methodology described in chapter 3.2. The second sub-research question is based on crossing two aspects: the common critical factors highlighted in literature and relevant in Ericsson Supply's case, and the insights gathered during the interviews concerning the current state at Supply.

Sub-RQ1.1: What are the issues currently affecting Supply's performance?

From the analysis of the six accounts in the Spiderweb program, 188 issues affecting the order flow were identified. The recurrence of certain issues in all six accounts resulted in conclusions being generalized to the entire region in the scope of the program (MELA). Even though these issues do not equally impact the end-to-end processes, they all lead to inefficiencies in the flow that result in performance losses. With performance being evaluated by the order handling lead times explained in chapter 3.3. When planning the automation of a process, one should bear in mind that the same issues affecting the order flow now will not be solved by using automation technologies. An automation implementation is only as good as the processes and the flow from which it is built upon: if the processes do not work, the implementation will not either. Hence, automation must start with upstream processes, to secure that the ones downstream receive all needed and correct information. If the previous order handling processes have delays (long lead times) or are missing information for the upcoming process, these issues must be addressed prior to considering automating the subsequent process.

During the Spiderweb step of classifying issues per improvement area and consolidating all accounts together (Appendix 1), it was possible to identify the most recurrent improvement areas by number of issues. The top five improvement areas are presented in table 3, together with a motivation for the most frequent issues affecting each area. It is assumed that by identifying the most recurrent pain points of the present hardware order flow, the main areas to improve before an automation implementation are exposed.

Table 3 - Top five improvement areas with most issues associated.

Improvement area	# of issues	Explanation
Cross-functional performance	30	• There is no one accountable for the end-to-end coordination of all processes, hindering end-to-end visibility and governance. Accountability for specific processes locally is also sometimes not assigned to anyone. • Too many interfaces, roadblocks in SAP and handovers in the order flow result in: limited end-to-end process knowledge, poor communication between stakeholders and missing information during handovers. Ultimately, these lead to many change requests received during the flow.
Master Data	25	• Non-updated sourcing and product master data impacts lead times related to supply chain preparation and establishment phases. One of the main obstacles for HW PO automation is the material master data situation, where there are multiple vendors for the same material, and no clear guidelines in how to choose the right vendor for each material in each case. • In other cases, master data management is overlooked at the local company level, with no clear responsibilities or competence assigned to this area.
Order Handling	13	• Unclear CPO information in local solutions and manual entry of this information lead to quality issues that impact Admin LT. • Workflow deviations in SAP due to the various ways of working at the different local companies and the inexistence of standardised routines to handle deviations in the flow.
CBE process	12	• Too many handovers between CBE and Supply (order delivery managers) leads to poor quality or late data input in Supply, and change requests related to incorrect information. • The CBE process is also delayed by missing data or poor-quality data from Pre-sales, making it unclear what the customer is ordering and delaying sales order creation.
Tools	12	• Some local companies use local solutions that are too dependent on Excel tools and email, due to lack of support and/or limited functionalities in SAP. These make order visibility unclear and invalidate the usage of *Tableau* dashboards. • This is the only improvement area from the top 5 that does not directly affect a specific segmented lead time. However, it makes manual processes more error-prone and results in poor visibility of orders.

From the Spiderweb findings, it was possible to conclude that the majority of the issues affecting the different segmented lead times, therefore affecting potential automations, have its roots outside Supply's responsibilities or during preparation of Supply. These are predecessors of Supply's activities, such as: pre-Sales, Customer Engagement, Sales, Sourcing and Finance (CBE). For example: supplier master data is Sourcing's responsibility, whereas structuring the project is CBE's responsibility. Hence, they will not be solved in Supply. Instead, they have to be addressed by the company as a whole, requiring cross-functional involvement.

Sub-RQ1.2: What are the critical factors in process automation?

The combination of knowledge gathered from the literature review and the insights from the conducted meetings and interviews provide a clear overview of the most relevant aspects for the success of process automation in Supply. Even though the chosen interviewees come from different areas of the business with different types of knowledge, background and hierarchical levels, there were commonalities in their answers. This increased the relevance and reliability of the results from the interviews. In table 4, a summary of the most relevant and decisive factors in automation is presented.

Table 4 - Critical factors in process automation.

Categories of factors	**Motivation**
Technical implementation	Technical feasibility of the solution: *how will it affect the existing IT-infrastructure?*
Financial aspects	The cost of the automated solution must be calculated including: budget for the initiative, time frame, resource availability, expected long term benefits.
Workforce	Evaluate current workforce and plan future workforce needs. Address the workforce gap by upskilling current workforce and/or attracting talent externally. *The right people, the right team.*
Support and strategy	Support from management must be aligned with the group's established strategy. Moreover, there must be a clear communication of plans and objectives from senior management to the implementation teams.
Coordination and communication	Supply chain coordination must include communication between each supply chain stage. Most of the deviations in current processes result in a lot of change management being required, which is often due to information not being shared between stakeholders during process handovers.
Culture	It is common to have strong resistance to cross-functional changes, in this case changes deriving from the digital transformation in place. This must be properly addressed by senior leaders and managers – work with people change management initiatives.
Data-driven organisation	Data-driven operations must be the core of the company's ways of working, with business decisions being stirred based on facts: *Is the right data available? What does the data show?*

By establishing a parallel between the most frequent issues currently affecting hardware order flow (sub-RQ1.1) and the afore mentioned critical factors in process automation (sub-RQ1.2), conclusions can be drawn on the relevance of different issues in making automation a reality in Supply:

Issue: ***Cross-functional performance*** *– Critical factor:* ***Culture***
Resistance to cross-functional collaboration is seen at every level of the order flow, sometimes due to a lack of process governance, others due to insufficient knowledge on who is accountable for a process or who has the right information. This resistance must be urgently addressed by managers that periodically review the issues affecting their team's performance and stimulate cross-functional discussions. The sharing of best practices and experiences between people across silos will help to improve the quality of the information shared in the system, besides helping to capture all the needed requirements and steps for a process to be automated.

Issue: ***Master data*** *– Critical factor:* ***Data-driven organisation***
Correct, relevant and updated master data, in all its types, is an absolute pre-requisite for any order flow to run smoothly. Incorrect master data affects every step of the flow, impacting all segmented lead times. Master data management is, therefore, one of the most important factors that must be ensured prior to implementing automation. An automated process built upon a system with wrong or unclear master data will inevitably fail to deliver the main goal of automation: improved efficiencies. By automating a process, the level of control over all inputs and tasks must increase as decisions in the organisation will be more and more based on system data. These decisions can be misled if based on results that had as a starting point wrong input data. In some cases, it is difficult to make decisions based on system data as the visibility of the order flow is so unclear that is not possible to capture all information related to changes that happened during the flow. Some of these changes sometimes happen "off record", i.e. not captured in events with time stamps in SAP.

Issue: ***Order handling, CBE process*** *– Critical factor:* ***Coordination and Communication***
Manual entry of information and too many handovers between stakeholders lead to non-standard ways of working and deviations in the SAP flow. These usually result in change requests to handle deviations or wrong input information that increase a process's lead time. Communication between stakeholders to standardise and align ways of working is crucial to improve the coordination of Supply's operations. The more standardised a process is, the easier it will be to map all tasks for automation and, eventually, scale the implementation by re-using the same automation resources to similar flows (bottom-up strategy).

Issue: ***Tools*** *– Critical factor:* ***Technical implementation***
Despite the disregard of technical aspects of automation by some authors when naming the most relevant factors, these must still be considered when targeting large-scale automation at a global company. The standardisation of IT-tools used in local Ericsson companies is vital to make top-down automation strategies a reality in Supply. This will also build towards Supply's strategic capability *Visibility:* by improving end-to-end order visibility throughout the supply chain and making real-time system data a reality no longer exclusive to Ericsson centrally, but also available to the local companies.

If the target of having a *zero-touch* order flow is to be met within its timeframe, standardisation of ways of working in Supply across the entire market area in scope must be established and communicated as an absolute priority for managers in all locations. Nevertheless, automation in Supply will require a joint effort with other business areas, since most issues now affecting the order flow have various roots and impact groups of stakeholders differently. These issues are dangerous threats to automation's viability.

If addressed properly and in a timely manner, it is possible to significantly reduce lead times (faster deliveries), increase customer satisfaction and improve customer's brand perception and loyalty.

7.2 Impact of automation: organisation, culture and workforce (RQ 2)

To answer the second research question, the impact of automation in Supply as an organisation is first presented, followed by an explanation on how automation will affect Supply's current workforce and the future competence needs.

<u>Establish a culture of information sharing in the organisation</u>

The automation journey involves numerous stakeholders at Ericsson, both within and outside Supply's organisation. As a result, there must be a strong alignment between all, alongside a clear definition of governance and accountability in all processes, to guarantee that the end goals, such as lead-time reductions and process simplification, are achieved. These goals will not only demand for improvements at Ericsson's internal organisation, but also challenge external stakeholders. The latter will have to become more efficient in how they communicate with Supply and in their business practices, by complying to Ericsson's ways of working and acknowledging the benefits of automation in the supply chain which they belong to. Automation in Supply will provide senior leaders with opportunities to improve their performance. However, at the expense of having to rethink their processes and organisational structure, to improve the coordination of all supply chain stages [27].

When establishing a comparison between Leask et al. formula for a successful automation strategy (see chapter 5.4) and the observations in Supply, it is possible to infer that Ericsson is already working towards the improvement of the organisation aspects suggested by the authors. Yet, there are still areas to be improved. Up next, a review of Supply under the organisational aspects highlighted in the formula is presented:

1. **Alignment of strategic objectives and management support**
   Automation is in itself a cultural shift that must be acknowledge and understood in order to be successful. The leadership team in Supply EMEA is sponsoring and driving this change with a clear strategy and communication on how the company will proceed. However, in what concerns the managers level, they should be more explicit on what are the expectations for their teams regarding the automation strategy in place. Although not everyone involved in automation projects will be implementing automation technologies, the results from these projects will certainly reach far more employees than simply the ones involved. Managers must communicate and plan how the automation of certain processes will directly or indirectly affect their teams. The more people communicate across the supply chain, the clearer organisational goals and objectives become, which may increase the overall level of coordination across supply chain functions [61].

2. **Local islands of knowledge**

   Organisational change is hard, but it must be properly planned to keep silos from continuing to obstruct collaboration among functions. From the Spiderweb analysis it can be inferred that individuals and teams still work in silos. This happens especially in the local companies. They do the best they can in their specific function, but they are not aware of the effect of their work in someone else's. An explanation for this might be the spotted inexistence of end-to-end process accountability in most local companies, affecting the flow at every connecting point in the organisation. This lack of accountability, or the tendency to believe that an issue is someone else's responsibility, is one of the primary symptoms of a siloed organisation, according to Goran et al. [48]. Every time there is a handover point in the organisation, there are flow inefficiencies.

   People are not working together, they are working at the same time. If employees lack knowledge regarding the bigger picture of the context of their work, they will not be able to critically judge what and how they can improve. Therefore, when establishing the strategic objectives, Supply leaders must consider how they can instil a collaborative culture to unlock the existing pockets of resistance [51]. This is where creating incentives to share information across divisions plays a vital role in Supply. Communication must be frequently established at different levels: central organisation to the local organisations, between managers of interdependent areas of business and from local managers to their teams. Failing to share information, knowledge or good practices leads to underperformance in Supply and to employee complacency. Complacency is the enemy of knowledge and the biggest obstacle for improvements [11].

3. **Clear communication of plans**

   As stated by Goldsbt and Martichenko, the ability to communicate and share knowledge may be the determining factor that differentiates organisational success from failure in the new age of technology [11]. At present, Ericsson Supply is trying to improve overall internal communication in the organisation. The latest Group Supply's strategy regarding internal communication is to be as open and transparent as possible, and to teach everyone in the organisation the strategies forward and how they can contribute. This communication strategy has resulted in successful initiatives, such as: knowledge sharing sessions on topics related to automation and innovation in Supply (at least once a month); Supply Monthly Pulse Strategy newsletter, to share the latest findings and ongoing activities addressing Supply's strategy and strategy execution; extensive usage of SharePoint tool to find all relevant material; Supply's all employee meetings, for group-wide communication of ongoing initiatives or strategy updates. The way forward should include a reinforcement of the relevance and increase the adherence to the already implemented initiatives.

<u>**Workforce development for a successful automation journey**</u>

The coined term *industrial revolution* has been around for centuries to describe periods of time in history where major technology innovations took place, to transform entire industries and, soon after, to change the entire world economy and society.

Yet, to think that the technology is the foremost success factor behind all industrial revolutions is to see only a small part of the picture. From the first to the fourth industrial revolution, there is a common factor that has been the driving force of all changes, the most disrupted group and the one who has benefited the most from these technology breakthroughs: society in general and labour markets, i.e. people. It is often said that people are a company's most important asset [11]. However, and as referred by one of the interviewees, it is also the most difficult to manage and the one that determines the success of any change initiative [48].

As commonly stated by many authors, the automation of job tasks will not happen in the same way for all job roles. From the literature review, it is possible to conclude on the main characteristics that define the job tasks more prone to automation, these are: rule-based, standardised, routine tasks with high volumes of structured data and low-levels of social interaction required to perform it. In Supply, the previous characteristics were identified in job roles such as supply delivery managers and order delivery managers, whose main repetitive tasks are conducted in SAP tools. Nevertheless, and according to McKinsey Global Institute, very few occupations (only five percent) are fully composed of tasks that make them candidates for full automation. Most job roles only have partial potential for today's existing automation technologies. As a result, employees will more and more perform activities that complement and monitor automation, focusing on tasks that cannot be automated. [27]

As some activities are transformed by automation, the nature of work itself must adapt to the new needs. With Supply looking into automation initiatives to improve its performance, it must not disregard how these will impact the current workforce and what the future workforce needs will be. Despite some company-wide human resources initiatives being already in place to prepare for a potential workforce shift, there is still room for improvements regarding:

1. **Employee resistance to change**

   Seniors managers and leaders are not only responsible for steering automation initiatives, but also accountable for how the related changes will impact their team's structure and motivation. The empirical findings from conducted meetings and interviews showed that many people at Ericsson may feel threatened and reluctant to change, as they are not able to recognise how they will benefit from automation. Therefore, it is leaders' responsibility to drive communication in their teams to make people aware of the need for the change in the organisation and how they will benefit from it. There is a need to demystify the idea that automation will make all jobs redundant. It will not, but it will lead to a shift of priorities, and a shift of expectations for certain job roles. Even when a *zero-touch* flow is achieved, there will be people monitoring and analysing operations. The nature of daily tasks will move towards more value adding activities, and away from repetitive and routine ones. This will lead to an increase in relevance of each person's role in the organisation.

   A successful change happens at the individual level. For Supply to change, all individuals within it must change. These call for Supply to work with change management initiatives in parallel with the automation programs. In spite of being commonly mistaken for each other, project management and people change management must be regarded as different but complementary concepts for the success of the automation journey in Supply.

   While project management focuses on the technical side of the implementation, change management stresses the activities that enable teams to achieve the desired future state and realize the intended business results, as defined by the Association of Change Management Professionals. [62]

People change requires the preparation, management and reinforcement of the change throughout the organisation. This can be done in different approaches. When interviewing an experienced professional in the change management sector, the **ADKAR model** was the recommended exercise to use in Supply, consisting of five areas to develop in individuals through a series of workshops: [62]

- **Awareness** of the need for change – What is the nature of change? Why is the change needed? What is the risk of not changing?
- **Desire** to participate and support the change – What is in it for me? Do I have the personal motivation to change?
- **Knowledge** of how to change – Understand how to change. Train on new processes, tools and learn new skills.
- **Ability** to implement the change – Achievement of the desired change in performance and behaviour.
- **Reinforcement** to keep the change in the organisation – Actions that increase the likelihood of sustaining the change.

2. **Future workforce preparation**

Managers and job role owners must work closely with human resources to plan how the automation of job tasks should be addressed in their business area, while also considering each team member's knowledge and skill levels in the subject. These stakeholders must plan together the workforce required to make automation a reality and identify the gap between current and future workforce needs. I.e. how existing job roles will have to adapt to the new scenarios, and what new skills will be essential in the future. In all Ericsson's group functions (where Supply is included) and business units, each job role owner is responsible for ensuring global competence readiness for its job role. This includes ensuring that the employees assigned to a job role have or will develop the competences required for the position.

Ericsson has already started a talent transformation: 40 percent of the developers at Ericsson have been here for less than 18 months, and 2500 R&D engineers have been recently hired. Yet, the injection of new people from outside Ericsson with hard-core skills for automation (AI, ML, data analytics, etc.) is only one of the strategies to follow. In a business area such as Supply, the technical knowledge is not enough to drive automation. A cross-functional team will be required for the success of automation initiatives, including: automation experts, process architects, process managers, change leaders and business analysts. Thus, Supply must also motivate and support people within the organisation to upskill themselves, building up on the many years of experience at the company with new competence development. Investing on re-educating current employees will not just minimize hiring costs, but also improve employee engagement, and provide a sense of purpose and community that adds towards one's well-being, since for most individuals work means more than its economic aspect [11].

It is crucial to provide education sessions and workshops on automation tools and digital skills. Not every job role is required to have an in-depth knowledge of the technicalities behind the technologies.

Yet, in many cases a simple understanding of the concepts and capabilities will result in empowered employees that are able to identify technical barriers or repetitive tasks that hinder their daily activities or cause them to work longer than necessary. In the future work will be less about using technology, and more about interacting with technology (which implies interpersonal skills). In other words, technical skills will become the "means to compete" and human skills the competitive advantage [6].

7.3 Reviewing the Spiderweb methodologies for automation discoveries (RQ 3)

To answer the third and last research question, a review of key success factors in Spiderweb's methodologies is first presented, to highlight the best practices that should be followed in future improvement programs based on Spiderweb's success (for example, the BNEW/MA 50% E2E Lead Time Reduction Program). In the second part of this chapter, a framework for automation discoveries based on the Spiderweb method will be presented and explained.

Review of Spiderweb's methodologies and best practices

The Spiderweb program has proved to be successful with nine out of eleven customer accounts having improved the average lead time to meet the contractual lead times. The study also showed that higher percentage values of the measurements supporting the KPIs (i.e. site material forecast and SIPP adherence) translate into faster deliveries, hence, shorter lead times. From the six thoroughly analysed accounts (table 2 in chapter 3.1), only Telia Sweden did not meet the contractual lead time, mainly due to an underperforming forecast accuracy and the customer sometimes requesting longer lead times than the contractual. Nevertheless, the success of the Spiderweb program should not be taken for granted, neither attributed simply to the methodology followed. To examine the processes performed centrally and locally to fulfil an order is, according to Goldsbt and Martichenko, a pre-requisite to decrease lead times [11]. However, the adoption of a Lean Six Sigma approach is not a novelty in improvement projects alike the Spiderweb at Ericsson. This methodology is actually part of what is called *Ericsson Change Engine*, a company-wide toolbox for improvement initiatives.

Findings from the Spiderweb program point to the fact that the **methodology is only as good as the people driving it and the stakeholders engaged in the different implementation stages**. Thus, its success owes itself to the people involved in all parts of the program: definition of the problem statement and scope, preparation of the workshops, engagement in the workshop discussion, action plan implementation and continuous follow up on the improvements. From the execution of the Spiderweb's model presented in chapter 3.3, the *DMAIC* model, the following findings for different steps of the method were reached:

3. ***Define***: during the step of defining the order lead time convention for the different flows, it was very difficult to clearly state the start and finish of the segmented lead time measurements for the financial flows analysed: PSF and QTC. This is due to not all accounts following the same standard supply chain flow and process triggers, even if they belong to the same financial flow category. Some argued that the end-to-end lead time should not have been set as a KPI, since there are too many factors affecting this measurement to be able to study how every factor impacts it in the different types of flow. In the case of QTC, there are certain tasks that are not clearly identifiable in SAP changes, as they are done without any time stamps associated to the beginning and end of the task (e.g.: blank period between CPO receival and SO creation due to the development and structuring of the roll-out plan).

   Thus, in future improvement initiatives, relevant and identifiable problem statements and KPIs must be clearly defined for all stakeholders in the program or that depend on the program's results. This is of increased importance when the information that must be communicated targets different organisation levels, since this information must be relatable to all involved stakeholders. For instance, different stakeholders have different levels of knowledge regarding the end-to-end flow. Hence, when defining the segmented lead time terminologies, different classifications were introduced to make the information relatable to everyone.

- ***Measure*** (As-Is mapping) and ***Analyse*** (root-cause analysis): at these stages, it is vital to conduct the workshop at the local companies' offices and to work with the local driver of the project to identify and involve in the workshop the relevant people from different business areas. I.e. by having people from different knowledge areas engaged in the discussion, a joint end-to-end knowledge is gathered in the same room, ensuring a collaboration that is cross-functional and gaining perspectives from all levels of business. Furthermore, and since the inputs in the workshop phase are predominantly qualitative, the analysis can be made more robust if supported by quantitative arguments, by working with local IT tools and relevant data.
  In the case of customer accounts that had the workshops conducted via *Skype* (e.g.: Telefonica Uruguay), it took longer to collect the information to create the As-Is map, having less information available and with poorer quality. Conducting workshops remotely is also a less personal approach compared to conducting the workshop locally, which leads to decreased engagement in the discussions from people working at the local company.
  These workshops are not Supply-centric, rather customer-centric (putting the customer account as the central focus) and collaboration-centric (by discussing how one's practices affect the other stakeholders in the order flow). Therefore, the benefits of conducting the Spiderweb workshops locally go beyond mapping the order handling flow for a certain customer account; it is a way of improving and imposing collaboration between different business areas.

- ***Improve*** and ***Control***: by scrutinizing the processes followed by each account in the program's scope, it was possible to infer that most issues affecting the KPIs rose locally and early-on in the order flow. As a result, the majority of the improvement actions were carried out at the local company level. In these steps, empirical findings showed that it is vital to have strong and committed local drivers, preferably working in the same location as the local teams.

The drivers and teams must be able to acknowledge the relevance of conducting this improvement program, with the local drivers pushing for the implementation of the procedures defined in the account's Action Plan and keeping close control of the KPIs of the program, to sustain fruitful improvements. In the cases where the local driver was not in the same location as the team implementing the local action plan, or when the local driver was not very engaged in the push for improvements, the action plans took longer to be fruitful and the results were poorer. For example, a strong driver and committed team in Brazil led to a good action plan implementation and fast status update meetings, where people were assertive in their statements and supported the results of the actions with system data. On the other hand, Chile and Uruguay had the same driver who was not as committed and engaged in the weekly discussions, so the result was a weaker implementation with slower and less clear discussions during the status update meetings. Concerning having the local driver in a different location from the local team, there is the example of Mexico: its initial driver was placed in Guatemala, which made it impossible to have an effective implementation and to closely track the improvements. Therefore, later in the program a local driver was appointed at the Mexico City office, one that was closer to the team implementing the actions.

During the status update meetings with the local teams (Control phase), in some cases it was unclear if Supply's performance was being tracked according to customer expectations or according to what the local company thought to be its delivery capabilities to the customer. Given that, ways of reporting local Supply's performance should be standardised for all locations to ensure a clear understanding of the results by all involved parties and avoid misinterpretations. I.e. to thoroughly consider: what data is used, how the data is used, which tool is used to track performance (*Excel* log sheets vs *Tableau* dashboards) and how the data is interpreted. Additionally, the defined KPI measurements should only be considered valid and relevant if they compare customer expectations against Ericsson's actual deliveries, instead of comparing Ericsson's expectations of what can be delivered against Ericsson's actual deliveries. Note that showing averaged KPI values can also lead to incorrect conclusions on how Supply is performing. For example: the customer requests 50 radios to be delivered in bulk in week 5. There might be no issue to deliver 20 radios in week 4 and 30 in week 5. Yet, it would be incorrect to assume that Supply is meeting the customer requested order on time if 25 radios are delivered in week 4 and the rest in week 6. Even if the customer raises no escalation with this delay, Supply's performance must still be measured against the initial request of 50 radios by week 5. Therefore, when presenting data of the unit's performance, this must be compared against the given information on what, when and how the customer wants Ericsson to deliver the order.

<u>The Spiderweb method to drive automation discoveries</u>

The degree of automation potential at Ericsson is a variable that depends on the digital maturity of the Market Areas and local companies. The latter have different maturity levels regarding technology adoption that most often derive from its customers' ways of working and business volume. For example: if most customers in the Caribbean islands place purchase orders and interact with the respective Ericsson local company manually, i.e. using paper and pen, the local company will be forced to have an order flow that follows customers' preferences.

As this is a small region, the low business volume transactions with these customers will not justify the investment in costly digital tools (e.g.: EDI connections). Therefore, the information systems used in Ericsson centrally are not used in all local offices, since the local cost structure would become too heavy with the implementation of some systems that would not be compensated with small revenues from small order volumes.

The differences in how local companies operate and interact with customers are present in more levels than the technological. As introduced in chapter 4.4, these differences are seen in the plethora of ways of working that lead to variations in the three types of flow: order flow, physical flow and financial flow. Even though the order flow can be associated with the local IT maturity, the physical flow depends on the contracts/agreements with external supply chain actors (ASPs, LSPs, suppliers or customs), and the financial flow on the country and customer's financial situation. An important consequence of the variations in the flows that must be acknowledged is that no automation implementation will ever be executed simultaneously in all company locations and in the same way, even when considering a top-down (central organisation to local) automation initiative. These variations impact Ericsson Supply in every aspect of its operations, hindering the technical feasibility of any automation consideration.

As stated by most of the interviewees of this study and confirmed by literature: automation in Supply will only become a reality if processes and order flows are simplified and standardised. The overall performance of a process is therefore affected by each step required. The mathematical principle of cumulative probabilities can be applied to this case: the overall performance of a process is equal to the multiplication of the performance of each individual step. Whilst simplification can be done by reducing waiting and over processing wastes, which are two of the eight waste types defined in Lean theory as process obstacles to provide value to customers. This regards decreasing process complexity that can have its origin in the number of steps it takes to complete it, the roadblocks in the system, the number of stakeholders involved or an unclear process governance. Processes with high degree of complexity have an increased likelihood of having errors and result in the wasting of resources. On the other hand, standardisation can be achieved through a Six Sigma approach that targets to improve the quality of a process by minimizing variations in the business processes. Standardisation is about finding the best way to complete a task, share information and guarantee the continuous improvement of that same task and process flow. Alike the Spiderweb program, an automation discovery can be supported by the Lean Six Sigma concept. [11]

Hence, the way forward in the automation journey at Ericsson will be made in stretches, in an inductive approach: by simplifying and standardizing order flows, identifying specific processes that are suitable automation candidates and choosing specific local flows that meet the requirements to deploy the technology. Later broadening the scope to Customer Units or Market Areas. This is analogous to the strategy followed in the Spiderweb program: from the study of local accounts, conclusions were taken to the Market Area level, expanding the scope of certain improvement actions to multiple locations.

With the identified similarities between the improvement methodology and an automation discovery, the considerations to join the two methods are further explained, highlighting how the Spiderweb "thinking" can be used to drive automation discoveries.

The Spiderweb is based on a Lean Six Sigma improvement management process that takes an end-to-end approach on improvements. The “DMAIC” is a systematic approach used to drive continuous operational and strategic improvements with speed and efficiency. This method is the core of Ericsson’s Change Engine. On the other hand, an automation discovery is an initiative carried out to find automation opportunities by identifying use cases that are feasible technically and also in terms of business relevance. The two methods are regularly considered separately and for different purposes.

However, from the empirical analysis when participating in the Spiderweb, it was possible to infer that only after identifying a “disease” (issue) is it possible to select the “medicine” (improvement action). An automation implementation must not be done simply to make use of the state-of-art technology, it must rather be understood as means of solving an issue or improving a way of working. As a result, and to support future initiatives that take the Spiderweb program as a reference, an adjustment of the methodology followed in the Spiderweb is presented (figure 16). This new framework targets to not only accelerate the improvement management process, but also to support possible automation discoveries that might be considered the right “medicine” (improvement action) for certain identified issues.

The main changes from the previous methodologies are in the automation discovery section, with increased relevance for considerations regarding workforce change, change management, organisational impact and communication of the strategy forward. Furthermore, in the step *Classify processes*, considerations on how to thoroughly analyse each process were supported by literature, and further explained in chapter 5.3. In the *DMAIC* section, the main improvement concerns the introduction of the process mining tool *QPR Process Analyzer* to facilitate and speed up the step of mapping the current situation at the workshop (As-is mapping step). The use of this tool is also suggested to be introduced in the *Control* phase as it provides better real-time visibility of the order flow of an account, complementing the information retrieved from *Tableau’s* (end-to-end) “Supply Lead Time” dashboard.

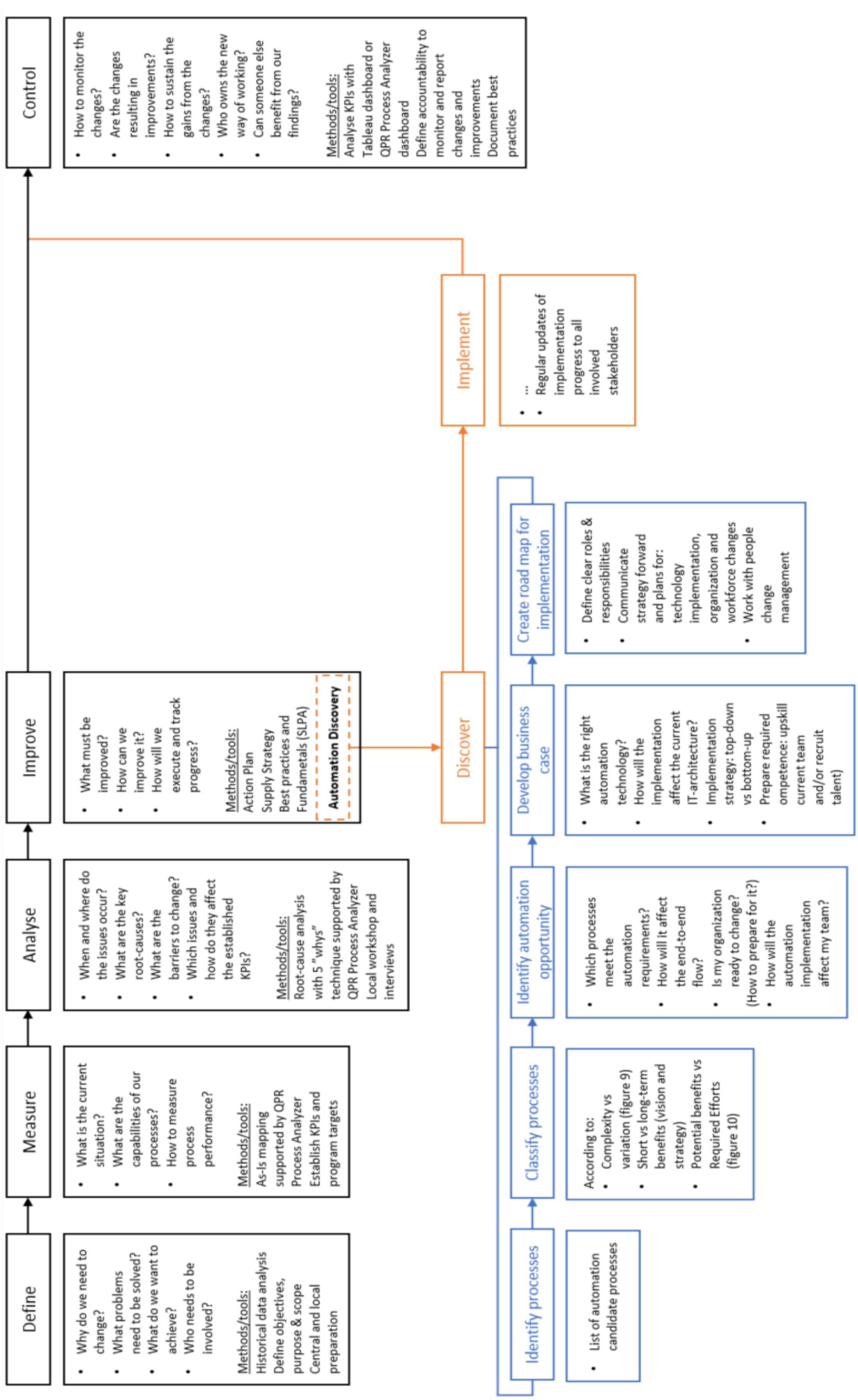

Figure 16 - Framework for a future improvement management process to drive automation initiatives.

8. Conclusions

The purpose of this study was to explore how automation technologies can improve Ericsson Supply's performance, its impact in Supply's organisation and workforce, as well as the factors to take into consideration when implementing automation. In order to achieve the intent of the study, an analysis of the issues most frequently affecting hardware deliveries to customers was also conducted.

Some authors point that now is the best time for the supply and logistics industry to embrace automation. In Supply, the network-based nature of the industry provides a natural framework for implementing and scaling automation. Companies lagging to adopt automation technologies run the risk of obsolescence in the long term, as competitors seize the opportunity of using automation to speed up their business. [40]

Customers continuously want faster and cheaper services, so for Ericsson to gain a competitive advantage and to achieve cost competitiveness speed and agility are required to optimise its supply performance. Lead time reduction driven by automation of processes can result in increased customer satisfaction and increased competitiveness. This will give Ericsson an advantage against competitors, as the time-to-deliver is reduced. However, and as showed throughout the study, the automation journey is unlikely to deliver competitive advantage if it is not accompanied by a clear communication of the strategy by managers and a corresponding "humanisation" of automation [6]. I.e. the development of the workforce to be able to adapt to the new scenario.

As a large corporation, Ericsson suffers from the common syndrome of its class when following a "Think Global, Act Local" strategy: a multitude of ways of working, complex processes with many possible deviations that hinder cooperation between local companies, as well as the effectiveness of measures and tools pushed from the central organisation. As perceived from the interviews, the main challenge for the success of Ericsson's automation journey is to simplify and standardise work practices. Even though the scope of this study focused only on Ericsson Supply, most of the tasks that should be first standardised are outside Supply's governance. These automation barriers are mainly predecessors of Supply's scope of activities, such as: pre-sales, sales, customer engagement, sourcing and finance (CBE).

Furthermore, this study has showed that the four critical factors that will require further developments for automation in Supply to become a reality are:

(1) *Culture* - It is people's motivation that drive the business forward. Hence, a decision must be made on what human benefit must be provided with automation, in order to produce customer benefit.
(2) *Data-driven organisation* - One of the most underutilized assets in the supply industry is the high volume of data (both structured and unstructured) that supply chains generate on a daily basis. Accurate, reliable, structured and relevant data must be in place before removing any blocks in system or before starting automation implementations. Data-driven operations must be the core of business decisions, requiring continuous master data management. [40]

(3) *Coordination and Communication* - Clear roles and responsibilities must be agreed on, as well as defining clear governance and ownership of processes [6]. Communication is the key to a good coordination between stakeholders and seamless process handovers.
(4) *Technical implementation* – The automation will only be as good as the processes from which it is built upon. The use of IT tools at the local companies must be standardised to allow the push of initiatives from the central organisation.

8.1 Recommendations

Automation technologies will continue affecting every part of Supply's organisation, from customers to business partners, including employee engagement and revenues. Automation should not be seen as a way to reduce lead times, rather a way of improving overall ways of working and efficiencies in the group function. The implemented technology must follow and adapt to the business, not the other way around. Yet, in the case of automation, order handling flows must be simplified and made consistent to retrieve the full benefits of automation. The final recommendations to Ericsson Supply to go forward with the automation journey are summarized below. These recommendations are divided into three categories: *operational* or *strategic* (classification introduced in chapter 4.5), and specific Spiderweb-related recommendations. In each category, the recommendations are ordered by importance of the measures for the viability of automation combined with the number of stakeholders required to successfully implement these. E.g.: a recommendation concerning securing a pre-requisite for the automation of processes only involving a specific group of people or one hierarchy level will be prioritised over, for example, a measure related to the technical implementation of automation. Since, in this case, the second measure will only be possible if the first is secured, the first is a precedent of the second.

Operational decisions:

1. **Data-driven culture:** Data analytics is crucial to retrieve data and to analyse the current state. Nevertheless, employees need to know how to read the data and identify the relevant information. Therefore, local companies should also be included in data analytics learning initiatives, so that a data driven culture can be spread to the entire organisation, and not just Ericsson centrally. This will increase process visibility to the local teams during the execution of an order.
2. **Cross-functional collaboration and communication**: Quoting a now familiar sentence that so clearly states what Ericsson should aim at: "Are we working together? Or are we just working at the same time?". Communication is the best way to bust silos. Merit must be given to those that "look at projects not as incremental improvements in isolated pockets of the business, but as opportunities to unify and improve the entire enterprise" [50].
   Managers must instigate frequent discussions between adjacent roles, so that people realize how their work is affecting the person to whom they will handover an order.

Adjacent process owners, i.e. people accountable for processes that depend upstream and/or downstream on other processes, should have frequent discussions on what must be improved in the handover process. This will help align stakeholders, sharing best practices and have processes done "right from the start", decreasing time spent with change requests because of missing or wrong input information.

3. **Standardisation and simplification:** The wanted position should not be RPA, this should be a midterm solution. The ideal is to automate in the SAP system, by removing blocks and check points. Yet, in order to get achieve this, standardisation of processes and data quality must be secured from the beginning of the order flow. At such a large company, these areas cannot be fixed in one swing. More programs focus on standardising and digitalizing local companies' flows must be conducted – more projects, such as the Spiderweb, are needed. A portfolio tactic should be followed, looking at end-to-end processes that combine wider use-cases, to identify the required process simplifications. Simple parts of a process should be automated first, maturing the automated solution by increasing the scope and adapting the implementation to include more similar cases, hence, increasing the return on investments.

Strategic decisions:

1. **Automation strategy**: It is easy to fall in the trap of focusing only on simple task automations (such as automating specific local company tasks with bots). Adopting a single bottom-up strategy will likely lead to very time-consuming initiatives that only result in marginal improvements. Therefore, these should be combined with top-down strategies (i.e. centrally-driven initiatives) that aim towards more ambitious goals that can only be achieved by pushing the organisation to work cross-functionally (with pre-sales, sales, finance, supply, etc.).
2. **Leaders role in the automation:** Top management's responsibility in the digital and automation transformations should not be given to functional units inside the organisation. This might create the risk of having isolated projects that lack cross-organisational involvement. Thus, projects that fail to deliver the sought gains. While some studies have found that most companies struggle with lack of leadership in digital transformation or automation initiatives, the main struggle identified in Ericsson's case is the lack of change management expertise [50].
3. **Change management:** Conduct change management initiatives to help more managers to become change leaders within Supply with "helicopter views", outside-the-box thinking and strategic planning capabilities. These are people with end-to-end cross-functional knowledge, that can proactively identify order flow issues. Change leaders must also be advisors to top management regarding the feasibility of organisational changes. They must be advocates and sponsors of the automation transformation strategies in place, steering and leading initiatives that require the involvement of different areas of the business. Change leaders are the bridge between different knowledge groups and one of the key stakeholders to bust silos in the organisation. The use of tools such as the ADKAR model, together with communication and training, will help managers to plan the organisational change management.

4. **Workforce changes:** It is more useful to consider work tasks instead of whole job roles or occupations when planning workforce changes from automation. Occupations comprise a range of tasks with different automation potential. Thus, hardly will there be a person whose tasks will be fully automated, rather there will be a change in one's responsibilities. Besides looking for people with the right technical skills (e.g.: cyber engineers and data scientists), Supply will need people to lead the change with an end-to-end overview of the company.
5. **Upskill employees:** Preparation for job role-shift must be done, by planning the future workforce needs. Talent development can be done by strengthening the investment in retraining existing staff. For instance, by developing the existing Ericsson Academy e-learning platform, introducing tests and certifications that help the company track the evolution of skills in Supply. I.e. include data analytics in the platform, to track which and how certain job roles are improving and upskilling for an automation future. In the cases of job roles that will inevitably be disrupted by automation of certain processes, a plan should be in place to reintegrate these employees by having mandatory e-learning courses or workshops. The mandatory sessions should be properly time framed in Supply's strategy and must take into account the current knowledge of the participants. Moreover, it is recommended the creation of knowledge sessions with external consultants or seminars with guest lecturers, so that people can view the company's business practices from the outsider perspective and start questioning their ways of working.

Recommendations from the engagement in the Spiderweb:

1. In order to address the different process maturity at the different local companies, the mandatory fundamentals (SLPA, see chapter 5.2) must be enforced. To support this, a tool (maturity ladder) can be provided to the local companies to self-diagnose themselves in terms of process maturity, motivating to become more process adherent. The local teams have to engage in a discussion about up to what extent and how do they want to increase process maturity. Each local team will have different maturity levels due to having to adapt to the local customers' ways of working.
2. SiPP adherence and forecast accuracy must be continuously improved in all accounts in MELA. For this to happen, Supply must work closely with the account's team (ASR) to make sure that the customer orders the products pre-agreed on the product portfolio. This will increase demand predictability, therefore, shortening lead times and improving Supply performance.
3. Share the improvement methodologies behind the Spiderweb program, so that more people can be proactive change leaders. But also share the reasons why the Spiderweb has been successful (see chapter 7.3). The Spiderweb's method, as so popularly called internally to the *Lean Six Sigma* methodology used in Supply, should not be seen as Spiderweb's. The Lean thinking and continuous improvement strategy that was adopted in the Spiderweb should be inherent of each person at every team. Instead of the reactive approach of only solving issues when they become evident, employees should take a proactive stance on their daily tasks. They should continuously ask themselves: *What are we doing? Why are we doing it? How are we doing it?* The Spiderweb method

should be a mentality built in employees at Supply, to routinely identify issues and deviations in Ericsson's ways of working.

4. An adjustment of the improvement methodology followed in the Spiderweb is suggested in figure 16. This is a recommendation on how to use the method to not only accelerate the improvement management process, but to support automation discoveries that might be considered the right action for certain identified issues.

8.2 Future work

With the main limitation of this study consisting of the lack of technical knowledge in automation technologies (such as AI or ML), no evaluation of the feasibility of any specific candidate process for automation was conducted. The proposed improvements and recommendations should be seen as pre-requisites or critical areas to consider for a successful automation. Therefore, extensive studies remain to be done before implementing some of the technologies suggested in chapter 5.6. Further research is suggested to complement this study and to study new areas of applicability of automation in Supply.

Ericsson has proved a successful automation start with the automation of global order management processes, for instance automation of local PO creation for high volume of orders using RPA technologies. Today's successful RPA initiatives can provide a foundation for tomorrow's more transformational automation. Nevertheless, and in order to achieve the wanted position for 2020+ (*zero-touch flow*) and to retrieve significant value to Ericsson, a combination of different types of system automation (automation in SAP, RPA, artificial intelligence and cognitive agents) will be required to scale automation to every part of the organisation. Further suggestions of automation studies are listed below:

1. Study the potential of having "smarter" RPA implementations by using artificial intelligence or machine learning algorithms. These can increase the capability of a bot to handle more complex scenarios and learn common deviations in the flow;
2. Feasibility study of developing a chatbot (cognitive agent) for customer support. This would automate low-level customer interactions, improving service desk operations for higher user satisfaction [40];
3. Improvement of forecasts and capacity planning with time series analysis and forecasting using machine learning.

Equally vital will be the streamline of a data-driven culture with the use of data analytics and process mining to detect patterns in the order flows, monitor end-to-end and individual process performance. These will speed up the automation discovery process by increasing order visibility and gathering real-time insights on flow deviations. Further work related to preparation of the workforce in Supply must be carried out to study how each job role will evolve with digitalization and automation. This future study should highlight what the future needed skills will be and how to prepare for the job role shift enticed by automation of processes. Moreover, managers must be clear in their expectations for their teams, raising awareness for people to engage in competence development initiatives to adapt to the future job scenario.

Future of the Spiderweb program

The second phase of the program should follow up on the general findings of phase one, communicating the final conclusions to the relevant stakeholders. Moreover, it should be decided whether these findings should be addressed as separate initiatives or include them in ongoing ones. The second phase should target the scalability of the methodology used to other regions, since throughout the development of the Spiderweb project, several stakeholders showed interest in learning more about the methodology. Furthermore, stakeholders from other market areas outside MELA showed enthusiasm in conducting similar projects in their customer units, with the main objective of reducing lead times for hardware deliveries. Hence, more change leaders should be trained on the Spiderweb's methodologies and best practices to conduct similar studies in the different market areas.

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Appendix 1: Classification of account issues by improvement area

- 3PP delivery
  Definition: issues related to services from third-party providers;
  Number of occurrences: 2.
- CBE process
  Definition: issues related to processes and tasks performed by the Customer Business Execution team;
  Number of occurrences: 12.
- Change control process
  Definition: issues related to change requests in orders;
  Number of occurrences: 2.
- Commercial management
  Definition: issues related to missing commercial documentation;
  Number of occurrences: 1.
- Competence
  Definition: issues related to human resources skills;
  Number of occurrences: 6.
- Cross-functional performance
  Definition: issues related to governance, accountability, roles and responsibilities;
  Number of occurrences: 30.
- Customer coordination
  Definition: issues related to lack of coordination of customer orders or poor sharing of information between the customer and the company;
  Number of occurrences: 7.
- Data quality
  Definition: issues related to having incorrect, outdated or missing data in the system;
  Number of occurrences: 3.
- EAB hardware delivery lead time
  Definition: issues related to long lead times for hardware delivery;
  Number of occurrences: 1.
- Early involvement
  Definition: issues related to activities that should have been performed earlier or stakeholders that should have been involved at an earlier stage;
  Number of occurrences: 4.
- Forecasting
  Definition: issues related to the planning of buffer levels for Ericsson's Supply Hubs;
  Number of occurrences: 8.
- LSP efficiency
  Definition: issues related to the performance of logistics services providers or the agreements signed with these;
  Number of occurrences: 11.
- Master data
  Definition: structured information that is vital to the operation of a business. It is the enabler of efficient transactional processes, operations and studying, used repeatedly when executing business transactions. This data can be in one application or spread across multiple systems;

Number of occurrences: 25.

- Material planning
  Definition: issues related to the planning of buffer levels at the Ericsson Supply Hubs or Ericsson Supply Sites;
  Number of occurrences: 4.
- Order acknowledgement (OA) accuracy
  Definition: issues related to the vendor sending back to the buyer the acknowledgement of a received purchase order. This is sometimes overlooked, but it can be pivotal to ensure a good communication between buyer and supplier. The two parties can be internal Ericsson entities or external suppliers.
  Number of occurrences: 4.
- Order handling
  Definition: issues related to order processes and deviations from the normal flow;
  Number of occurrences: 13.
- Order planning
  Definition: issues related to the planning of activities within the order flow;
  Number of occurrences: 5.
- Order visibility
  Definition: issues related to lack of visibility of order status or process performance;
  Number of occurrences: 6.
- Organisation
  Definition: issues related to lack of resources to perform certain order tasks;
  Number of occurrences: 2.
- Pick & pack
  Definition: issues related to incorrect items being packed and shipped or items being picked and packed too early;
  Number of occurrences: 3.
- "Productification"
  Definition: issues related to the Product ID of materials and/or products in the system, e.g.: missing or incorrect product ID;
  Number of occurrences: 1.
- Site delivery
  Definition: issues related to the delivery of materials/boxes to the site;
  Number of occurrences: 5.
- Supplier management
  Definition: issues related to supplier performance;
  Number of occurrences: 3.
- Technical solution control
  Definition: issues related to technical requirements;
  Number of occurrences: 11.
- Tool
  Definition: issues related to internal systems used to manage orders (e.g.: EDI, Premium Proposal, SAP);
  Number of occurrences: 12.
- Transport efficiency
  Definition: issues related to the physical transportation of products to customers;
  Number of occurrences: 3.

Appendix 2: Examples of Order flows

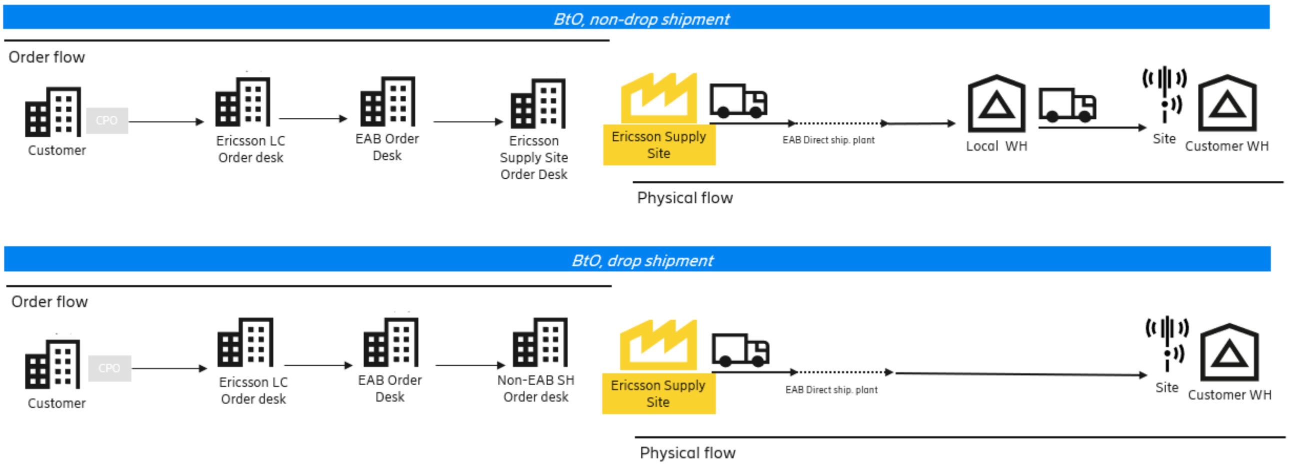


Figure 17 - two examples of a Flow Market flow, adapted from Ericsson's internal documents.

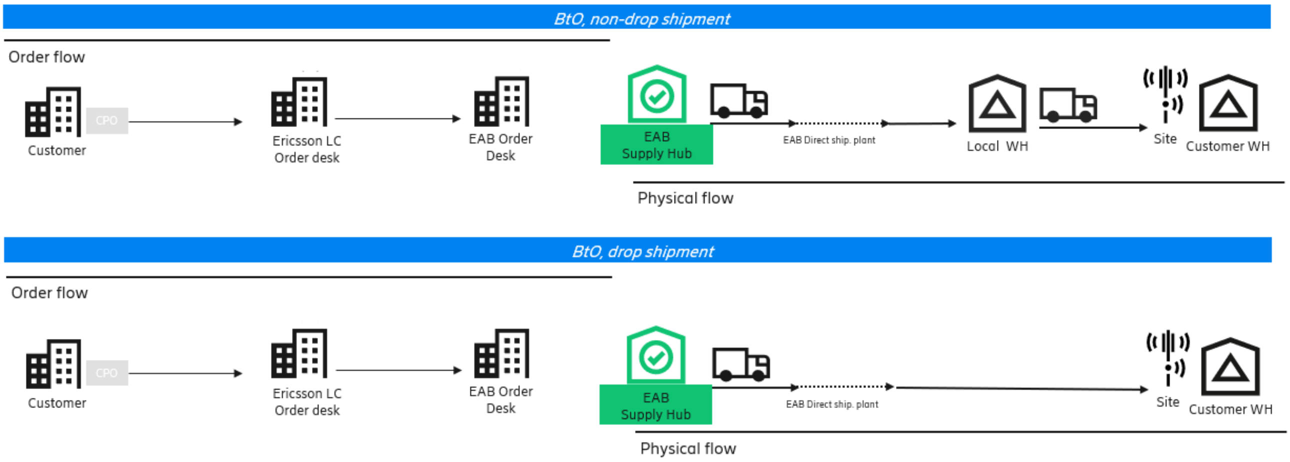
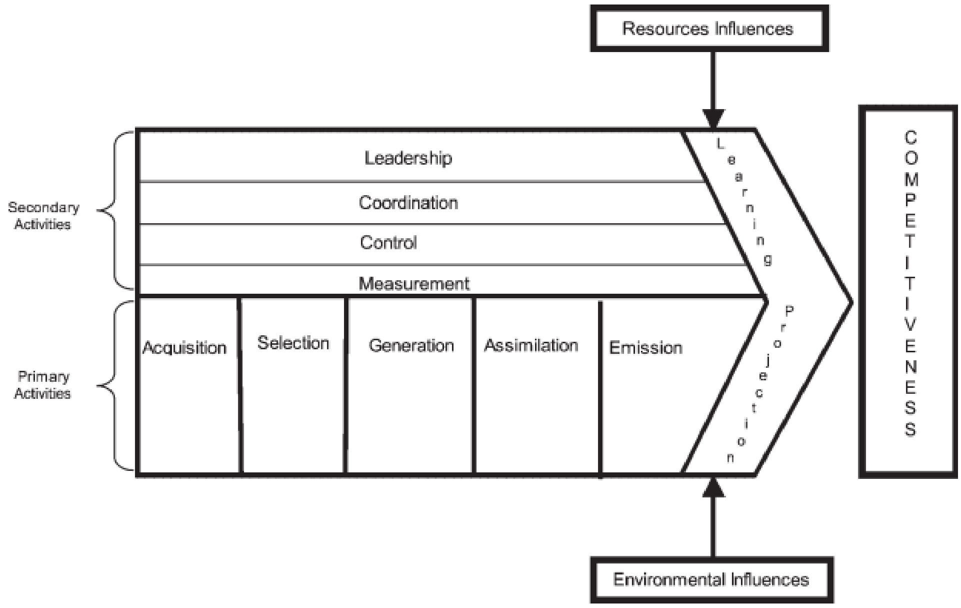


Figure 18 - two examples of a Flow Market flow, adapted from Ericsson's internal documents.

Appendix 3: Knowledge Chain model by Holsapple and Jones [52]



Primary activities:

Activity class	Description
Knowledge acquisition	Acquiring knowledge from external sources and making it suitable for subsequent use
Knowledge selection	Selecting needed knowledge from internal sources and making it suitable for subsequent use
Knowledge generation	Producing knowledge by either discovery or derivation from existing knowledge
Knowledge assimilation	Altering the state of an organisation's knowledge resources by distributing and storing acquired, selected, or generated knowledge
Knowledge emission	Embedding knowledge into organisational outputs for release into the environment

Secondary activities:

Activity class	Description
Knowledge measurement	Assessing values of knowledge resources, knowledge processors, and their deployment
Knowledge control	Ensuring that needed knowledge processors and resources are available in sufficient quality and quantity, subject to security requirements
Knowledge coordination	Managing dependencies among knowledge management activities to ensure that proper processes and resources are brought to bear adequately at appropriate times
Knowledge leadership	Establishing conditions that enable and facilitate fruitful conduct of knowledge management

Appendix 4: S&OP integration framework by Grimson and Pyke [14]

	Stage 1 No S&OP Processes	Stage 2 Reactive	Stage 3 Standard	Stage 4 Advanced	Stage 5 Proactive
Meetings & Collaboration	• Silo Culture • No meetings • No collaboration	• Discussed at top level management meetings • Focus on financial goals	• Staff Pre-Meetings • Executive S&OP Meetings • Some supplier / customer data	• Supplier & customer data incorporated • Suppliers & customers participate in parts of meetings	• Event driven meetings supersede scheduled meetings • Real-time access to external data
Organization	• No S&OP organization	• No formal S&OP function • Components of S&OP are in other positions	• S&OP function is part of other position: Product Manager, Supply Chain Manager	• Formal S&OP team • Executive participation	• Throughout the organization, S&OP is understood as a tool for optimizing company profit.
Measurements	• No measurements	• Measure how well Operations meets the sales plan	• Stage 2 plus: • Sales measured on forecast accuracy	• Stage3 plus: • New Product Introduction • S&OP effectiveness	• Stage 4 plus: • Company profitability
Information Technology	• Individual managers keep own spreadsheets • No consolidation of information	• Many spreadsheets • Some consolidation, but done manually	• Centralized information • Revenue or operations planning software	• Batch process • Revenue & operations optimization software – link to ERP but not jointly optimized • S&OP workbench	• Integrated S&OP optimization software • Full interface with ERP, accounting, forecasting • Real-time solver
S&OP Plan Integration	• No formal planning • Operations attempts to meet incoming orders	• Sales plan drives Operations • Top-down process • Capacity utilization dynamics ignored	• Some plan integration • Sequential process in one direction only • Bottom up plans - tempered by business goals	• Plans highly integrated • Concurrent & collaborative process • Constraints applied in both directions	• Seamless integration of plans • Process focuses on profit optimization for whole company

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