POLITECNICO DI TORINO

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Industry 4.0:
Connected Supply Chain

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Summary

This thesis discusses the. The first chapter is an introduction about the manufacturing industry in Europe, the challenges it faces and the opportunities that arises. The second chapter talks about the industry 4.0 in general and its impact on the industry in terms of efficiency and saved cost. The third chapter talk about the industry 4.0 in the supply chain and how the supply chain in the future would look like. The forth chapter is about a technology that is already starting to be used which is the Electronic Data Interchange EDI. This technology is one of the first steps towards a completely digitalized supply chain system. The first chapter is about a case study of a leading company in the automotive industry and how I as one of the team who implemented the EDI to their system. This chapter includes the scope of the project, problems faced during implementation. Finally chapter 6 includes a conclusion on what is required by a company to have a smooth implementation and digitalization of the system.

Acknowledgement

First, I would like to thank my parents for giving me the opportunities throughout my life to grow, for challenging me and believing in me.

I want to thank my professor Marco Cantamessa for having the patience to guide me and assist me during this thesis. Thank you for your time and effort. Thank you for your knowledge that you did not hesitate to share with me during the thesis and with the class during the course.

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Last but not least, I would like share my appreciation for everyone whom I met during these 2 years' experience that made a new place feel like a second home, to my friends and colleagues.

Abstract

This master thesis is about the challenges faced by the European Union in Industry and the steps that should be taken to overcome the rising incumbents. Industry 4.0 is the answer for the developed countries.

A case study is included about a leading company in the automotive sector to show the system it implemented and the effect of the digitalization on its supply chain.

Key words: Indurtry, Manufacturing in Europe, EDI, Electronic Data Interchange, EDIFACT, Delfor, Digitization, Labels, Industry 4.0, Connected supply chain, digitized supply chain, supply chain

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Chapter 1: Introduction

1.1 Industry in the European Union

Industry plays a fundamental role in the economy of the European Union; accounting for 17.3%[1] of the GDP (2015) and for 15%[1] of value added (compared to 12% in the US). It serves as a key factor of research, innovation, manufacturing, job opportunities creation and exports. It interests 80% of private research and innovation and employs 23.6% of European workers and, it has a ripple effect that for each additional job in manufacturing, 0,5-2[1] jobs are simultaneously created in other sectors. Moreover, manufacturing accounts for over 80% of Europe's exports, generating a €365[1] billion surplus in the trade of industrial products;. In addition to its effect on the services, industry can be considered the economic and social engine drive of Europe.

On the down side the industry in Europe has lost a huge amount manufacturing jobs over the last decades, and is facing tougher competition from emerging markets. The ghost of "deindustrialization" currently haunting the European Commission and the European governments is galvanizing them into action. European industry is fundamentally very diverse: On one hand the German and Eastern European industrial sector is gaining market share and witnessing productivity growing rapidly, on the other hand other EU states are on the road to deindustrialization. France and the United Kingdom in particular have seen their market share shrink drastically since 2000, followed by southern European industrial sectors such as Spain's. Is this industrial fracture in Europe foreseeable? Why don't these countries on their high way to deindustrialization focus on high value-added service activities, leaving Germany and Eastern Europe to be the industrial powerhouse of Europe? We don't think so. There is a convincing case for Europe to strengthen and develop its industry in all of its countries

1.2 Challenges facing the European Union

International competition from developing countries is increasing vigorously which is putting the European industry at stake, not only in traditional industry, but also in the

highest value-added and dynamic manufacturing sectors. The competitive advantage of these emerging economies is their low labor cost which can have major negative consequences: it can push European enterprises to de-localize production with consequent declining employment and job opportunities for European workers; international demand can substitute European industrial products with lower-price products; Foreign direct investments (FDI) can be displaced from Europe to emerging areas.

The global industrial footprint has changed dramatically over the past 20 years. In the early 1990s, the world's manufacturing value added stood at EUR 3,451 billion in 1991. Over 60% of that could be attributed to six major industrial nations – the US, Japan, Germany, Italy, the UK and France. At that time, emerging countries only produced 21% of the manufacturing value added. This gap is even more striking when looking at the evolution of industrial jobs in different countries. The number of manufacturing jobs in China and Brazil increased by 39% and 23% respectively, whereas in Germany this figure decreased by 8%, by 20% in France and by 29% in the UK. All of the traditional industrialized countries experienced a decline in manufacturing employment due to three main factors. Firstly, the major productivity gains achieved in mature economies over the last few decades. Secondly, the loss of market share to newly emerging competitors. And thirdly, outsourcing of activities such as facility management, logistics, maintenance and different types of specialized services to the service industry. This outsourcing often led to the relocation of the activity. The main drivers of the decline in the industry in Europe and accordingly the employment percentage are the increased productivity and low cost which lead to a vigorous international competition and accordingly outsourcing. While some traditional industrialized countries were able to adapt to this new situation, others were not.

The first Industrial breakage appeared with the rise of developing countries. This invasion was led by BRIC (Brazil, Russia, India and China), and soon followed by European countries such as Poland, Romania and the Czech Republic. In the years 1990 to 2011, the value added to manufacturing observed robust growth, up to around EUR 6,577 billion. Over

that period, the traditional industrialized countries saw their average manufacturing value added rise by 17%, while in the emerging industrial countries it increased by 179%. These emerging countries now represent 40% of the total manufacturing value added in the world.

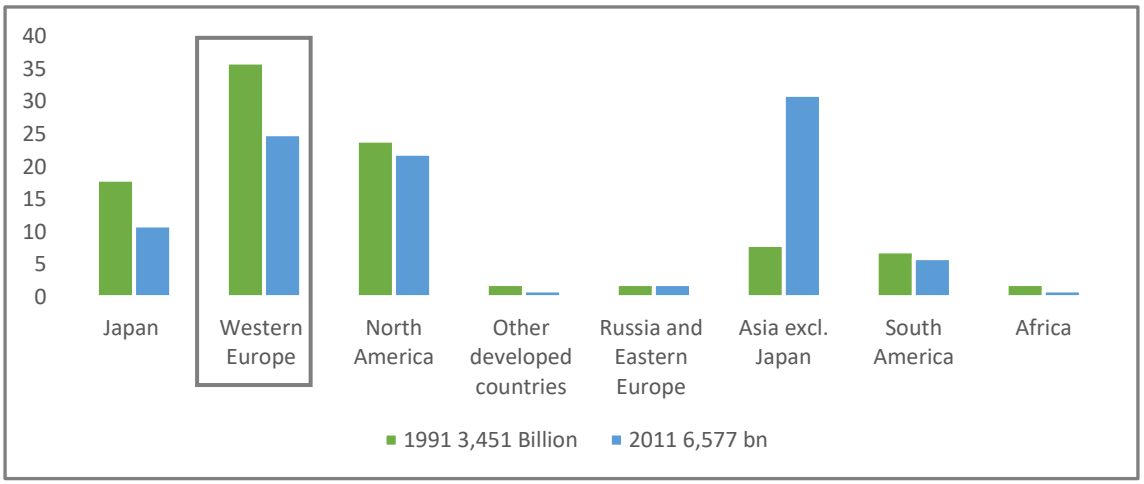


Figure 1-1 Size of manufacturing industry in Europe 1191 vs 2011

The second industrial breakage has appeared recently among the traditional industrialized countries. A few have retained high industrial value added in spite of the significant decline in jobs: Germany, Italy and Switzerland have kept their industrialization rate (manufacturing value added as a percentage of total value added) around 20% over the past 10 years. Others, however, unfortunately witnessed both industrial value added and employment drop. This is the case for France, whose rate of industrialization has fallen from 15% in 2001 to 11% in 2011. Spain and the UK followed the same behavior. These two fractures cut right across Europe, resulting in an extremely diverse continent in terms of industry. Concerning the future strategy for the European industrial value creation, it seems that Europe is drifting apart instead of moving in the same direction. The winners of this era are the traditional industrialized countries such as Germany, Sweden and Austria which captured important value added in key sectors. But Europe has several industrialized countries on its eastern side, such as Poland, Romania and the Czech Republic, where industry's role in the economy has always been significant (over 20% of

the national value added). Their main competitive advantage used to lie in the low-cost manufacturing, and the value added per job is still lower than in traditional industrialized countries. But recently the well established plants in these territories are brand new, highly automated, and will enable the rapid development of high value-added activities. Meanwhile, the United Kingdom, France, Belgium and Spain are facing considerable decline in industrial employment and value added. Europe is now at a crossroads. Countries clearly need some industry and Europe should decide as a whole what the new pattern of industrialization among its member states should be and what are the steps to reach it.

2. Why does Europe need industry?

Industry is a core component of the value chain. When plants relocate to a new place they often move with with them expertise and employment in the high value-added sectors: development (product and process design), sales and marketing. In order to offer high-quality services in an area, an innovative and creative manufacturing industry is crucial. The trend toward deindustrialization in some of the European countries puts Europe at risk of losing high-value activities. Industry is crucial to ensure a balanced skills and labor market pyramid. The ratio of skilled jobs is higher in industry, whereas the production of services is often characterized by a concentration of highly skilled jobs (engineering, consulting, information technology, research, etc.) or, on the other hand, low skilled jobs (tourism, distribution, etc.). Deindustrialization weakens the European middle class, as it puts the mid-salary jobs to a limit. The organizational change will cause a misalignment of supply and demand on the labor market. In the long run this separates society. Industry and services are back to back sides of the same coin. Although some may argue that services will eventually replace manufacturing, this is unlikely as the two sectors are closely coiled together. Manufacturing adds value in the service sector (e.g. product-related services such as insurance or maintenance, business-related services such as consultancy or accounting, or restaurants, hotels, etc.). 40% of jobs in the European manufacturing sector are service- related, and on average, services make up about 25% of all inputs bought by the European industry. On the back side, new services, like the

cloud economy, are changing manufacturing and adding more value in the sector. Deindustrialization in some European countries is therefore a reason for concern as it affects more than just industry – it could impact European competitiveness as a whole. An industrial imbalance creates a gap in trade policies.

Eventually the growing gap between European countries in terms of industrial performance has an impact on European international trade relationships. On one side of the gap there are countries with a strong industrial sector, which are dependent on exports and keen on open borders, and on the other side, countries with a weak industrial sector that have tendency to put up barriers to protect themselves.

Innovation, automation and sophisticated methods are the root cause of industrial success strategies and have proven to be critical in maintaining a leading position. Therefore, having a vision and looking toward the future is critical factor of success.

Reindustrialization needs to be much more than simply rebuilding the same structures of an old-fashioned manufacturing that vanished a long time ago. Copying the successful business models of countries such as Germany, Sweden or Austria is not a viable solution for the rest of Europe either. A successful approach to reindustrialization should take into consideration the ever-changing environment and align processes, production and products to the new situation. And Europe's industrial future has to be planned and designed to cross borders.

1.3 More opportunities to emerge

Chapter 2: Industry 4.0

Driven by the emergence of new technologies, industry 4.0 refers to a new generation of connected, robotic and intelligent plants. With the digital revolution, the boundaries between the physical and digital worlds are blurring to create an interconnected factory 4.0 in which, machines and products interact. Industry 4.0 is a challenge and a real opportunity for the European industry.

Today, there is no longer any question of a means of production producing (or rather reproducing) a product thousands of times. We have entered the era of product customization. The consumer wants a completely personalized product, which does not resemble that of its neighbor. Industry 4.0 is committed to meeting this requirement for unique and customized products while maintaining equivalent costs, despite the low production volumes generated. This is why one of the challenges of this 4^{th} industrial revolution is to successfully connect the customer's need to the production organ. This connection cannot be made without the contribution of new technologies, which will have to be exploited in the model of this new factory.

Highly mechanized and automated material goods are produced by the industrial sector of an economy. Ever since industrialization begun, technological inclines have led to paradigm shifts, which we call today the industrial revolutions. Primarily in automation and mechanization, recognized as the 1st industrial revolution, secondly, in the rigorous use of electrical energy, acknowledged as the 2nd industrial revolution, and finally, in the pervasive digitalization known as the 3rd industrial revolution. Nowadays, factories and firms tend to combine two aspects of unconventional digitalization, which are future-oriented technologies and Internet technologies leading the world of industrialization and production towards a new paradigm shift.

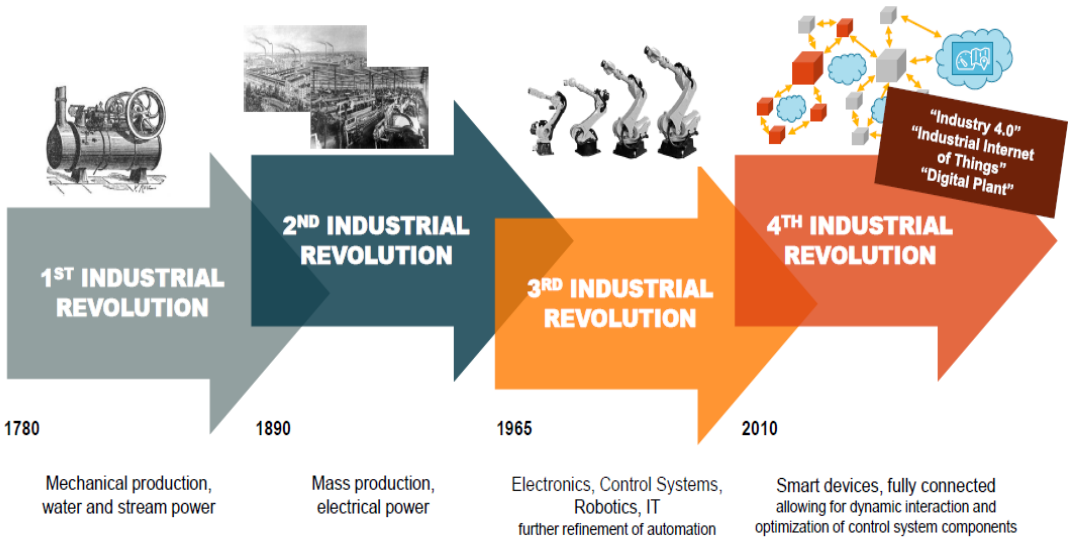


Figure 2-1 Industrial Revolutions Timeline Source: Industrial Revolution Research

Industry 4.0 happens to be a representative of the 4th massive industrial revolution that strikes the world of manufacturing. Recalling the first and second industrial revolutions, which started to work in altering the world of mechanization through water and steam power, up until the mass production and assembly lines, the fourth revolution aims to combine the objectives of the third revolution adding to it the technological advancement of automation and computers as well as boosting it with autonomous systems powered by data and machine learning. Despite the fact that some disregard Industry 4.0 and do not give it its necessary credit, it's still important to acknowledge the manufacturing shifts it is bringing.

Industry 4.0 optimizes the computerization of Industry 3.0

Industry 3.0 was relatively troublesome due to the fact that an entirely new technology was added, namely computers. Nowadays, as Industry 4.0 unfolds, computers are interlinked together in order to make decisions without human interaction or contribution. The reason why Industry 4.0 is now coming to life is because innovators are now able to make a combine cyber physical systems, the Internet of Systems and the Internet of Things all together in order to turn the idea of smart factory into reality. Smart

machines that have access to data keep getting smarter as they dig deeper into data base systems. As a result, factories turn out to be more productive and efficient and less lavish. If we combine these smart machines and create a network digitally interconnected between them, that shares information and results then we've guaranteed ourselves a true powerful 4th industrial revolution; Industry 4.0.

Industry 4.0 applications today

While many companies and firms are ignorant of the benefits of Industry 4.0 and are neglecting the efficiency boost this technology could have on their production, some are implementing changes and are preparing themselves to incorporate smart technology and machinery in their business shortly.

For example, The Boston Consulting Group assessed the impact of smart machinery in Germany and divided their assessment into four sections:

Firstly, they looked at productivity. They estimated that the benefits are at 90-150 billion euros over the upcoming five to ten years. These ratios depend on improvements in productivity of five to eight percent including costs of materials and fifteen to twenty five percent excluding material costs. It is expected that the greatest paybacks are going to be in the automotive and industrial components.

Secondly, they investigated revenue growth, which is estimated to be at 30 billion euros or one percent of Germany's Growth Domestic Product (GDP) annually. These estimations are based on expected upsurge in producer's demand for smart equipment and data applications joint with customized products demanded by consumers.

Thirdly, they assessed employment and figured out that this is a controversial area because in the short run, automation and technology have led to a reduction in the rate of employment in the past. Hence, The Boston Consulting Group estimates an increase of six percent in the employment rate over the upcoming 10 years because highly sophisticated machinery will demand high skilled labor such as engineers and IT experts,

while this will lead to the displacement of many low-skilled workers because they will not be able to adapt with the great level of technology.

Lastly, they investigated the effects of Industry 4.0 on Investments. The Boston Consulting Group estimates that the German producers require 250 billion euros in the upcoming ten years. This figure equates to almost 1-1.5% of their revenues. The figure seems rational because Roland Berger[1] had estimated a budget of 1350 billion euros for the entire European Union over the upcoming fifteen years.

The benefits of Industry 4.0 will vary from one country to another and from one industry to another. Industries with variety of products such as foot and beverages will have the luxury of a higher degree of flexibility while industries that meticulously emphasis on high quality products such as pharmaceutical companies and semi conductors will have the advantage of a reduced error rate. Some companies have better positions for new markets. The key companies that will surge in standing are ones that include: technology supplies such as Dassault, infrastructure providers such as big data bases processing and cloud computing, and finally industrial users such as Siemens. In each of these categories, new players may join the completive oligopoly and new established economies may gain lead in Europe.

The company size may play a role in the impact of Industry 4.0. Start ups might need to collide to bigger chains and integrate themselves with bigger firms in order to be able to

[1] CCI Bordeaux Gironde. "INDUSTRY 4.0 The New Industrial Revolution - Think Act 2014." *LinkedIn SlideShare*, 30 Sept. 2014, www.slideshare.net/polenumerique33/roland-berger-tabindustry40201404031.

enter the competitive digitalized market or else the digital transformation may be an entry barrier for them; hence they will shut down or exit the market.

The impact between states and provinces may differ depending on how ready they are to adapt to new technologies and how advanced they are in production. Noting that Industry 4.0 could also benefit regions that are underdeveloped with technologies like three-dimensional printing turning personalized and local production a possibility, ceteris parabus, and relevant pre-conditions are assumed to be present.)

Chapter 3: Connected Supply Chains

Internet of Things or Industry 4.0 is characterized by connected devices. The cloud is a key element of Industry 4.0; not only does it help in internal operations to avoid losing information, but with the cloud environment where data is stored, equipment and operations are optimized by leveraging the insights of others using the same equipment. Moreover, it allows smaller enterprises to have access to technology they wouldn't be able to reach on their own.

An optimized logistics and supply chains is considered a connected supply chain. A connected supply chain can regulate and accommodate when new information suddenly arise. If a material dropped below a certain level in the warehouse an automatic purchasing order is forwarded to the supplier. If a delay in a shipment rises up due to weather conditions, a connected system can self-adjust to that unexpected reality and modify manufacturing priorities.

Even accepting shipping containers from vehicles or ships can be done autonomously. There are cranes and trucks that are programmed to read the part numbers and deliver them to the right spot in the warehouse or directly to the production line at the exact right moment to be assembled or altered if the plant is following the Just in Time (JIT) model.

Robots are no longer an option only for large enterprises with a huge budget, they are now more affordable and can be adjusted to fit each enterprises size and needs. They are currently used extensively in manufacturing from picking products at a warehouse to dropping them in the production line and then finally picking end products to be shipped. Robots can now efficiently and safely support manufacturers. The leading company now

in using robots is Amazon. They allow it to reduce costs and allow a better use of the warehouse space for the online retailer.[2]

3.1 Supply Chain Ecosystem As Is

Most companies use a very standardized process to deliver the products to their customers or consumers. First the marketing analyzes the demands of the customers and from the information he collects he tries to forecast the sales volume. According to this sales forecast, the production starts making their calculations of the raw materials required or parts needed for assembly. These needs are then transferred to the buyers in the company to contact the suppliers and send the purchasing orders. Theoretically speaking if all goes well and estimations were done accurately the gap between demand and supply at each phase in the system should be very small.

If this happened, there would be no missing sales, no excess or expired inventory, no rush orders in the plants, and no extra fees paid to suppliers. The factories could safely operate with longer cost-efficient production runs. The time spent by employees responding to demand excess, product shortages, and forecast changes would be saved.

[2] Marr, B. (2016, June 20). What Everyone Must Know About Industry 4.0. Retrieved from https://www.forbes.com/sites/bernardmarr/2016/06/20/what-everyone-must-know-about-industry-4-0/#45a6a92b795f

Practically speaking this rarely happens in real life, a typical range for the total cost of forecast error is 5-15% of sales1. These costs come from 1- the inefficiency in the production batches which ranges from 1-3% of sales , the factory underestimated their sales so they ended up producing more than one batch of a small volume thus preventing the economies of scale that could have reduced the direct costs. 1-3% in air freight and paying premiums. Around 1-4% are lost in inventory for storing excess materials or components or losing the value of the stored parts or extra stocking for price protection. Finally 2-5% can be extra sales but were lost due to underestimation of sales percentage.

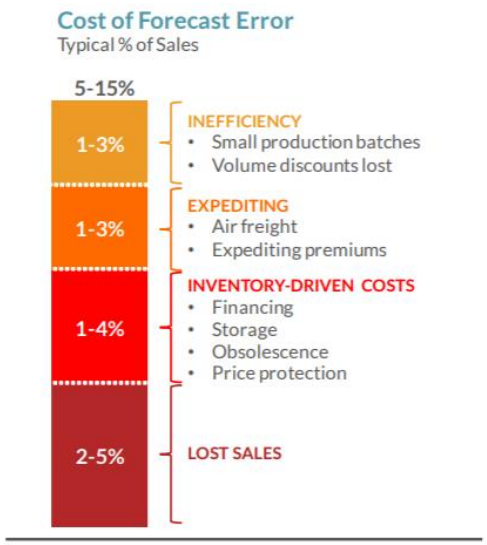


Figure 3-1 Sources of forecast error
Source:End to end analytics Demand Planning &Forecasting

Forecasting remains an inexact science, no matter how much effort is done to optimize the forecast, an error will remain. Lack of transparency and real time data means that none of the links of the supply chain really knows what the other links are performing.

Figure 3-2 Supply Chain Ecosystem

3.2 Supply Chain Ecosystem as Industry 4.0

Over the course of the next few years, this gap between demand planning and forecast and supply will start to decrease as will the lack of complete transparency in the supply chain will start to evaporate. As a result of digitization of the supply chain, every link will have a full visibility of the performance, challenges and needs of the other links. The supply and demand can be calculated at any instant and at any point throughout the cycle and can be transmitted immediately throughout the network. So if at any point in the cycle a

disruptive event happened; machine failure, a storm happened, demand increased real time information can be transferred giving time to players to readjust the decisions across the cycle to mitigate the loss that can arise from these sudden unfortunate events.

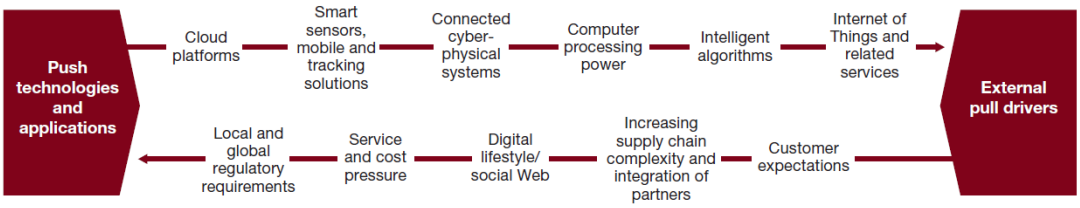
The goal of the digital supply chain is to build an altogether new kind of supply network that's both responsive and resilient.

The digital supply chain, as we imagine it, consists of eight key fundamentals: logistics visibility, Procurement 4.0, integrated planning and execution, smart warehousing, efficient spare parts management, autonomous and B2C logistics, digital supply chain enablers and prescriptive supply chain analytics. Companies that can put these pieces together and form a coherent fully transparent body, will gain enormous advantages in flexibility, customer, efficiency, and cost reduction. While those that cannot visualize the future and will delay the integration will be left behind.

But if companies want to digitalize their supply chain they need to head hunt people with such capabilities and skills whom can support the process of shifting of the company's culture and introduce the disruptive technology and fight the reluctance to change. In other words, they need to find people that can transform the entire organization

On the other hand, more exacting expectations on the part of consumers, employees, and business partners are pulling companies to develop more reliable and responsive supply chains (*see Exhibit 4*).

Exhibit 4
Effect of push technologies and pull demand on the digital supply chain



Source: Strategy& analysis

Figure 3-3 Effect of push technolgies and pull demand on the digital supply chain. Source PWC: Strategy & analysis Industry 4.0 and connected supply chain

Chapter 4: Electronic Data Interchange

4.1 Introduction

Electronic Data Interchange (EDI) is the exchange of business documents directly from a computer to computer in a standard format of business partners. It is usually used for e-commerce purposes, such as sending orders to warehouses, tracking shipments, and creating invoices. In 1975, the first EDI (electronic data interchange) standards were published and within a very few years, manufacturers like Ford and General Motors, and retailers like K-Mart and Sears, had mandated their suppliers to use EDI.

Traditional system:

It is a paper bases system currently used, the buyer creates a Purchase Order bases on information retrieved from his Material Resources Planning system (MRP). He then sends it to a supplier via email or fax. The supplier receives the document and forms a document of the material he is supplying and then send the confirmation via email or fax again to the buyer which then integrates this information back into his system. A typical manual process looks like Figure 4.1, including lots of paper and people involvement.

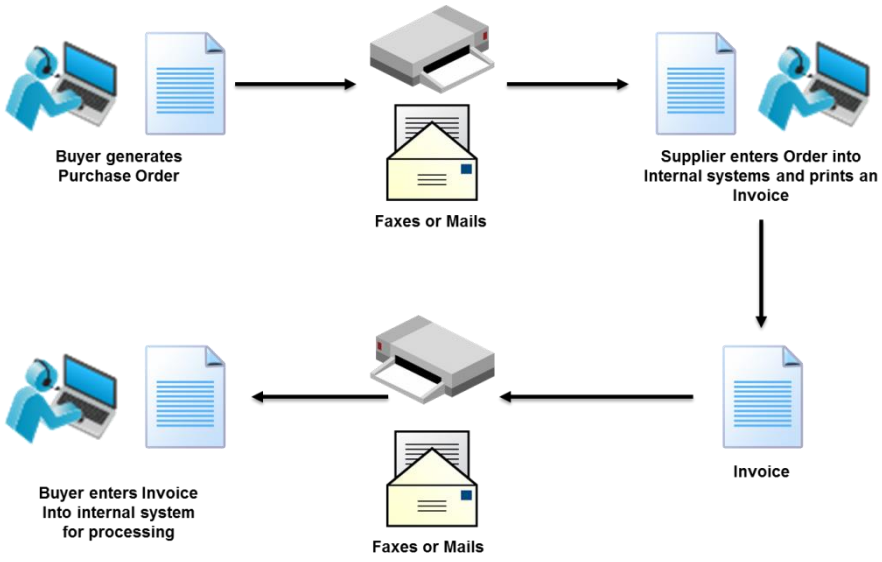


Figure 4.1 Traditional System of Data Interchange Source: EDI Basics

Digitalized system (EDI):

An automatic transmission of information from the buyer's to the supplier's MRP system of the Purchase Order and an automatic respond from the supplier's to the buyer's MRP system with an Advanced Shipping Notice ASN and Invoice. The ASN includes information regarding the shipment is delivered to the buyer to prepare his production line in advance. He receives information on the part numbers and quantities he is receiving, The organization of the delivery; number of pallets and boxes sent, and expected time of arrival of the delivery. EDI replaces postal mail, fax and email. Although email is considered an electronic mean of sending information, the documents exchanged via email must still be handled by people rather than computers. Having people involved has the probability always of errors which slows down the process and cause higher costs. On the contrary, EDI documents flow straight for the sender's system to the receiver's computer through appropriate application (e.g., the Order Management System) and once received processing can begin immediately.

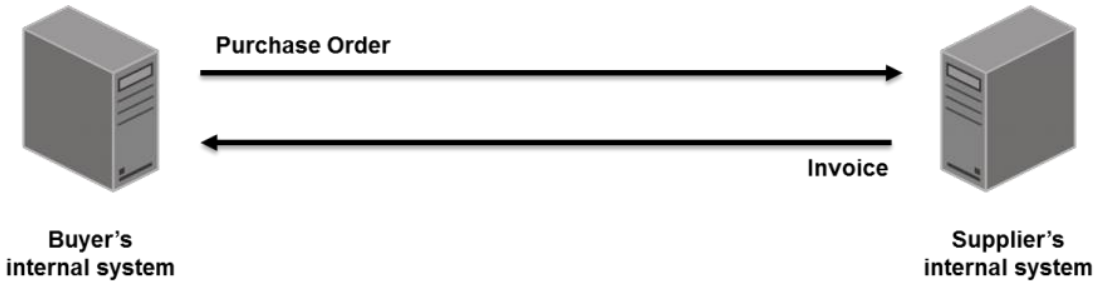


Figure 4.2 Electronic Data Interchange Source:EDI Basics

By moving from the traditional paper bases system to the EDI systems, businesses enjoy major benefits such as:

- Processes are made simpler
- Standard Means of communication and
- High quality of data that does not require manual intervention or media disruption
- Business processes are much faster and more transparent (data transfer within seconds!)
- Coordinated processes improve business partner relations

- Enhanced accuracy
- High adaptability
- Lowers costs

Standard format

Because EDI documents must be processed by computers rather than humans, standardization of the format of the messages transmitted is essential so that the recipient computer will be able to read and understand the documents. A standard format that describes what each information reflects and its type(e.g., integer, decimal, date, time). If each company sent it is own specific format, the recipient computer will not be able to translate this message and decode to understandable information.

There are several EDI standards used today, including EDIFACT, TRADACOMS, DELINS and ebXML. And, for each standard there are various versions, e.g., EDIFACT version D12 or, Release A. When two businesses decide to exchange EDI documents, they must both agree on the same EDI standard and version to follow.

Businesses typically need to use an EDI translator – either as in-house software or outsourced via an EDI service provider to translate the EDI format to readable data so the data can be used by their internal applications and thus enable direct processing of documents.

4.2 EDI Adoption in the Automotive Industry

As you can see from Figure 4.3, the automotive industry is the leading industry in the adoption and maturity of Business to business (B2B) ecommerce. The automotive industry is a great example of a complex ecosystem of numerous B2B relationships. Within the automotive sector, there is an extremely huge supply chain that represents companies that do everything from supplying the initial raw materials (metals, glass, rubber, etc.), to the manufacturing of not just the car itself but also all the components of the car, from radios to headlamps, computer systems and more.

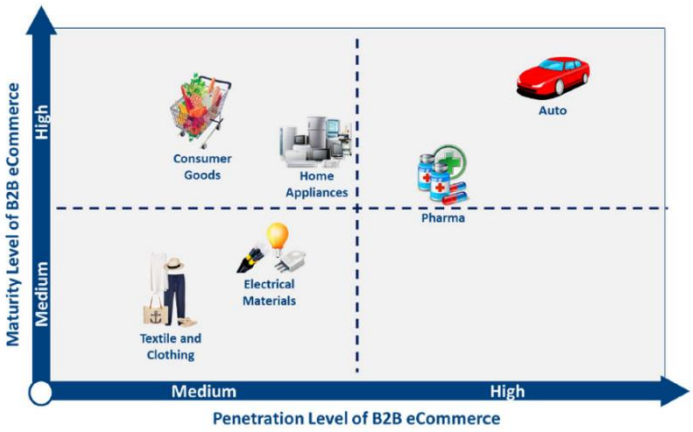


Figure 4-3 Maturity and Penetration of Industries to B2B eCommerce Source: Accenture

The supply chain is a very long chain of hundreds and hundreds of businesses and B2B customer relationships to produce a single car that will then be sold to the end consumer. The eCommerce component speaks to how all these different types of businesses may use the Internet to transact and manage relationships with one another.

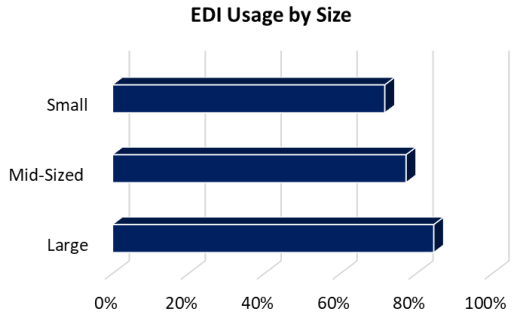


Figure 4-4 EDI Usage by Size of Company Source: Accenture

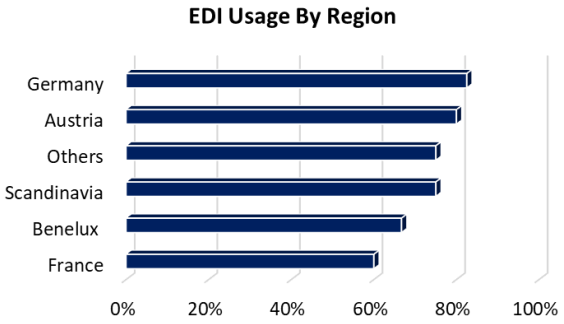


Figure 4-5 EDI Usage By Region Source: Accenture

EDI has been in use across the automotive industry for more than 40 years. The smooth running of today's car production lines relies on the continuous exchange of business documents between the car manufacturers and their supply chain.

Many of the business processes followed in the manufacturing of today's cars were developed from a production system devised by Toyota in Japan. The most popular and best practices such as Just-In-Time (JIT) and Lean Manufacturing were developed around the 'Toyota Production System.' Lean Manufacturing and JIT processes are central to the smooth running of many production lines around the world. EDI provides a fast and efficient way to transmit business documents to help support these types of manufacturing processes that requires on the moment response. Providing clear visibility of inventory levels and immediate notification of when shipments are due to arrive at the production line are critical to making JIT and Lean manufacturing processes a success.

The global nature of the automotive industry dictates that it is crucial for car manufacturers to be able to onboard their suppliers as quickly as possible, no matter where they are located around the World. Many car manufacturers have established a manufacturing presence and have their own plants in Eastern Europe, Brazil, China and India, for example. It is very important to ensure that suppliers located in these regions are able to exchange EDI documents as smoothly and effortlessly as possible. ICT skills across low-cost or emerging markets are traditionally very rare. Therefore, the car

manufacturers must make sure that they can provide user friendly and simple-to-use EDI tools that enable even the smallest suppliers to trade electronically.

Due to the global nature of the automotive industry, there are various communications, formats and document standards in use today, along with a number of regional EDI networks and providors. The structure of the automotive supply chain and a description of the communication protocols and document standards used are described below.

4.3 Barriers to implementation

If this technology is so useful, then why it is not yet widely adopted? There are few barriers to adopt the Electronic Data Interchange EDI; one of the most significant barriers is the associated business process change. Existing business processes built around paper handling may not be suited for EDI and would require changes to accommodate automated processing of business documents. For example, a business may receive the wholesale of their goods by 1 or 2-day shipping and all of their invoices by mail. The existing process may therefore assume that goods are typically received before the invoice. With EDI, the invoice will typically be sent when the goods ship and will therefore require a process that handles a huge numbers of invoices whose corresponding goods have not even yet been received.

Another significant barrier to implementation is the initial investment of cost and time in the initial setup. This preliminary expenses and time spent that are required for the implementation, customization and training can be costly. It is important to know and select the correct level of integration to match the business needs and requirements. For a business with relatively few relations and transactions with EDI-based partners, it may make more sense for businesses to implement inexpensive "rip and read" solutions, where the EDI format is printed out in human-readable form, and people rather than computers confirm and reply to the transaction. Another alternative is outsourcing EDI solutions provided by EDI "Service Bureaus". On the other hand, for some businesses with

a high trading volume, the implementation of an integrated EDI solution may be necessary brought on by EDI force them to re-implement their order processing business processes.

The key hindrance to a successful implementation of EDI is the idea and perception many businesses have about the nature of EDI, many view EDI from the technical perspective that EDI is just a data format or a computer language; it would be more accurate to consider not only the technical view but also the business, that EDI is a system for exchanging business documents with external parties, and integrating the data from those documents into the company's internal system. This information will be saved on their internal systems and validate the business information received. For example, allowing a supplier to update directly a retailer's accounts payable system without sufficient and appropriate checks and balances would put the company at a significant risk. Businesses not familiar with EDI and new to the implementation must understand the underlying business process and apply proper judgement.

Chapter 5. Case Study

5.1 Key Actors

The client is a multinational company and a leading player in the automotive industry. It has various business lines; Powertrain (PWC), Automotive Lighting (AL), Plastic Component and Modules (PCMA), Electronic System (ELS), After market Services (SA) and Exhaust System (EXH).

Accenture is a global management consulting and professional services firm that provides strategy, consulting, digital, technology and operations services. A Fortune Global 500 company, it has been incorporated in Dublin, Irel and, since 1 September 2009.Accenture is responsible for the digitalization of the supply chain of the client by implementing the Electronic Data Interchange. Accenture is the connecting ring between the buyer, the suppliers and the EDI and portal provider.

The provider responsible for managing two portals; the ticket-based portal and the client's web portal. Also responsible for establishing the EDI connections between suppliers and plants for each relation.

5.2 Scope of the Project

The project does not include all suppliers with all the relations our client is in business with but only 200 suppliers. These 200 suppliers are distributed globally among the various locations; Europe, the Middle East and Africa (EMEA), North America (NAFTA), Latin America (LATAM) and Asia Pacific (APAC).

The goal of the program is to transfer all sorts of communication taking place between the client and his suppliers per emails, faxes or phone calls to EDI. In case the supplier is currently incapable of EDI or is shipping with a low frequency to the buyer so he does not see the return of this investment, the company has offered him the web portal as an

alternative. In figure 5.1 you can see the criteria, the buyer decides upon if he wants this supplier in EDI or in web portal.

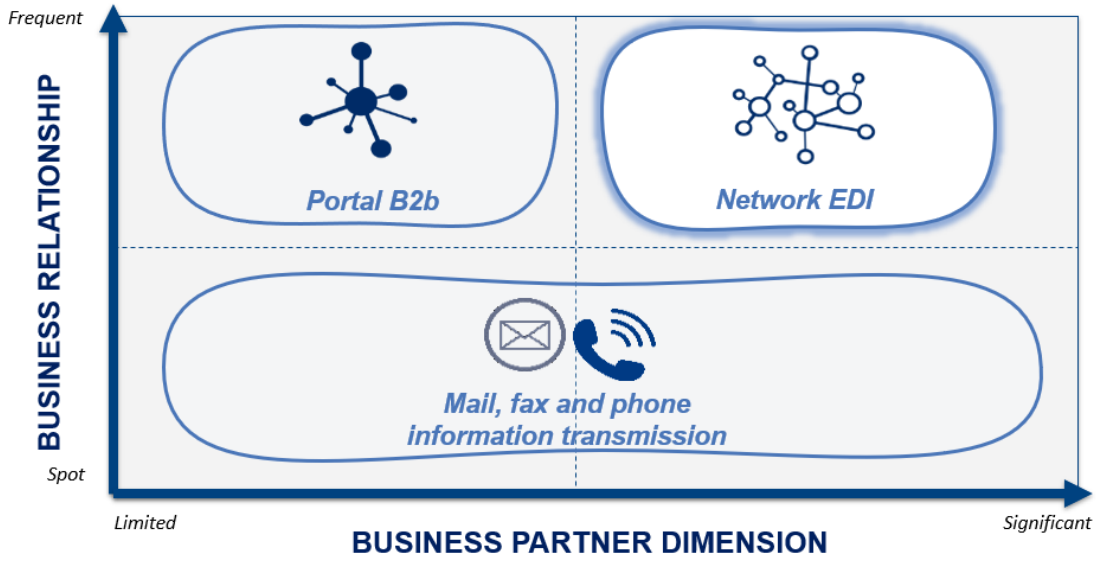


Figure 5-1 Business Relationship vs Partner Dimension and its Influence on Method

1-Network EDI

The first and preferred option by the client. Essential and highly beneficial in the case when a supplier is has significant business partner dimensions; shipping to different plants of the buyer, receives several purchasing orders (PO) requests from MM and ships deliveries with high frequency

2- Portal B2B

The alternative option to the EDI is the Web portal if he has limited business partnership. The supplier uses the same B2B portal he is currently using for downloading the Purchasing Order PO and a new page is enabled for him to prepare and send the Advanced Shipping Notice (ASN). Therefore, no extra costs or intensive training is required.

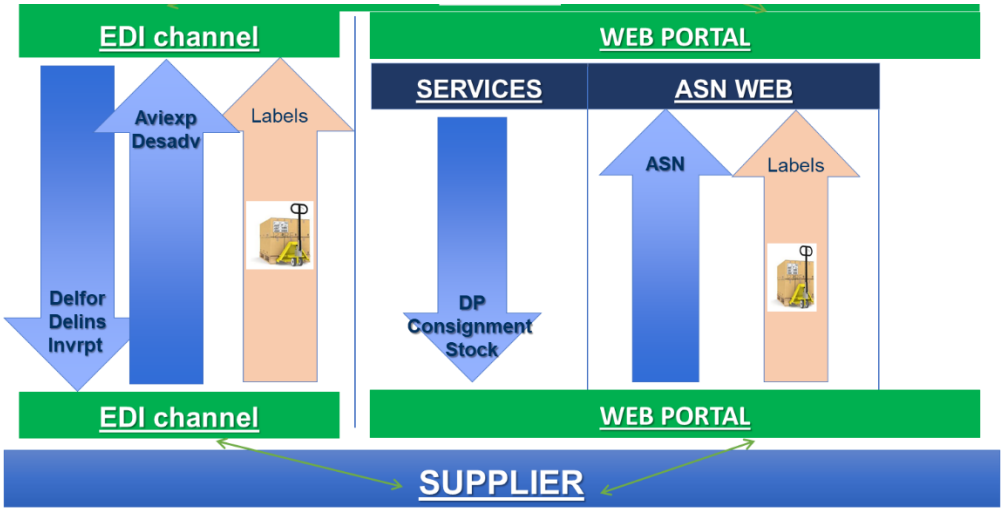


Figure 5-2Data Flow EDI vs Web Portal

Figure 5-2 shows the different data flows between the buyer and the supplier for activating the relation either in EDI or via Web Portal. On the left hand side is the data flow for the EDI, the buyer sends the PO (EDI_out) in its format and then the supplier sends the shipment confirmation (EDI_out) and print and attach the labels to his pallets and boxes as well. On the other hand the web portal option includes receiving the PO on the web portal, downloading it and then compiling the Advanced Shipping Notice ASN and forwarding it to the plant.

5.3 Phases of the project

Following is the Work Breakdown Structure (WBS) of the project

It should the different task to be carried out during the project and the responsible actor.

Tasks carried by the supplier are under the responsibility of Accenture also since we are the direct contact with the supplier and we support him in each step

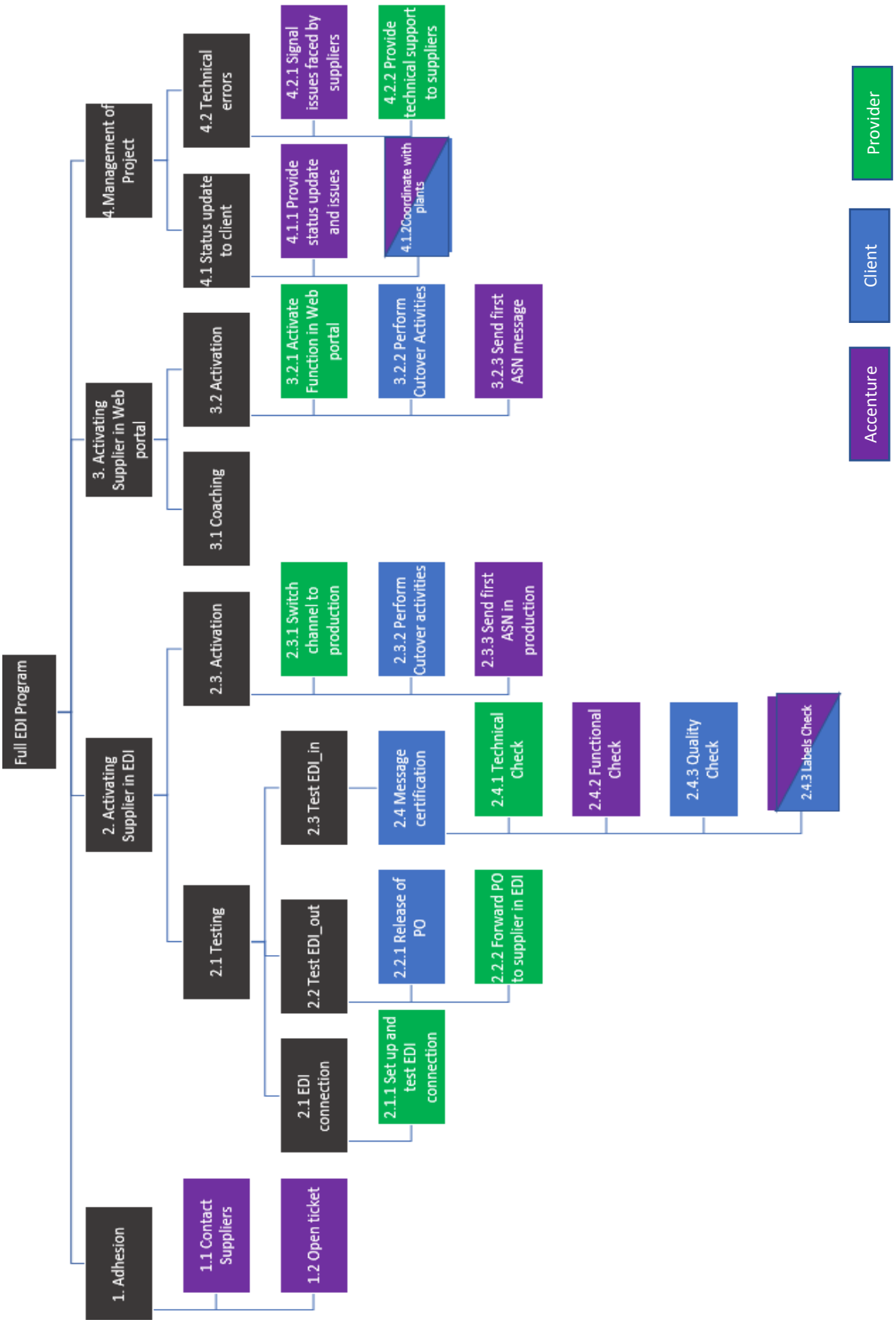


Figure 5-3 WBS of the project

The process of onboarding a supplier in either Web portal of EDI goes through 3 phases. The phases for the web portal are 1- Adhesion 2- Coaching and 3- Activation in Web Portal. On the other, if they want to implement EDI they pass through 1- Adhesion 2- Testing and 3- Activation in EDI.

Figure 5-4 Shows Phases of Implementation for Web Portal and EDI

5.3.1. Adhesion

The Adhesion phase is the same for both suppliers Web Portal and EDI. The suppliers are distributed among several waves depending on their location; EMEA, NAFTA, LATAM or APAC. Each wave starts with a kick off convention held at the country with the most suppliers in that area. The kick-off of each wave takes place about a month after the previous one to give room for preparation. Some companies have plants in different locations so they decide if they want to manage the project centrally by a steering team or decentralize the process and each plant handles its own implementation separately and be treated like a standalone company with its own referents. In the first case, the steering team are invited to the convention related to their wave. In the second case each branch of the company attends the related wave. We prefer centralized EDI person as it will be more efficient as usually activating the first relation is the hardest, then the upcoming ones are easier since now the supplier is more accustomed to the guidelines and expectations.

The client first sends formal invitation letter to each supplier and hand the contacts to Accenture which then follows up on the suppliers relative to the next upcoming wave. The follow up email should have the Agenda, Subscription Form and Full EDI Guidelines documents as attachments. The Agenda is to show the schedule of the day or of the session as sometimes a morning session and an evening session are organized depending on the number or attendees. The subscription form is for the supplier to fill out with the contact details and role of the attendees from his side. The EDI guidelines give a brief explanation of the required formats for the EDI message. It is always advised that an ICT person, a decision maker and a logistic manager to attend the convention from each company.

After receiving a feedback from the supplier about his attendance or the filled-out subscription form, the tracker file is to be updated. The tracker file is an excel file prepared for each wave the includes all Meta suppliers that are included in that wave and their response to the invitation; whether they confirmed attendance and who is attending, not attending or still checking.

On the day of the convention sessions are given and the suppliers are encouraged to adhere to the first preferred option which is the EDI. If the supplier discovers that he is not able to implement the EDI system now or does not have high shipments frequency towards the client, so the investment is not worthwhile, the second option which is the Web Portal is given to him.

A ticket is to be opened for each supplier using a ticket managing portal offered by the provider. This ticket becomes the main communication channel between the supplier, Accenture and the provider. The task of this ticket is to communicate and monitor the progress of activities until all relations are successfully activated. Each ticket must contain the company's name, the contact person, the relations between each warehouse of the

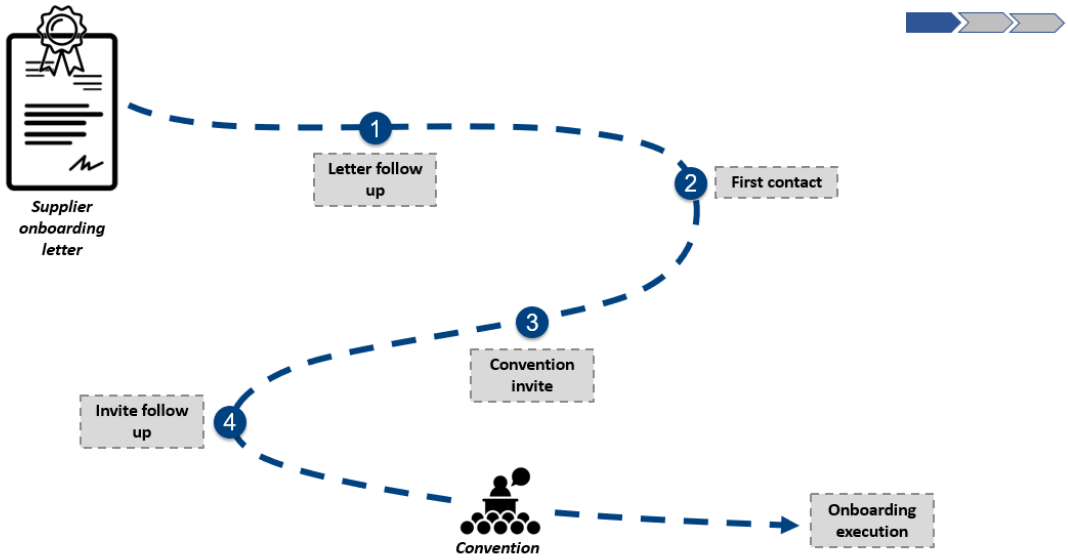


Figure 5-5 Steps during the adhesion phase, it ends when suppliers are onboarded.

supplier and each plant of the client. This can be 1 to 1, 1 to many, many to 1 or many to many.

5.3.2. Intermediate phase

Coaching

The coaching targets the suppliers that chose the second option which is the Web Portal. The coaching session is around a one-hour tutorial and is usually done through a video conference call. Material for the call was prepared by Accenture. This session introduces and explain to the supplier how to send the ASN message via Web portal, which information is important and what to do in case their system is not functioning as required or in case of sending a wrong ASN message. By the end of the call the supplier is asked some questions regarding the relation with the plant. Information required to be collected

are: 1. Number of part numbers shipped per delivery 2. Frequency of shipment to the plant 3. Transit time between of the trip from the supplier's warehouse to the client's plant. 4. His login name to the portal 5. If he has some special cases like if he sends different boxes capacity, if he includes more than one-part number in the same box.

Since before the coaching the possibility to send an ASN message is disactivated to the supplier to make sure that he does not send a wrong ASN because of his lack of knowledge on how to compile the message and the importance of it. After the coaching is done, ACN needs to update the ticket that the coaching has been done to the supplier and to activate the ASN WEB tab in the web portal to him.

Testing

This phase is dedicated to the suppliers who chose the preferred option the EDI system.

First step is configuring the channel between the provide, the plant and the supplier. This step is done by the provider. Accenture follows up on the supplier to receive from them the UNB code and the certification.

UNB code: is the Interchange Header, the first segment of an EDI message; it identifies and specifies the type of interchange, sender and receiver. UNB and other main codes present in EDI format are produced and processed automatically from the software package.

The UNB segment is used to envelope the interchange and also to identify the party for whom the interchange is intended and the party who has sent the interchange. The principle of the UNB segment is the same as a physical envelope which covers one or more letters or documents and which details the address where delivery is to take place and the address from where the envelope has come.

Ex. UNB+UNOC =
3+5012345678901:14+4598765432198:14+000316:1402+INV73529++INVOIC'

VAN (**Value Added Network**): is a private owned network that provides a specific service, acts as a regional post office. It receives transactions, examines the 'from' and the 'to' information, and routes the transaction to the final recipient. Because of these and other services VANs provide, businesses frequently use a VAN even when both trading partners are using Internet-based protocols.

The others acronym (OFTP, AS2 and ENX) are all protocols or software dedicated to a correct and secure transmission of data between two or more actors. The connection parameters are useful for the provider INTESA but not necessary to open the ticket (optional), so it is just requested the availability on this tool (YES/NO).

OFTP (Odette File Transfer Protocol): is a protocol between two communications business partners that can assure a correct sending of information using secure data transfer mechanism. This protocol is used exclusively for automotive industries (ODETTE). Like this one there is also **OFTP 2** that is an evolution of the precedent protocol with some tools added, like file compression. Additional description for OFPT are: SSID, SFID, ISDN Number, Password

AS2 (Applicability Statement 2): is a specification about how to transport data securely and reliably over the Internet. Other information: AS2 ID, URL

ENX: standardised communications services securely exchange development-, production control- and logistic data.

Second step is the testing of the EDI-OUT which is sending the PO to the supplier. The provider enables the channel between the plant and the supplier, the plant releases the PO and the supplier checks if he received the EDI_out correctly by comparing it to the PO received using the old system (Web Portal or simply via email). Once the supplier confirms correct receival, the channel is changed to production and the supplier from then on starts receiving the PO via EDI. Theoretically this step requires only a week if all actors were highly responsive.

Third step is the testing of the EDI_IN which is the ASN send by the supplier. A supplier works on the message and sends it. Testing of the message goes through 3 filters and if it does not pass one it does not go through the other. The supplier will have to correct the message first and resend.

1. Technical and Structure check

This is done by the provider. It automatically checks the message if all it is in the right format and all the requested fields are included in the message. If the message is found in the lab with the sign KO then it means it did not pass the technical and structure check and an error log is provided with the wrong structure or the missing fields. If the message has the sign OK it means it passed this check and can now go to the functional check.

2. Functional check

This is done by Accenture. We receive the Delivery Note document from the supplier that he is creating this message for. This is the document that contains details about the shipment; part numbers, quantities, document number and date. We check that the fields are correctly filled out and they correspond perfectly to the delivery note.

Information in the ASN message are not all included in the Delivery Note but also in the PO from the client like the supplier code for this supplier in the data base of the client, the part numbers as well and the plant code.

3. Quality check

This is done by the plant. Once the ASN andtest passes the technical check, Accenture writes on the ticket that the message is ok from our side and can be forwarded to quality for the last review. The provider then forwards the message to the plant and the plant does its checks.

The plant does not check the raw material sent in the EDI format but checks it in its SAP system, if the message is correctly implemented and read by the system. If the system needs a specific field or if any information is to be corrected.

There is a referent person for this type of check from the plant which then provides Accenture with the feedback whether if the message is ok or still needs to be corrected.

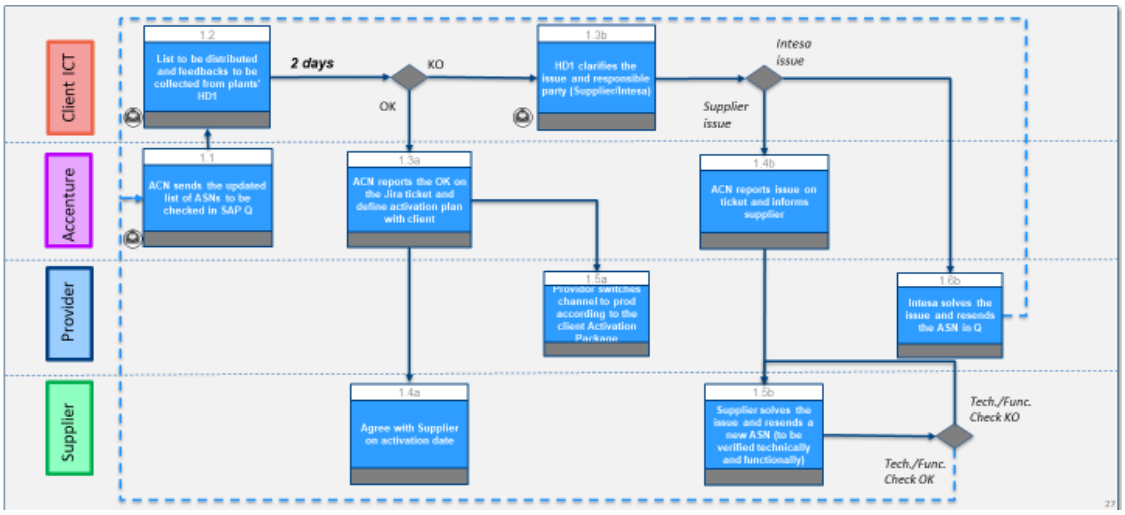


Figure 5-6 Flow chart for checking ASN in Quality

4. Labels check

In case the supplier is also implementing labels to be attached on their boxes and pallets according to the guidelines of the client. They are changing the labels currently used by them and conforming to the labels suggested by the buyer. The new labels prepared by the supplier are to be sent directly to Accenture and Accenture checks them and provides a feedback to the supplier if corrections are required. When the labels are okay, Accenture forwards them to the plant to be checked as well. Unlike the quality check, if a supplier is having relations with 5 different plants, an ASN has to created for each plant and has to be sent for a quality check by each plant. In the case of labels, the supplier sends the labels for the first plant and if the labels are okay by one plant they are considered okay for all plants and the supplier does not have to check for each plant.

5.3.2. Activation

Web Portal Activation

The day of the activation is agreed upon by the supplier, central team and the plant. The most critical player is the plant as they need to switch from the old system to the new system. Once the plant moves to the new system the plant cannot make the inbound of the goods without receiving the ASN message. The cutover activities has to be planned right as any delay may cause the production line to stop which is considered a disaster for the production side.To activate a relation on web portal, a conference call is to be scheduled with the supplier, the plant referent and the plant logistic referent to send the first ASN live together.

The plant need to be informed in advance in order to complete cut-over activities to receive the ASN via the web portal, Intesa needs also to be informed in advance about the expected date of activation to configure the relation enable the ASNWEB tab for the supplier.

The ASN has to be sent after the new PO has been published on the Web Portal and the DDT document is ready. The plant should receive the ASN before the physical arrival of the goods and preferably before the truck leaves the warehouse. After the ASN is sent, the plant must verify the correct receipt of the ASN message and then we can mark this relation as activated.

If a supplier handles various relations with the client, they can start activating the other relations.

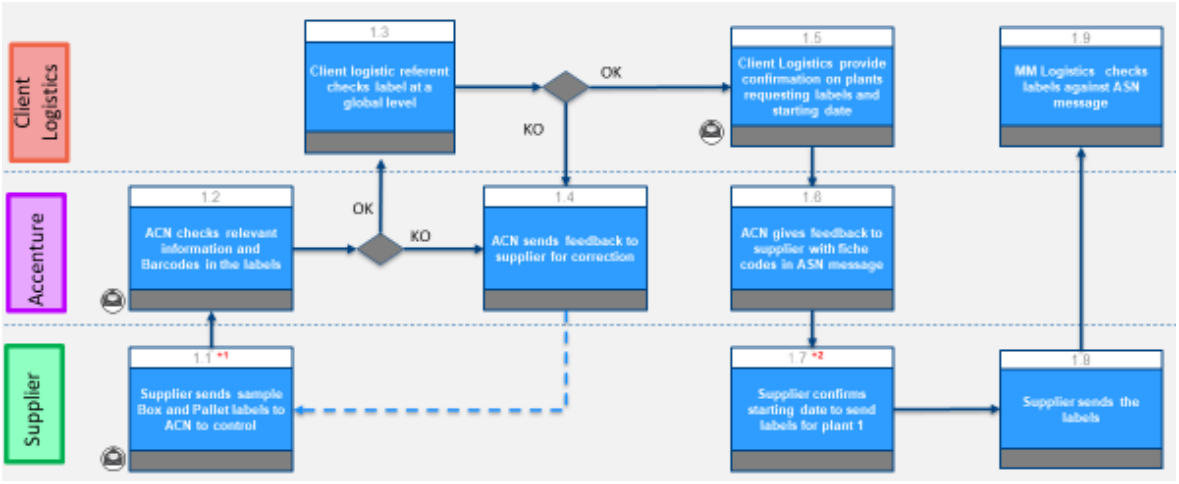


Figure 5-7 Flow Chart for Checking Labels

Full EDI Activation

This step happens after receiving the final confirmation from the quality team that the test ASN was correct and can be switched to production. At this point we contact the supplier and the plant to organize the activation date. We need to take into consideration that the plant needs from 1 to 2 days to complete the cutover activates to be able to switch from the old system to the new system to no longer receive the shipment confirmation via Email or Web Portal but rather via EDI.

After the date is confirmed by the supplier and the plant and the cutover activities are done, the supplier sends the EDI message to production. The plant should then confirm correct receival in their system. If everything is okay then the relation between the plant and the supplier is considered activated and the supplier starts using the EDI from then on.

5.3 Challenges faced

The client had plants in 31 locations each with more than one business line. A central team was shaped to manage the transformation from the old to the new system in each plant. Managing the project centrally will make benefit of the economies of scope. To learn from the possible problems that can arise, how to fix them and how to avoid them the following times.

Following will be a description of what actually happened during each phase that hindered and delayed the processes of implementation and activation and how they were overcame.

Adhesion

During the adhesion phase where Accenture should contact the supplier, and the supplier should decide on which system to adhere to and to open the Jira ticket.

1. Sometimes we were supplied by old outdated contacts of people that may not be still even in the company
2. Sometimes we were supplied with contacts of people not in charge of decision making
3. Sometimes we were supplied with some companies as if they were one company since they have the same name but with time we discover that this company is not managed centrally but rather as if they are separate entities and we had to find the contacts for the other companies
4. Sometime the supplier was not sure about the size of the project and if he had capabilities to implement the option chosen. Sometimes after a supplier adheres to full EDI he finds out that he is not managing a lot of deliveries towards the client and it is not requested by anyone else of his buyers to use EDI, so he realizes that the investment in EDI is not worth it for him. On the other hand, after a supplier chooses the web portal he discovers that he would rather adhere to the EDI as he

is shipping maybe more than once to the client and with a huge number of reference parts, so he cannot afford that time spent.

5. Some suppliers were very unresponsive to email and phone calls, others refused to join the project at all.

These situations resulted in losing time and shifting of the timeline of the project, as some suppliers were contacted later or switched to the other option later or joined after being escalated to the client purchasing team so they started in the process much later than they should have.

The performance of the adhesion phase is measured by the number of tickets opened. If all suppliers that were in this phase

Coaching

Coaching is targeted at suppliers who agreed to adhere to the second preferred option; web portal. This phase is a 1 hour session on screen sharing application where the main functionalities of the web portal are introduced and how to send the ASN message is explained to the supplier.

1- Some suppliers were not replying to emails or phone call to set the coaching session
2- Some suppliers after agreeing to the coaching sessions did not join the call
3- Some suppliers appointed a wrong referent person; the person who should attend the coaching session should be the person who is aware of the shipments, so he will be sending the ASN messages. So sometimes we still need to wait until they company appoints someone for this new task.

Testing

This is the most critical and the longest phase. It is considered the bottle neck of the process and can take from a week to months.

This phase was the reason the project was extended for 4 months. At the beginning of the project the suppliers are provided with guidelines to write the ASN message according to each format (EDIFACT,etc). These guidelines contain what the client expects to receive in the ASN message and which information is obligatory and which are not. Suppliers started working according to this information and started forming and testing for the ASN message and then midway through the project, the client discovered that he wants to receive extra information and that there are other different requirements with reference to each plant and each business line. This misalignment between plants caused confusion and frustration to the suppliers, and accordingly delay in time. Suppliers who were almost ready and their test already passed the functional check and was forwarded to have the quality check where returned. They had to adjust their ASN message according to the new guidelines. The new requirements by the client were 2

1- For the suppliers who are responsible for the transportation of the delivery until the client's plant (not delivering EX works) to include the Estimated Time or Arrival ETA of the delivery.

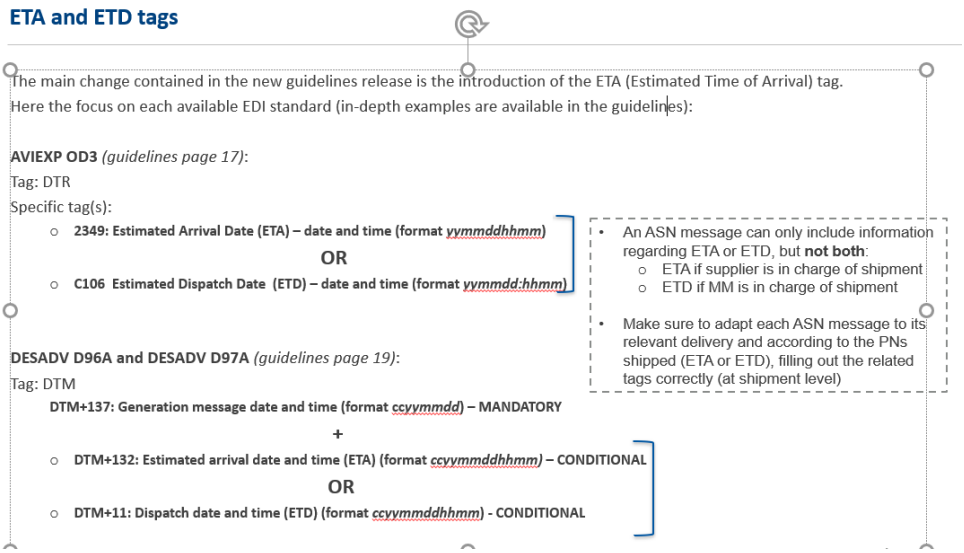


Figure5-8 ETA/ETD requirements

2- For the suppliers who were shipping to the Electronic Business Line, there was a requirement to include the label identification number with a certain format of the client's guidelines even if the supplier was not sending the actual client's physical labels but was still using his own. So a supplier can keep using his labels and have a certain identification number but in the ASN message to include the label identification number as required by the client. For most of the plants the format for that label identification number named as the fiche code was to have the first 5 digits of fixed number provided was the client and unique for each supplier and for each plant. These 5 digits are to be concatenated with 7 progressive digits that work like a counter. For other plants this format was 4 fixed digits plus 6 digits.

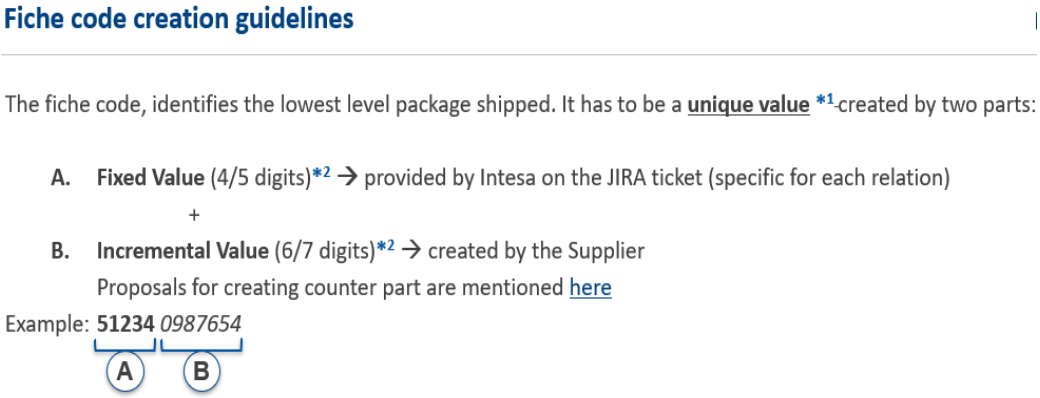


Figure 5-9 Fiche Code format

Following is the requirements I constructed and shared with the suppliers to explain to them what each business line is expecting:

For the Electronic Business Line, supplier shipping to it had to include the fiche code in the ASN message regardless of if they are changing also their labels format and having the same fiche code on their labels or not. The plant would then print the labels on their own and attach them to the boxes when they are delivered and during the inbound.

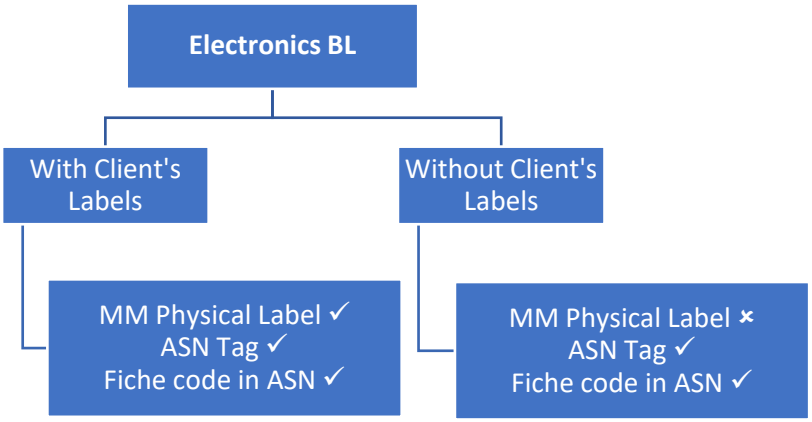


Figure 5-10 Managing ASN for ELS

For the other business lines it was according to the supplier, if he wants to implement the client's specific label format, he should include the fiche code in the ASN. Otherwise, he should not any packaging information to the ASN message.

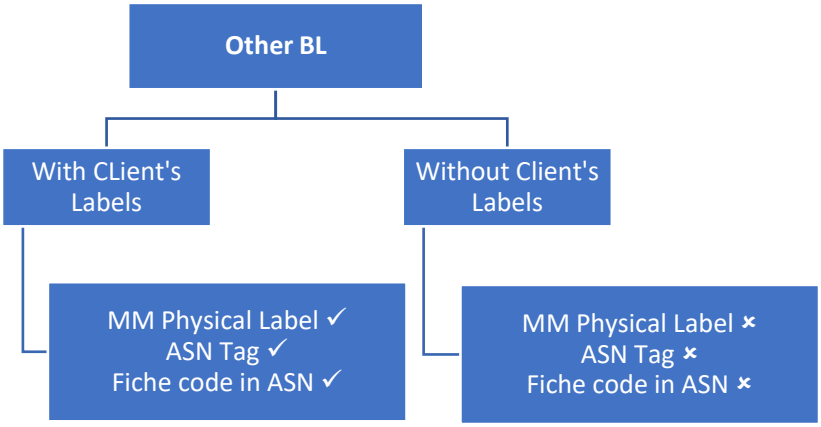


Figure 5-11 Managing ASN for other BL

It was forecasted that by the end of the year 2018 we would have activated 62% of the total number of GRs (GR works like an index to indicate how big or important is a relation, it is a measure of how many part numbers were shipped to the client by the supplier within a time frame) but due to the problems mentioned above in EDI and Web portal this target was not reached and only 34% were reached. Following is a gap analysis between the 34% and the 62% to define the main factors that hindered the process.

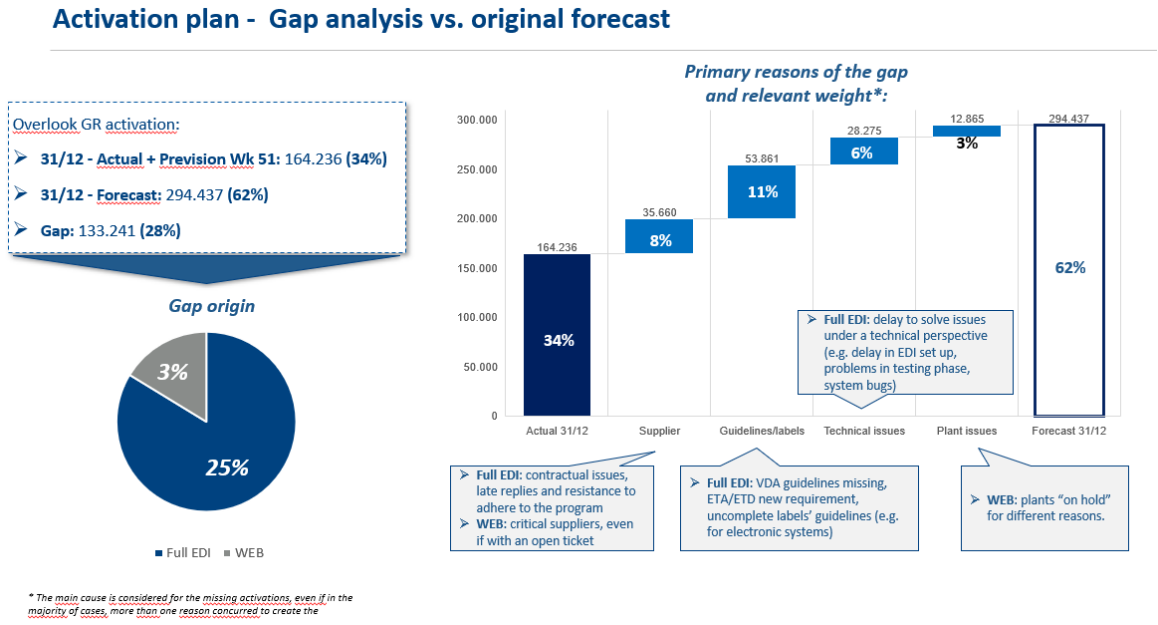


Figure 5-12 Gap Analysis between Forecast and Actual

Activation in EDI and Web Portal

After the supplier is ready to switch to the new system whether in Full EDI or in Web portal, the plant had to perform some cutover activities:

1. client Purchasing informs client IT if to duplicate old lines or create new PO
2. client IT executes the chosen option and extracts cumulated quantities
3. client logistics validates the cumulated quantities
4. client IT migrates confirmed quantities and updates source list

Problems encountered during that phase can be summarized in the following:

From the side of the supplier:

- We realize on the day of the activation that the client did not supply us with correct shipment details or full shipment details for example that he is creating more the delivery note per shipment, sometimes to the extent of 1 delivery note for each PN he is shipping. It might result in having to send 100 ASNs and

maybe if the warehouse of the supplier is really close to the plant of the client, the goods might arrive before the ASNs are sent and the plant sometimes could not want to receive it to make the inbound of the good as the shipment may contain part numbers that are critical for the continuation of the production line. Critical for Just In Time JIT suppliers.

- Supplier might send a wrong ASN, related to another shipment or include wrong information. In that case the plant needs to be informed directly, ASN needs to be deleted, a new PO has to be issued to increment the values in the ASN web since they were discounted when the last ASN was sent and a new ASN is to be sent.

From the side of the plant:

- Plant might not be able to finish the cutover activities in time so the activation is postponed.
- Plant might have a technical error disabling it from receiving the ASN in the ERP system. Investigations are to be done which might take months in some cases. Some plants s are not happy about these changed as it might cause problems and delays to their production lines so they are fighting the change.

From the side of the provider:

- ASN function is not enabled in web by the provider so the supplier can not send the ASN message. The plant would need to make a manual inbound of the goods which is really time consuming.
- Sometimes after sending the ASN an error in the connection between the provider and the client prevents the message to be forwarded to the client's ERP system and thus delayed the production cycle as well.

These are some of the specific cases that were faced during the activation of the ASN in web and how they were fixed

Case	Explanation	Possible Solutions
Variable quantity per box for the same part number	Some suppliers are not using standard box quantities for the same part number, because they are creating boxes with the same size of their production lots which the system does not allow this kind of flexibility	An extended CSV file was created that can be uploaded to the system and allow for such flexibility.
First ASN on in transit goods	For some suppliers that are shipping with a low frequency, it is possible to do the ASN on in transit goods, but the inbound from plant side will require some adjustments.	• The ASN sent from the supplier will be considered a test and the plant should do manually the ASN in order to do the inbound • Reconciliate POs from plant side
Delivery on demand	Some suppliers receive requests from plant for consumable material not through a PO. Therefore, no ASN can be done.	If the request is not related to closed order (no ASN must be done), the plant should issue a new PO with all the required part number and quantities
Various DDTs for same shipment	Some supplier are creating more than one DDT per part number for each delivery which is time consuming for Web Portal suppliers and costly for EDI ones.	• If required from supplier side, supplier should consolidate all DDTs in one • If required from plant side, plant need to investigate how to improve the process
Shipping more than requested quantity	Suppliers who are producing material solely for the client, want to ship all produced items but they cannot send it through web-portal.	Issue PO for upcoming deliveries so supplier can send parts in advance.

Unavailable POs	Some supplier codes are updated by the client without being communicated to us. Our request to Intesa for the activation of the web portal is related to a wrong supplier code.	Communicate to ACN any update on supplier codes.
Inability to send WEB ASN for LATAM suppliers	DDT number have the format xxxxxxxxx-xxx which is longer than the accepted length by the portal.	Modify restrictions on DDT number length on the web portal.

Table 1 Special Cases faced by Suppliers to be activated in WEB Portal

The project was estimated to activate 200 suppliers in Full EDI or Web portal to receive the purchase order and send the shipment confirmation within a time frame of 7 months but was extended to 10 months. Some suppliers were not ready at the beginning, misalignment between plants at the beginning and guidelines were not completely developed. These were the reasons for the extended time. But now that everything is established, activating other suppliers and relations in EDI will be an easy job. As a next step, the client can activate all of the other relations with his suppliers and the plants in EDI. The information shared using EDI can also be extended to share billing information and consignment stock as well.

Chapter 6: Conclusion

Companies have not succeeded yet in building digital supply chain organisms due to their complexity. Even though a lot of its necessary applications are not prevalently used nowadays, it is important to notice that in 10 years it is not going to be the case due to the implementation of DSC in many industries at varying speeds. Companies with accelerated technological paces will get there first but will face a difficult-to-challenge advantage in the industry 4.0 race. They will be able to set for themselves the technical standards they need for their specific industry. The benefit will certainly not be restricted to greater competences and efficiencies. The real target here lies beneath the new start-ups and business models as well as the new revenue streams that the digitalized supply chain technology will introduce.

Industry 4.0 is the solution for the challenges faced by the European Industry and the competition arising from the uprising developing countries due to the cost benefit they are offering. One of the main barriers for the industry 4.0 is the lack of incentive for some suppliers. There is a very high resistance to change as they can see that the current used traditional system is working well and they cannot vision after that so they cannot see the return for the investment in the new system whether from the money point of view or the time. The EDI program is directly impacting logistics referents which are usually very busy and do not have enough time and can not afford the system to be interrupted. Therefore, for a company before asking its suppliers to implement an EDI system, they new to make sure that they themselves are ready, they need to form a centralized team which knows the procedures and are able to train the plant referents to ensure the procedure will take the least time possible and no replication of tasks will take place. Regarding the money incentive, the governments should add an incentive for companies following the industry 4.0 and for other big companies to change their systems and to start asking their suppliers to implement the EDI. This will create a trend towards the Industry 4.0 that will motivate the companies to invest in the digitalized systems. When

they start receiving requests by most of their big buyers to switch to industry 4.0 they will be forced to adhere to their digitalized system or might soon become obsolete and lose shares of their businesses.

Smart supply chain enablers — success factors

Firstly, it is crucial for companies to develop a strategy that is totally receptive and responsible to opportunities on offer in a fully digitalized medium. Indeed, this task is considered to be the most difficult task for companies that are starting to incorporate smart supply chain, yet it is of extreme importance. If disregarded, the digitalized supply chain system will likely be proved impossible. This system must be based on new business models and not on just on the company's current business model and operations. New business models that include leapfrogging levels in the value chain as well as creating sales channels must be taken as reference in model once digitalization has been implemented.

When the strategy is set, companies must refer to a couple of key capabilities in order to implement it correctly. They must also refer to the supply chain applications deliberated previously. The key capabilities necessarily are as follows:

- **Processes.** It is the process of establishing a new end-to-end connection clinking consumer to buyers or customers to suppliers. The new digitalization technology makes such connection possible due to cloud-based platforms that make these collaborations possible.
- **Organization and skills.** This process engenders an end-to-end comprehension of the value chain mechanics. This results in altering the mindset; from firefighter mentality -solving problems instantly as they pop up – to transforming into a supply chain orchestrator. One that is able to optimize, see and manage the whole chain. This level of digitalization requires a high level of adaptability since it will necessitate a shift towards a fast learning digital culture that endorses global multimedia communication across different users and medias. Also, it

necessitates updating users to the new level of expertise required to adapt and build the necessary technology to carry out digitalized supply chain operations.

- **Performance management.** It is the process of setting rules for the management of the supply chain and implementing key indicators to assess and measure the performance outcome.
- **Partnering.** It is important to focus on making connections and partnering up with other companies because a fully digitalized supply chain system cannot be implemented nor built without collaborating with other supplies and a variety of other technology providers.
- **Technology.** The last key capability is to plan a road map for the variety of old and new technologies that will reinforce the digitalized supply chain system. That includes the databases, the analytics the information integration layer and finally the cloud.

Supply chain maturity

Only a few companies were able to reach something close to a fully mature digital supply chain system. In order to ensure that efforts are coherently being exerted, it is crucial for companies to be aware of their starting point and starting position. There are four stages of maturity in this process:

1. **Digital novice.** At the first stage the firms are still starting their digitalization journey. Their supply chain procedures are discrete and they are still supported by business units and individual departments.
2. **Vertical integrator.** At the second stage, the company should have managed to incorporate internally the digitalized supply chain processes among all departments.
3. **Horizontal collaborator.** At the third companies should have started to adapt to work with supply chain partners and should be able to set defined goals and carry out mutual processes in order to attain a good level of fairness and honesty in the chain.

4. **Digital champion.** At the last stage, companies should be at their peak level of collaboration with several partners and all their operations must be mutually transparent, while taking into consideration mutual benefits in the process as well as opting together to optimize the whole supply chain.

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