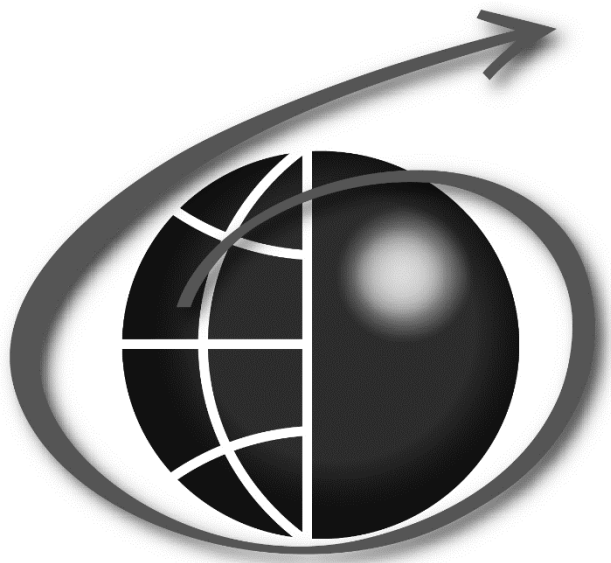


**NEED AND VALUE OF INFORMATION IN ITS:
SUPPLY CHAIN PERFORMANCE
THROUGH PREDICTIVE ANALYTICS**

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Abstract

In a context of globalization of supply chains, increasing demand and supply uncertainty, supply chain network complexity, changes in environmental rules and regulations, growing human and freight transportation, big risks and Big Data, supply chains dynamics have changed significantly. In the transportation industry, the data collected by the numerous technologies of ITS are complex and characterized by large quantity, volume and heterogeneity of data. In addition to the complexity of data structure, supply chain manager suffers from a lack of visibility. In this way, supply chain managers had to find new tools and methods to analyze the big quantity of data, improve their visibility and the performance of their supply chain. Hence, they agree in saying that Big Data and Predictive Analytics will be new levers for supply chain managers to identify, assess, mitigate and manage global risk and, logically global performance of the supply chain. The utilization of emerging data analytics software and technology, with efficient data collection process and accurate information communication systems, offer great opportunities to build ITS of tomorrow. After having defined the key components of Intelligent Transportation Systems and the technologies related to it, also as the nature and need for information in these systems. Different research questions and arguments related to visibility and Big Data will prove that Predictive Analytics is a vector of performance.

Keywords: Intelligent Transportation Systems, Big Data, Predictive Analytics, Supply Chain, Visibility, Performance

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List of Acronyms and Abbreviations

ACVOS: Advanced Commercial Vehicles Operations Systems

AFMS: Advanced Fleet Management Systems

AI: Artificial Intelligence

APTS: Advanced Public Transportation System

ARTS: Advanced Rural Transportation System

ATIS: Advanced Traffic Information Systems

ATMS: Advanced Traffic Management Systems

AVC: Advanced Vehicle Classification

AVCS: Advanced Vehicle Control Systems

AVL: Advanced Vehicle Location

B2B: Business-to-Business

CAGR: Compound Annual Growth Rate

CEO: Chief Executives Officers

C-ITS Platform: Cooperative Intelligent Transportation Systems Platform

CVO: Commercial Vehicles Operations

DSRC: Dedicated Short-Range Communication

EU: European Commission

GPS: Geo-Positioning Systems

ICT: Information and Communication Technology

ITS: Intelligent Transportation Systems

KPI: Key Performance Indicators

RFID: Radio Frequency Identification

TMC: Transportation Management Centers

TOC: Transportation Operations Centers

UAS: Unmanned Aircraft System (UAS)

UAV: Unmanned Aerial Vehicle (UAV)

WIM: Weigh-In-Motion

Introduction

1. Background of the study and statement of the problem

The continuous growth in vehicular and freight has lead governments and corporate entities to find news way to manage and control transportation in an efficient manner. Transportation and freight domain is one of the most challenging one and having a developed and efficient logistic network is a real lever of competitiveness for a country or organization (Crainic, Laporte, 1997). It was considered that the solution to transportation and freight issues way to build more infrastructure to support the growing numbers of vehicles. However, better logistics need to be achieve through efficient management. Since a few years, globalization era as permitted the enhancement of already existing roadway technologies and infrastructure, communication and data transmission, computing technologies, geo-positioning systems, as well as planning and data analysis tools. However, these improvements alone are not able to ensure traffic and freight management; therefore, supply chain and pubic authorities must have developed advanced transportation management systems which are called Intelligent Transportation Systems. The term of ITS referred as the inter-connection of technologies, infrastructure and services under a single system. It uses advanced planning systems to predict models an established control methods for application implantation. In the previous decade, the exponential increasing of internet-based commercial applications as conducted to the digitalization of transportation and freight. The data exchange generated by these interactions are creating tremendous amount of data which need to be further analyzed. Intelligent Transportation Systems allow supply chain managers to access to a large panel of visibility information on transportation state. Software-based processing and analysis technology in ITS extract relevant information from data and distributed them to decision-making agents. Supply chain managers are elaborating plan and make decision based on relevant information. Which, is use by decision operations to leverage and improve performance through value-adding information. For that reason, to improve supply chain performance in corporate entities, it is crucial to obtain precise information in the right moment to gain wider visibility and implement efficient and adapting strategies. The growth in the quantity of data accessible required enabling systems and advanced information process methods. Supply chain manager are looking forward to explore new data acquisition application and forecasting techniques such as Big Data and predictive analytics.

2. Aim and Objective of the study

Considering the fast-pace changing environment in the transportation and logistics domain, this thesis aim is to identify and synthesize the components of Intelligent Transportation Systems and especially freight and commercial vehicle operations. Moreover, it tends to show in what way the performance and functions of freight transportation is affected by ITS. Furthermore, this thesis identifies what value and nature of information is used by these systems. Finally, the last research purpose is to explore and give insights in Big Data and predictive analytics to help supply chain and ITS systems.

3. Research questions

Corporate entities are constantly seeking for ways to improve performance and increase their visibility to create efficiency. To become more profitable, these businesses develop new processes and techniques to enhance their visibility. This paper is focused on new applications and technology that can be used to increase supply chain performance and visibility. For research this study several questions emerge and will guide the argumentation:

<i>RQ1: What are the components of freight ITS and what types of technologies are used?</i>
<i>RQ2: What types of information are valuable for actors of supply chain?</i>
<i>RQ3: Supply chain executives don't have sufficient visibility over the supply chain?</i>
<i>RQ4: Big Data, Predictive Analytics increase supply chain visibility?</i>
<i>RQ5: End-to-end visibility is vital for supply chain executives?</i>
<i>RQ6: Is visibility is a factor of performance in the supply chain?</i>

4. Structure of the thesis

The first section try to give an overview of Intelligent Transportation Systems and the technologies used in these concrete applications. In a second time, the type of information in supply chain and the value of information will be developed. After that research methodology, will be applied to compare questionnaire and interview to estimate the current state of visibility of supply chain managers and executives. Lastly, a section will evaluate emerging data collection process and analysis applicable to transportation and supply chain methods: Big Data predictive analytics.

Literature Review

The continuous increase in the volume of road and freight transportation worldwide associated with the growth of the economy and mobility requirements of human's activities is the primary cause of increasing congestion of road infrastructure and rising challenges on freight logistics operations, as well as sources of environmental and social problems. These issues and challenges lead to the rise of Intelligent Transportation Systems in public and private sector. ITS Market size value is expected to reach \$47.5 billion by 2022, growing at a CAGR of over 13% between 2015 and 2022 (Global Market Insights, 2016). These systems provide a set of strategies to overcome congestion issues, ensure a reliable safety and mobility of users while considering the growth in transit capacity and freight exchange flows. (Maccubbin et al., 2008). These data-driven systems required to process the large volume of data and convert into valuable and timely information for advanced operations planning and efficient fleet management (Crainic et al., 2009). In the same time, the growth in the quantity and diversity of data has led to data sets larger than is manageable by conventional hands on management tools. To manage these new and potentially invaluable data sets, new methods of data science and new applications in the form of predictive analytics have been developed (Russo et al., 2015). Indeed, 90% of all data that exists in the world was created just two years ago (Schlegel, 2014). Having available a big volume of data is useless if managers don't explore and investigate them in order to offer a decision help. In this way, Big Data is a BI and data mining prolongation in a huger field, including structured and unstructured data, from different sources, with a dimension of processing in real-time (Calais, 2014). Within this context, supply chain management predictive analytics can play a great role using both quantitative and qualitative methods to convert information into knowledge (Hair, 2007 in Russo et al., 2015). This improves supply chain design and competitiveness by estimating past and future levels of integration of business processes (Russo et al., 2015). Data science, predictive analytics, and "Big Data" are each thought to be a part of an emerging competitive area that will transform the way in which supply chains are managed and designed (Waller, Fawcett, 2013 in Russo et al., 2015). With the new normal operating environment, supply chain professionals feel very comfortable saying that Big Data and Predictive Analytics will be new levers for supply chain managers to identify, assess, mitigate and manage global risk (Schlegel, 2014) and, logically global performance of the supply chain. How do Big Data and predictive analytics increase the supply chain and Intelligent Transportation Systems performance?

I – Intelligent Transportation Systems

1.1 Overview of Intelligent Transportation Systems

To have a clearer understanding of what are Intelligent Transportation Systems (ITS) in general, a brief overview is needed. Intelligent Transportation Systems are multiple and complex applications of information, communication and technology to transportation and freight domain. Information and Communication Technologies (ICT) relies mostly upon data, where their function consists in obtaining, processing and distributing information to help managers in decision making. However, what is modern in Intelligent Transportation Systems concept, is the aim to achieve the integration of a global structure facilitating the cooperation between several systems previously isolated (Crainic et al, 2009). Therefore, it is useful to sort the different applications and components in ITS due to the complexity and variety of technologies. While the list provided below does not include every possible Intelligent Transportation Systems applications, it includes the most important ones. A full and complete taxonomy of ITS was released in 2015 by AECOM on the EU Commission consulting purpose of current level of use of KPI in ITS (Appendix 1). Nonetheless, ITS applications can be organized and divided into six subcategories which are defined by their use function. (Whale et al, 2002; Ezell, 2010)

Advanced Traffic Management Systems (ATMS)	ATMS monitor, control, and manage traffic on roads and freeways
Advanced Traffic Information Systems (ATIS)	ATIS include a variety of systems that provide real-time, in-vehicle information to drivers
Advanced Vehicle Control Systems (AVCS)	AVCS are mainly focused to in-car use and systems to assist drivers in controlling their vehicle.
Advanced Commercial Vehicles Operations Systems (ACVOS)	ACVOS address the application of ITS technologies to the special needs of commercial vehicles

<p>Advanced Public Transportation System (APTS)</p>	<p>APTS enhance the effectiveness, attractiveness, and efficiency of public transportation.</p>
<p>Advanced Rural Transportation System (ARTS)</p>	<p>ARTS include systems that apply ITS technology to the special needs of rural areas.</p>

Table 1: Classification of Intelligent Transportation Systems (Whale et al, 2002)

However not every application is relevant for our study which is more concerned about B2B Logistics and Supply Chain Operations related usage. This first section will develop further the relevant ones.

Nonetheless, these ITS applications need a wide range of technological capabilities which is used at a vehicular or infrastructural level. Where, advanced electronics devices such as electronic imaging, data processors, information and communication systems, roadside messages, GPS updates and automated traffic prioritization signals etc ... are key features in these systems. Moreover, as Cranic in Transportation Research Part C 17 (2009): “It is important to remember that the ITS idea is not a brand new concept emerging suddenly, but rather a rational and logical evolution of transportation management drawing on old and new technologies.”. The digital revolution along with the improvements in terms of quality and prices of IT technology allows researcher to develop better devices every day. Emerging tools such as Unmanned Aircraft Systems (UAS) or commonly called drones and Artificial Intelligence (AI) or autonomous vehicles have for some been tested to experiment new transportation methods.

Intelligent Transportation Systems and especially freight ITS are extremely dependent on information’s. Advanced planning and forecasting systems needs to provide timely and accurate information to managers and thus, give useful insight and perspectives. The main source of data is collected by their own operating ITS technology such as sensors for example. These data are key valuable information to gain visibility among the supply chain. Having visibility across the different areas of the supply chain gives the company the opportunity of improving the supply chain reliability and predictability and having more visibility lead to better information and clearer views of the entire supply chain.

To support the collection and process of the arriving flow of data supply chain need to implement a “*control tower*” which centralized the data collected. In Intelligent Transportation Systems, this fundamental unit is referred as Transportation Management Centers (TMC), sometimes called Traffic Management Centers or Traffic Operations Centers (TOC), where data is collected and analyzed for further operations and control management. (Rawal, Devadas, 2015). As reported by U.S. Department of Transportation: “*Coordination through a TMC can also improve the performance of the various strategies. TMCs are often the venue for the instantaneous communication and coordination among various transportation organizations that enable improved system performance.*” (Maccubbin et al., 2008). However, it is for sure that the efficiency and processing speed depends on the level of integration of ICT among the different actors and levels of the supply chain.

ITS can be represented as a cycle involving coordination and easy and accurate exchange of information between the four main components as shown below:

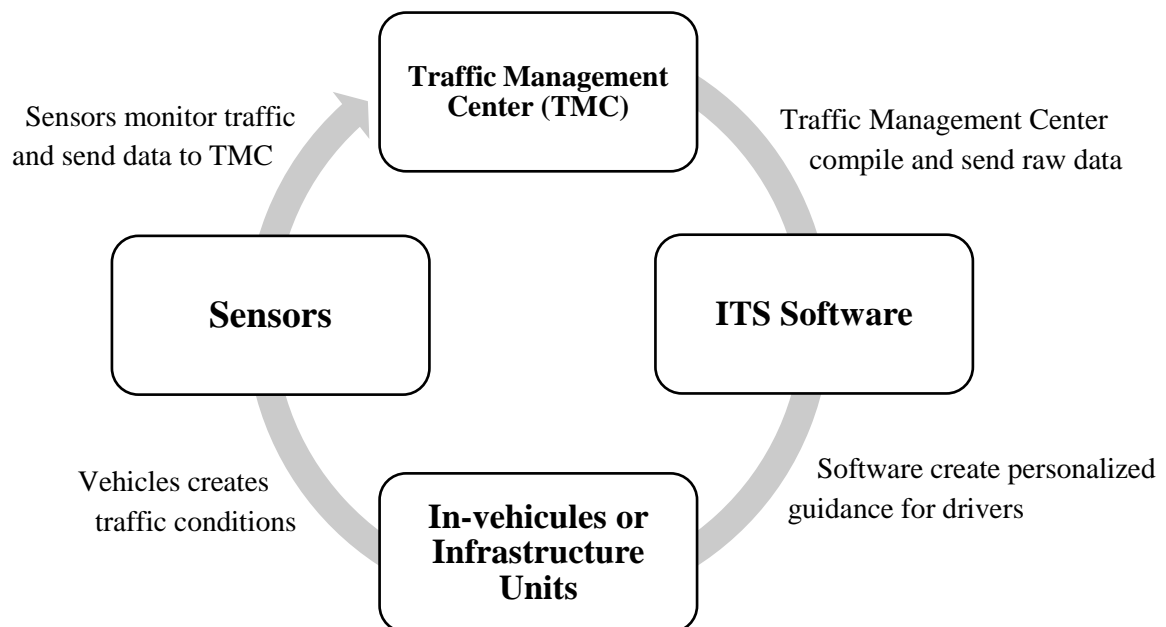


Figure 1: The Intelligent Transportation Systems Cycle

1.2 Technologies of Intelligent Transportation Systems

Intelligent transport relies on technology development and database infrastructure capacity to efficiently perform analysis and give reliable information to traffic agents regulator or corporate entity managers. Technology involve several devices and application of existing feature as Geo-Positioning System (GPS), camera and sensors, and especially wireless communication technologies (RFID, DSRC, Radiowave) to ensure sufficient data transmission between implemented equipment, in-vehicle or inside infrastructure, and the Traffic Management Center.

Geo-Positioning Systems (GPS)

Since a few years, Global Positioning Systems have known huge advancement in terms of technologies and features to ensure an accurate and real-time guidance of the user. GPS devices are embedded inside the vehicle and communicate with satellites through wireless communication and therefore determine the device position. Nonetheless, this requires line of sight to satellites, which can inhibit use of GPS in downtown settings due to “*urban canyon*” effects (Ezell, 2010). However, GPS is the key technology and offer great promises in most of ITS applications and implementation settings related to vehicular navigation and route guidance. Advanced Geo Positioning Systems are likely to display information to user and the role of traffic management centers is to provide this timely and accurate personalized information to the road user.

Dedicated-Short Range Communications (DSRC)

Dedicated Short-Range Communications (DSRC) is a spectrum at 5.8 GHz or 5.9Hz using wireless medium range communication. This technology comprises many application for example in bilateral electronic data exchange between vehicles in traffic and vehicles to infrastructure communication and monitoring. When it comes to vehicle-to-vehicle communication it can easily help in detecting collision avoidance for example as well as other valuable applications, such as Electronic Toll Collection (ETC), real-time traffic advisories, digital map update (Yin et al., 2004). However, to support an efficient communication, public organization and authorities need to unify the levels of different branches by involving a higher sharing of current information hold by private companies.

Radio Frequency Identification (RFID)

This is a very common method used everywhere and in every domain. This wireless identification process required a RFID-Tag or RFID-Transponder which memorize a set of preset information. When this RFID-Tag is scanner manually or pass through automated scanning portals it instantly read and collect the data from the devices. It can be implemented on a product to know its description or even a full truck containing different goods.

Considerably improving areas such as tracking and shipping operations RFID becomes more reliable and faster in providing accurate and timely data for managing the information flow. (Dai, Tseng, 2012 in Vlachos, 2014)

Microwave Communication

Microwave wireless communication is an effective type of Electromagnetic Radiation (EMR) communication, mainly this transmission uses radio waves technologies. In this communication, the data or information can be transmitted using two methods. The first one is satellite and the second is terrestrial transmission method. Satellite, obviously imply data transfer through the use of a satellite orbiting around 35.000 kilometers above earth. In terrestrial mode, instead use, two “microwave tower” that must be visible interdependently. Which means, that is essential to ensure a visually clear and direct line through the space between the transponder, which is the source emitting the data and the destination point receiving this data, the receptor. Even if, microwave technologies is for medium and long range communication, they can be affected by bad weather conditions, especially when it is raining.

Infrared Radiation Communication (IR)

Infrared Radiation or IR wireless communication transmit information in a system-to-system way through Electromagnetic Radiation (EMR). The wavelength of IR spectrum is comprised in-between microwaves and visible light, it is usually used for short range communications. In IR communications, a LED transmitter and diode receptor are required to ensure a successful transmission of electronic data. As well as in Microwave communication, both LED transmitter and diode receptor need to be in line of sight.

Roadside Camera Recognition

Camera recognition systems are used for purpose such as license plate identification, traffic congestion or accident detection, motion detection, surveillance and safety. For example, strategically placed, safety cameras will identify congestion or accident zone and automatically alerting emergency personnel, rerouting traffic by notifying approaching vehicle and updated nearby digital road sign. Real-time broadcasting of cameras vision to the TMC give insights of traffic conditions and easily help traffic monitoring to display accurate and timely messages. Moreover, based on Roadside Camera Recognition technologies, certain cities developed a “*Zone-based congestion charging systems*”, as for example in London. These cameras in London use Automatic License Plate Recognition (ALPR), based on Optical Character Recognition (OCR) technology, to identify vehicle license plates (Ezell, 2010). Strategically placed at entrance and exit of defined area it scans, process and transfer ID plate number to back-offices coordinators. Then by correlating transferred data with the National License Plate Record, traffic coordinators charges £11.50 per day each vehicle passing through congestion zone gates between 7:00AM and 6:00PM. Thus, limiting traffic in city center district congestion by rerouting vehicles to another adapted traffic infrastructure.

Probe Vehicles

As for most of technologies used in ITS, this Probe Vehicle concept lays in the interaction between the vehicle equipped by sensors and GPS technology, and the TMC. The previously stated, equipped vehicle, is usually public-owned vehicle or some fleet vehicle extent such as taxi for example. The main aim of the system is to transmit real-time in-traffic data about the current speed and position. Moreover, it can be used to transmit theses information at a fixed time interval or at points. For example, by collecting speed and location its easy by the mean of calculation to determine the time span between two gate points or two selected collection time. Thus, comparing this time interval to normal traffic flow expected time span, it is for instance possible to draw a map of area-wide congestion and fluidity based on real-time data.

Autonomous Vehicle and Autonomous Freight Transportation

Applications similar to “*Autonomous Driving*” as started to be experimented for in-house logistics in the early 50’s. Automated, driverless and partially autonomous vehicles have been operation within the supply chain and logistics domain for a long time (Flämig, 2016).

However, technology development and modernization as permitted to enhance the capability in term of localization, safety, mobility, user experience, accuracy and communication of commercial and private vehicles. Highly and fully automated vehicles can also navigate “freely” assisted by in-traffic sensor and cameras to continuously monitor car direction and speed by the mean of two-way communication and data collection.

Inductive Loops

A magnetic induction loop is an electromagnetic communication or detection system. It uses a movable magnet to induce an electric current in an adjacent loop. Inductive loops are often used in roadway entry to collect data of vehicles crossing this loop. This technology related to communication and transmission of information, count the number of vehicle but also their size, weight, speed, length, as the vehicle classification. Theses loops are very efficient and are addressed to either low and high speed traffic infrastructure as the sensors are able to analyze lots of quantity of data in few minutes.

Each of these technologies applications mentions before are useful in getting more knowledge about traffic conditions by ensuring a two-way information exchange. Thanks to the continuous development of technology, more and more applications and method of transportation are being design and tested.

1.3 Emerging Technologies Applicable to Intelligent Transportation Systems

Very new technologies and transportation methods emerge every day. In recent years, we have seen an increasing demand for optimization and automatization in supply chains. Optimization passes through the improvement of already existing technologies, although as finding new ones. Even if not all the technologies presented below is not developed or directly applied to supply chain, it contains characteristics and specification that fit ITS optimization objective.

Unmanned Aircraft System (UAS)

Unmanned Aerial Vehicle (UAV) - commonly referred to as drones, is an aircraft without any human pilot aboard. It can be remotely controlled or autonomously with the assistance of onboard technologies. According to, Kharchenko and Pursov, the UAV cannot operate alone

and required indeed a structure able to communicate with the drone and the on-ground operator. It required the UAV itself, but also control station for management purpose, software and system for communication and on-board monitoring of the UAV, landing and launching systems, storage and terminals of data processing. (Welch, 2015)

Drone are far more economic in terms of energy consumption and carbone dioxide emission especially when it comes to last-mile delivery which is a key challenge of carriers nowadays. Several plans and project are in development for application of a drone based delivery package system. Companies such as Amazon or, La Poste in France are currently testing this new delivery method.

Emergence of Unmanned Aircraft Systems as a transportation alternative to trucks is a challenging opportunity to consider especially in large cities where congestion and need for large facilities for pick up or drop-off is required and restrictive due to size issues. (Tavana et al., 2017) However, the substitution of conventional mode of transportation such as trucks can only be determined by the cost-effective assessment of this method compare to the other one. Which means by comparing each respective route traffic density, and drop load capacity. Even if, UAVs lack of carrying capacity due to their size compared to truck. As stated by Amazon, their drone-based package delivery program allow their drone to cover 86% of website potential orders. However, packages must have a lower weight than 2.5kg to be lifted-up. Recent researches estimated the cost per delivery to be of \$0.88 per delivery compared to \$1.2 on average for trucks (Wang, 2016 in Tavana et al., 2017)

SpaceX - Tunnel Transportation

Very recently Elon Musk former CEO of SpaceX, the worldwide know aerospace manufacturer and space transporter, launch a new project of city logistics and car transportation. Instead of constructing infrastructure on-ground he suggest that, similarly as underground train, city transportation should move in the same direction with tunnel arterial system conducting vehicle autonomously. He created therefore, The Boring Company, which is in charge of carrying the project. They already established some plans of the transportation systems. Basically, the vehicle park's itself in a transportation platform which safely locked bring the vehicle and its passengers to underground rail infrastructure. From there the vehicle is guided automatically to the selected destination at a speed of 200 km/h (Tested by Elon Musk on the 13/05/2017 in Los

Angeles). Underground structure allows vehicles to avoid congestion area and ensure a fast and safe transportation method. However, this new technology requires more experiments to be achieved in order to oversee the full capacity and challenges of the implementation process

Dynamic Electric Vehicle Charging (DEVC)

On a press release on the 18th of May 2017, Qualcomm Technologies Inc, reported to have experimented Dynamic Electric Vehicle Charging (DEVC). A revolutionary technology created to provide electrical charging to vehicle while in traffic. This company developed, as they call it, the Qualcomm Halo™ Wireless Electric Vehicle Charging technology. The experiment is part of the FABRIC project, a 9 million program funded in part by the European Union to evaluate the technological feasibility and economic viability of a dynamic induction charging system for electric vehicles. Two electrical vehicles from the French well-known brand Renault have been chosen, two “Kangoo” are used on the hundred meters of the test track, built by Vedecom (associated with Qualcomm) in Satory, near Versailles. The system delivers up to 20 kW of power and ensures the transfer at the speed of 100 km/h. Additionally two vehicles simultaneously rolling in opposite directions can charge at the same time, also as in reverse. (Qualcomm, 2017)

1.4 Commercial and Freight Applications of Intelligent Transportation Systems

Intelligent Transportation Systems applications are multiple and serve to fulfill several functions, as we have seen according to Whale, 2002. Even if this classification comprises most of the general ITS applications, not every section is relevant for the study purpose. Moreover, some are closely related and only differ in the level of infrastructure implemented. Therefore, to facilitate reader’s comprehension while defining ITS functions and components, this study will summarize ITS and especially freight ITS as two broad areas which are: Advanced Commercial Vehicle Operations Systems (ACVOS) and Advanced Fleet Management Systems (AFMS). Both are very similar and achieve co-objectives however they can be differentiated as explained by Crainic, Gendreau and Lebeuf in 2009. These two application types differ in the implementation level that is required: ACVOS are used at the institutional, regional or national level whereas AFMS is dedicated to carrier and B2B level.

1.4.1. Advanced Commercial Vehicle Operations Systems (ACVOS)

Advanced Commercial Vehicles Operation Systems (ACVOS) or CVO in short is part of Intelligent Transportation Systems. It involves the cooperation and mutual exchange of information between public entities at a regional, national or international level. Under Commercial Vehicle Operations, various methods such as road-sign electronic screening, route planning and scheduling, vehicles monitoring and tracking, electronic credentials, weigh-in-motion, automated vehicle control are commonly used. (Wooton et al., 1995).

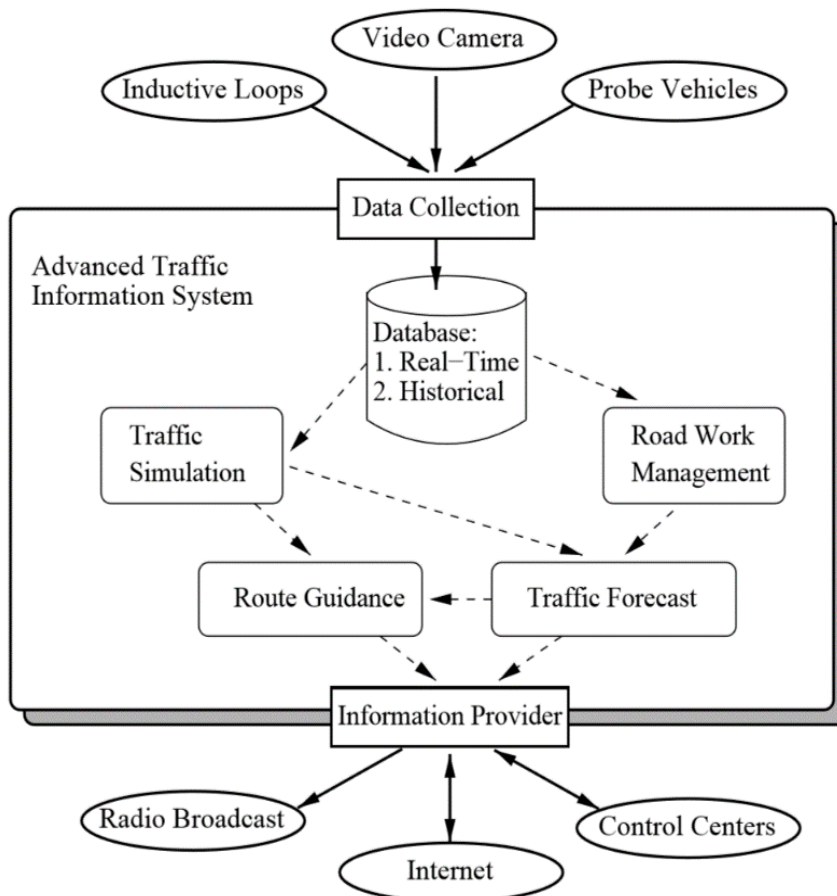
The procedures related to CVO and Intelligent Transportation System are complex, particularly at institutional level. The numerous interactions between different parties with different objectives and operation policies complexify once again the supply chain. However regulatory agencies exist and achieve a monitoring and guidance purpose for the roadway and traffic management. ACVOS is supported by Electronic Data Interchange which imply, the collection, transmission, process, storage and analysis of real-time traffic information for management and travel informative purpose. For example, ATIS or ATMS are based on the exchange of electronic data between in-vehicle sensors or monitoring detection system and the TMC. ACVOS is comprising several aspects and applications of ITS. It can be affiliated to ATIS, ATMS and AVCS because these systems are commonly used by transportation governmental organizations. They are based on the technologies seen previously in Section 1.1 but required also specific additional components. Cooperation is a key asset for further progress in ITS and supply chain management. The unification and association of several systems applications is important and useful to get wider insight and visibility. By encouraging exchange of information and knowledge from either private or public partners in supply chain transportation and traffic conditions can be enhanced and optimized. Three main application previously stated are link closely linked to ACVOS.

Advanced Traffic Information Systems

The aim of ATIS is to provide accurate and in real-time information on traffic status condition, also as to offer transportation mode and option while being geo-localized. Advanced traffic information systems are used for advisory purpose, to inform quickly and easily road users. This system deliver real-time information such as travel duration and current speed, accidents warning, route guidance, congestion zone, weather conditions etc... This information is display

through-out electronic devices along highways, on short message signs, directly on driver's devices (cellphone, GPS) or with media announcement such as radio, television channel or internet.

The technologies are mainly based on Geo-positioning systems to determine precisely the vehicle location in real time; Camera Recognition Systems situated at some crucial location to identify traffic conditions and incidents; and Wireless Communication devices to transmit established data to the TMC for further analysis and process. It can either work autonomously with in-vehicular devices collection, transmitting, processing and displaying information directly with other interaction such as GPS for example. Also, as based on Traffic Management Centers decision established by pre-collected traffic information. A figure provided below show the interaction and data flows in a ATIS system based on TMC support and information exchange.



On the figure 2 provided aside, it shows the data flow in ATIS software-based implementation. The first upper part implies collecting and aggregating real-time traffic data from advanced ITS technologies seen before, such as Inductive Loops, Road Side Camera or Probe Vehicles. Once these data are collected from these sources, they are send directly to ATIS processing and analysis software, through either wireless, cable or optical transmission method.

Figure 2: Advanced Traffic Information System Model (Whale et al, 2002)

Then, advanced traffic information system software process and further analyze the data collected. The decision and analysis is developed on both real-time and historical data, which are stored in a database. It is used for several decision and monitoring purposes such as traffic simulation and forecast, route guidance, incident detection etc... This process step is crucial, for extracting meaningful information to traffic operators in the elaboration of efficient planning and strategies for fluidifying traffic flow.

After that, data that have been transferred into usable and relevant information are diffused through several mean of roadway broadcast services. Radio information is very common and popular, most of private vehicle is equipped with radio devices. Information are directly provided to the drivers concerning for example eventual congested areas, or incident on the road. In the Internet Era, drivers plans and prepare their roadmap on the web searching for the fastest and shortest way to get from point A to B. Additionally traffic control and management centers apply traffic operators, previously elaborated, strategy. Monitoring, roadway information messages and traffic users route guidance. Fast and real-time communication is the key to effectiveness and performance of ITS implementation.

Advanced Traffic Management Systems

Recent travel demand and travel capacity projections indicate that the exponential growth of traffic flow cannot longer be managed by the construction of additional roads and infrastructure. It is clear that the solution to this issue is to improve travel capacity and monitoring through an efficient management of exiting capabilities, using Advanced Traffic Management Systems (ATMS) (Wooton et al., 1995).

Similarly, to ATIS in terms of data collection process, ATMS use sensors and ITS-enabling technologies as sources of information. This field of ITS as in perspective to improve the traffic flow, avoid congestion, detect accidents, unexpected weather conditions, or other roadway hazards. Indeed, it is aimed at increasing already existing transportation system efficiency and vehicle mobility and safety. Advanced Traffic management include applications that mainly focus on traffic control devices such as traffic signalization, Variable Message Signs (VMS) to inform drivers of roadways status. ATMS market size was valued at over USD 7 billion in 2014 and is likely to reach USD 18.4 billion by 2022 (Global Market Insights, 2016). Technologies

used in ATMS are sensors, probes vehicle, camera, road signs or display, in-road equipment's, and wireless communication to ensure a centralization of information directly to TMCs. When several Traffic Management Centers collaborate and exchange information it is instead referred as Traffic Operations Centers (TOC).

ATMS use different components and information collection and management than ATIS. By connecting and distributing ITS devices inside vehicles and throughout the transportation infrastructure. Travelers will remain seamless connected across every mean of travel. Enabling safety, mobility an interconnection of drivers. Distributing ITS is the key, transforming the entire traffic infrastructure from being passive and individualist to a proactive and intelligent connected respondent system.

Traffic management center collected also information about the vehicle itself and also about its drivers for safety and monitoring purpose. The Strategic Plan for Intelligent Vehicle–Highway Systems in the United States (America I. V. H. S., 1992) shows key components applied by ATMS for example to support ITS CVO implementation project. The more important ones are:

- Driver/Vehicle Safety Monitoring: (DVSM)

It consists in collecting in a record information about the driver and its vehicle. Driver's data includes their age, number of hours' drive, medical qualifications, driver's license and duty logs. Collecting this data help traffic operators identify overtime driving to increase safety. Moreover, collecting data on the status conditions of brakes, lights, tires and steering parts, is thus to prevent risks and accidents due to trucks mechanics issues.

- Automatic Vehicle Classification (AVC) and Automated Vehicle Location (AVL):

The first one, intend to provide a simple and accurate electronical file containing a record of every vehicle within a corporate entity. This AVC will give visibility by listing the vehicle type and specification, load characteristics and destination. It can serve several purposes such as to identify hazardous vehicle in the traffic with automated vehicle identification sensors, or helping in the research of stolen vehicles. The second one, AVL, employs geo-positioning technologies, to display real–time information regarding the location and status of vehicles. It is very useful when changing drivers route or in solving driver route misunderstanding.

- *Weigh in Motion (WIM)*

The principles of Weigh-In-Motion (WIM) is to collect and interpret data from the scales and sensors in-ground measuring axis distances, individual axis weight, gross vehicle weight, vehicle speed, distance between vehicles, and the recording the location and time stamp for each vehicle. Trucks sometimes are constraints in terms of speed and weight limit on certain highway. Weigh in Motion can help identify those that does not respect the recommendation in term of safety regulation. Moreover, these systems can be applied in both low and high speed environment such as running lanes, weigh station or tolling booths while achieving a high level of accuracy. WIM combine with AVC and AVL gives true perspectives regarding the vehicles classification and positioning identification which enhance safety, mobility, and efficiency. (America I. V. H. S., 1992)

As we can see each of this method required again data collection and exchange. Components and methods used in CVO always required cooperation and collaboration from public, and also private traffic agents to support a well-established and efficient ITS implementation and use. CVO needs government and public organization approbation and technical support to achieve improvement in terms of private ITS technology implementation. Many projects exist around the world discussing concerning agreement facilitating deployment of cooperative ITS directives.

The need for information is essential for carriers to avoid their drivers being block on the road. It requires thinking in horizontal industry layers rather than in a silo approach. Each of the Transportation, Information and Communication industry must be involved in ITS and ACVOS application to ensure the reduction of traffic congestion and efficient management. The reduction of the traffic also interacts and influence with freight and carrier transportation. Efficient management through ACVOS will reduce delay and avoid wasted-mileage on the road ensuring in-time delivery and lower transportation costs.

1.4.2 Advanced Fleet Management Systems (AFMS)

Advanced Fleet Management Systems (AFMS) is an application of ITS applied at carrier or business-to business level. Similarly, to ACVOS, it involves high requirement standards in terms of Intelligent Transportation System Technologies and Electronic Data Interchange. As stated by Cainic, Gendreau and Potvin in 2009; *“it is remarkable that Electronic Data*

Interchange (EDI) was one of the strongest initial enabling factors of partnerships and alliances between large numbers of carriers and shippers.” This type of application emphasizes their operational scope on single firm and strategic alliances. Improving fleet management is concerned about planning and scheduling to deliver their shipments in time, also as monitoring efficiently and at the lower cost their fleet.

AFMS provide, once the fleet equipped with ITS devices, a large panel of data to carriers. With such system, a huge quantity of data become more accessible for decision making process. The role of companies and transport firm is to satisfy their customer needs, they need to deliver their shipments in the right place, in the right time and in quantity demanded while ensuring a safe and cost-effective trip. These systems applications aim at first satisfying this need through a “more timely operation, efficient allocation and utilization of the fleet” (Crainic et al., 2009).

Technologies used in AFMS implementation is satellite geo-positioning, in-vehicular sensors communication methods such as in ACVOS. However, the difference lays that each company should either ask for providing and managing its fleet in an out-sourced way or to manage it internally. The cost of implementation and monitoring and AFMS will depend on several factors such as the number of vehicles, size of the infrastructure, level of integration and monitoring aspects also as the desired software. Freight transportation management system can be represented as the simplified figure provided below

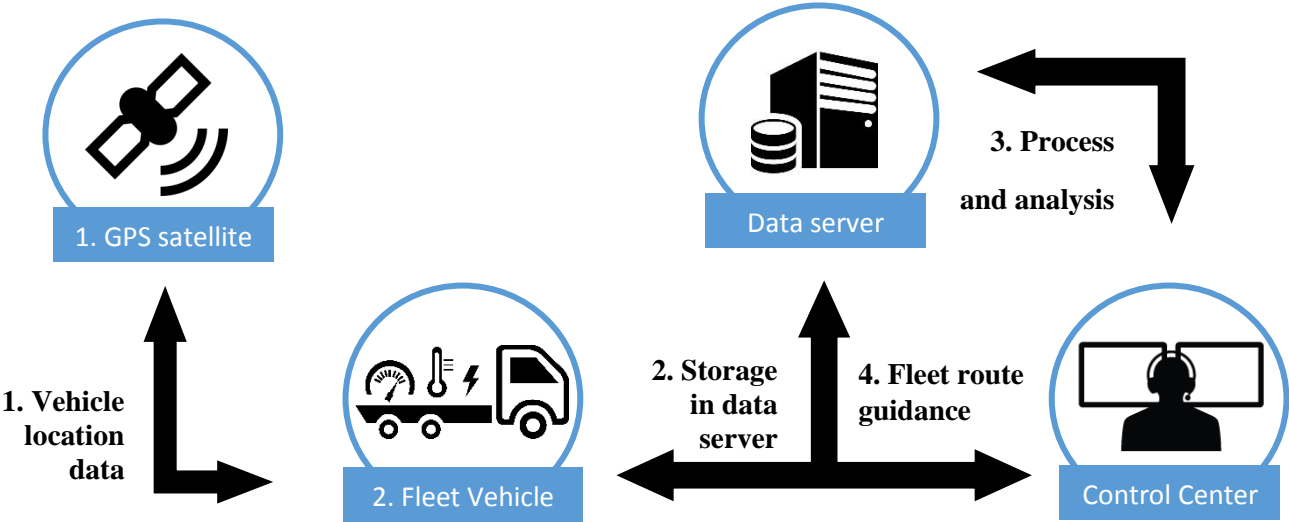


Figure 3: Advanced Fleet Management System Model.

The concept of freight ITS include the ability to track and trace precisely shipments all along its route. Even if the shipments changes of method of transportation as in multi-modal transportation. Automated exchange of strategic transport related data for commercial and monitoring purpose are made possible thanks to collaboration and cooperation between private stakeholders, and by the strong implication of governments and regulatory agencies for transportation. However, having available a big volume of data is useless if managers don't explore and investigate them in order to make accurate decisions. The power of calculation of software has grown to analyze and process data in only a few minutes, which was needed days to handle not so long ago. Several benefits comes with its use: minimization of manual data entry, increased transaction speed and accuracy, lower communication costs, and simplification of procedures. Finally, an essential condition to the successful completion of business objective and cooperation is the inter-operability across each industry and mode of transport is ensured.

Public organization oversee maintaining the inter-operability and collaboration of ITS implementation. One recent example is the platform for a Cooperative Intelligent Transport Systems in the European Union, also known as C-ITS Platform. It was launch in November 2014 by the Directorate-General for Mobility and Transports, shorten to DG MOVE. It has been created in an optic to elaborate a clear and commonly shared vision by each of the actors involved in supply chains. Due to cultural, geographical, political, economic and social factors Members States of the EU need to use a unique platform along the supply chain. C-ITS Platform gathers either public or private stakeholders such as national or regional public authorities, private suppliers and contractors, vehicles manufacturers, IT service and telecom providers etc... Cooperation is a key asset for further progress in ITS and supply chain management. Learning from collaboration between international or regional partners is essential in establishing a long-term vision for transportation and fare trade. The C-ITS Platform and the European Commission encourages public sector to exchange on political, organizational and technical data of ITS projects, while asking to private stakeholders to communicate information related to commercial and logistical concerns (DG MOVE, 2016).

Not so long ago logistics and supply chain have seen the emergence of intermodal logistics which avoid some logistical issues. Distribution center placed out of the cities border are huge infrastructure capable of receiving large trucks also as smaller vehicles. Larger trucks come

from inter-regional and international carriers, however smaller vehicles are contributing to the local delivery. Lastly AFMS, is thus becoming essential due to city logistics and last-mile delivery growing challenges. Certain region even restraint access to roadway infrastructure within cities to some vehicle, thus raising new difficulties for carriers. As an example, Paris has become the first city in France with a Restricted Circulation Zone (RCZ) for polluting vehicles. To be allowed to drive within Paris' border there is a need to apply a vignette on the front of the vehicle. This is basically an air quality certificate called "*Crit'Air*", and it has been in place since 15 January 2017 in Paris. Therefore, this system obliges companies to be careful in which transportation method they use to deliver their shipments.

In this chapter, Intelligent Transportation Systems (ITS) have been introduced. As we have seen before ITS is based on enabling technologies, such as GPS, sensors, cameras, wireless communication, and therefore imply exchange of electronic data between logistics agents. Moreover, technologies are continuously upgrading and evolving to simplify everyday life. In a near future Unmanned Air Systems will certainly be a determining factor of improvements of transportation and freight. ITS is composed of several applications, however this study has focused on two main one Advanced Commercial Vehicle Operations Systems (ACVOS) and Advanced Fleet Management Systems (AFMS). These two domains are respectively addressing to institutional and business. Their development as permitted to cover traffic and freight logistics challenges and oversee some perspectives. Enhancing travelling through efficiency, providing economic benefits to companies and governments, ensuring the safety of road users, also as to having an environmental vision by optimizing traffic and freight reducing CO₂ emissions. Nonetheless, the integration of ITS require a consequent data input from technology used, to supply software in information. Data which are transformed into valuable are key sources of knowledge for managers. The value of information and their need, as the data information type and structure will be develop further.

II - The Value and Need for Information

2.1 Information in Supply Chain

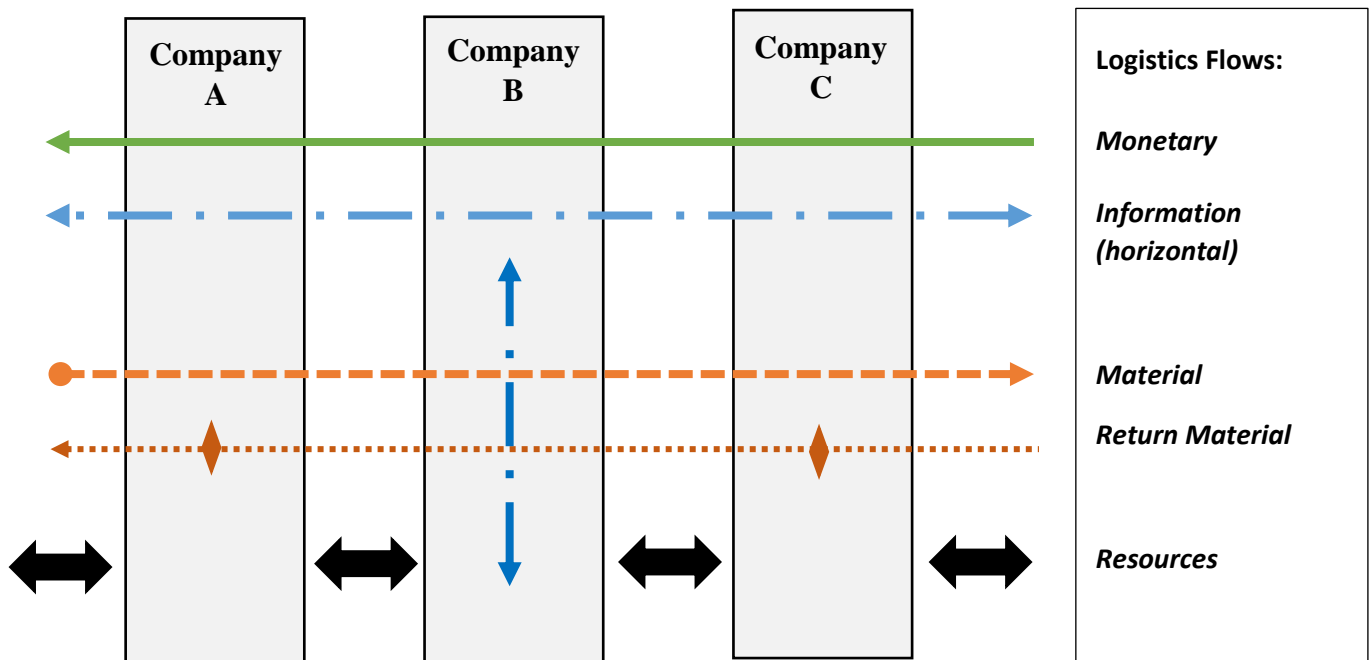


Figure 4: The Fives Flows of Logistics. (Lumsden, 2006)

Information flows in supply chain and logistics are complex and several of them should be managed to ensure the successful completion of transportation operations (Lumsden, 2006 in Beiki, 2010). It is characterized by five type of flows which are defined as, Monetary, Information (Vertical and Horizontal), Material and Resources flow. However, each of these streams are not oriented to communicate in the same direction. For example, resources and information flows imply two-way communication between each actor in the supply chain.

To ensure an efficient data and information flow among transportation entities (Logistics services providers, carriers, forwarder, ports, public authorities etc...) horizontal exchange of information is achieved. It requires as stated previously a two-way communication between supply chain agent “N”, and it’s two upper- and lower-stream agents “N-1” and “N+1”. Collaboration is therefore essential in horizontal information exchange. On the other hand, vertical information stream is based on the exchange of knowledge within a corporate entity and is often kept within the border of the corporation and is used to achieve information competitive advantage

Resources in supply chain are considered to be either internal or external and are mean of transporting goods. Forklifts, pallets and other load units are internal resources because they operate within the organization infrastructure. On the contrary, external resources are vehicles, containers, cargo etc... are used in a two direction in the supply chain. These resources are used to carry and transport material flows, usually downstream, between each supply chain actor. However, return of material flow is going in the opposite directions from the customer to the supplier and involve reverse logistics process. Material and resources flow are always trigger by financial transfers between companies. Monetary stream goes from the end customers to the beginning supplier or manufacturer. Furthermore, efficient and close collaboration and exchange of information is required to achieve cooperative objectives and customer satisfaction.

2.2 The Value of Information

In the *Oxford English Dictionary* (OED), value can be defined as the importance or usefulness of something. Value is often employ to qualify the material or monetary worth of something also as the worth of something compared to the price paid or asked for it.

Information in companies have great value and power, nonetheless, one information can have an important value for one doesn't mean it will have the same value for another. The process of converting data into information and knowledge has been explain by Lumsden, Roudolphe, Sjöstedt, can be represented as the following figure:

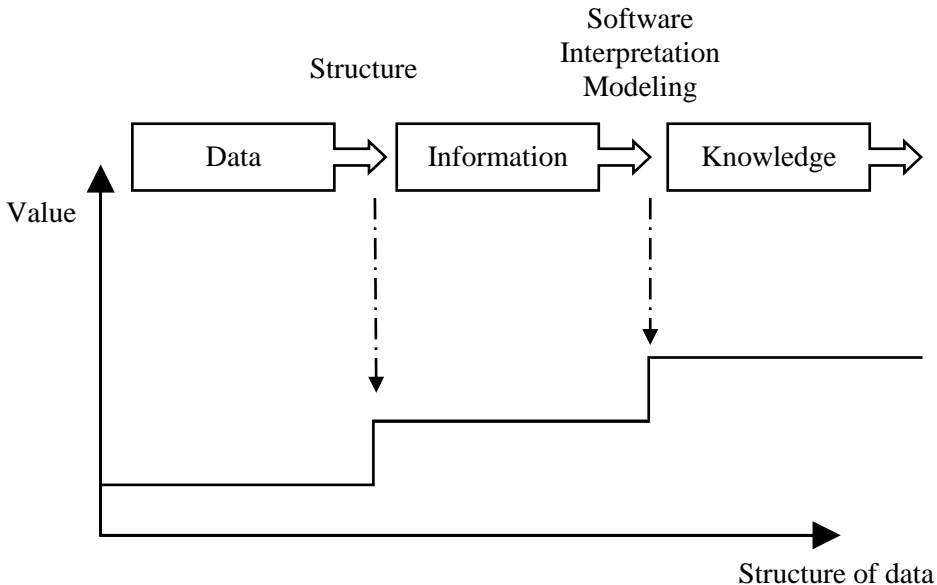


Figure 5: Information Value Chain (Lumsden et al., 1997)

The process first imply, the collection of data by several methods as seen in chapter 1. These raw data about real-time traffic status, weather conditions, product availability, delivery or tracking for example are not a big value when not processed and organize in a meaningful way. The second step is going through software-based analysis and process to convert raw data into relevant information. Once they have been treated these information gained in terms of value, and can be transmitted, analyzed, used and modeled. After that managers, should be able to elaborate significant management monitoring and planning based their analysis of information. This step is crucial to give sense to information and leverage their value for the corporate entity. (Stair, Reynolds, 2007).

There are four main reasons that demonstrate the decisive impact of accuracy and time in information exchange for supply chain and logistics systems in general (Bowersox et al., 2007). Firstly, major necessary dimension is the customer information need. Along with the development and expansion of Internet and e-commerce customer are used to be inform through real-time information about their order status, product availability, shipments delay, customs related information etc ... It is essential to convey timely and accurate data to guarantee the maximum customer satisfaction through trustworthy services. Secondly, by increasing knowledge in term of delivery time and shift schedule it allows to better manage the technological and human resources necessary to accomplish business objectives. When, significant information is exchange over order, trucks for example are allocated in advanced and in case of unintended event the company is able to provide an emergency solution. Moreover, by achieving an advanced planning of delivery and order it also help reduce inventory level to its optimum quantity. Thirdly, in the same vision, information enhances the supply chain agility and response time by having information on where, when and how to allocate their resources in order to benefit for a strategic competitive advantage. Lastly, due to the consistent growth of internet based-technologies the exchange of information becomes easier and faster, thus facilitating cooperation and collaboration among companies previously isolated. Information sharing, is vital in supply chain nowadays and it pass by redefining supply chain relationships.

2.3 Information Range and Dimensions in Intelligent Transportation Systems

Based on what we have seen before, Intelligent Transportation Systems information range can be divided in two separate time dimensions: time-period and time-update.

The first dimensions, time-period information characterized which type of information is used to monitor traffic and manage freight. Each time-period update category is classified from least to most effective method. Using none information in ITS is dangerous and lead to inefficiency in management. However, in a more advanced stage ITS using historical data can access different perspective and planning approach. Analyzing past and already occurred events in traffic to guide and control current drivers on the road. ITS current technologies improvements allow supply chain and national authorities to collect real-time traffic information instantly. Collecting and transmitting instantaneous information help fluidity transportation flows. Last but not least, predictive information developed on both historical and instantaneous data are the most-effective method. These predictive information process by powerful softer-based systems offer a high accuracy and give wider visibility on the long-run.

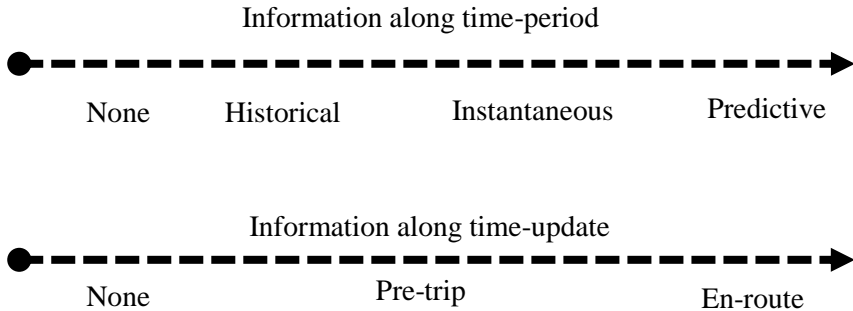


Figure 6: The Two Dimensions of Information in Intelligent Transportation Systems

The second dimensions, time-update information characterized the moment when the information is updated. Similarly, to time-period information, when none information is display to drivers or traffic infrastructure systems are unuseful and at least on data input is needed to be considered. Among time-update information there is Pre-Trip information. It implies sending one set of information to the drivers before he starts his transportation route. However, the drivers will not receive any further information along the way. The information previously received will never be updated after that. On a higher update scale, there is en-route information. Route guidance and trip details can be continuously updated or timely updated on a predetermined rate. This time-update method allows carriers and drivers to receive every time

interval information about a possible change in travel itinerary or incidents on the road. En-route time-update period along with continuous information flow maximize driver's responsiveness to unintended events adapting their travel route quickly based on real-time traffic conditions.

Nonetheless, as stated before, historical information is based on already occurred event in traffic. It is not relevant to associate en-route update with historical information as they are already available pre-trip and can be accessible also while en-route.

2.4 Intelligent Transportation Systems Data Architecture

It is assumed by managers and researcher that widespread deployment of ITS application brings together private and public sector. However, considering the complexity of ITS researcher suggested the need to established a proper and complete ITS data architecture. In the report called "*National Freight Cooperative Research Program (NCFRP) Report 9: Guidance for Developing a Freight Transportation Data Architecture*", the Transportation Research Board (TRB) have listed and reported ITS data sources and components of freight ITS and incorporated them in a single taxonomy. They also provide a definition in which "*freight data architecture is the manner in which data elements are organized and integrated for freight transportation-related applications or business processes. The data architecture includes the necessary set of tools that describe related functions or roles, components where those roles reside or apply, and data flows that connect roles and components at different domain and aggregation levels.*" (Quiroga, 2011).

Three application approaches of this architecture are drawn depending on the level of integration and implementation desired. The first one is the single-application approach. It consists in apply this architecture system to a single and precise business application or process. Single approach is often used at national level for system-wide integration. The second one is intermediate approaches, resulting in the application to a set of applications. However, this time the implementation level is done at national but also regional and local. The last one, is the optimum approach, which regroup all the freight transportation-related applications at any level. Nevertheless, this last approach face huge constraints in term of integration and infrastructure requirements.

As we can see on the figure 7 below, freight data architecture framework is very intricate as it comports nine main categories of data, and many more components in each category. ITS data framework can be described as a data-driven system which is characterized by three elements: data producers and consumers, databases, and intelligent operational and decisional support (Chowdhury et al., 2017). The very complexity of Intelligent transportation systems data can lead to misunderstanding and visibility issues in data server.

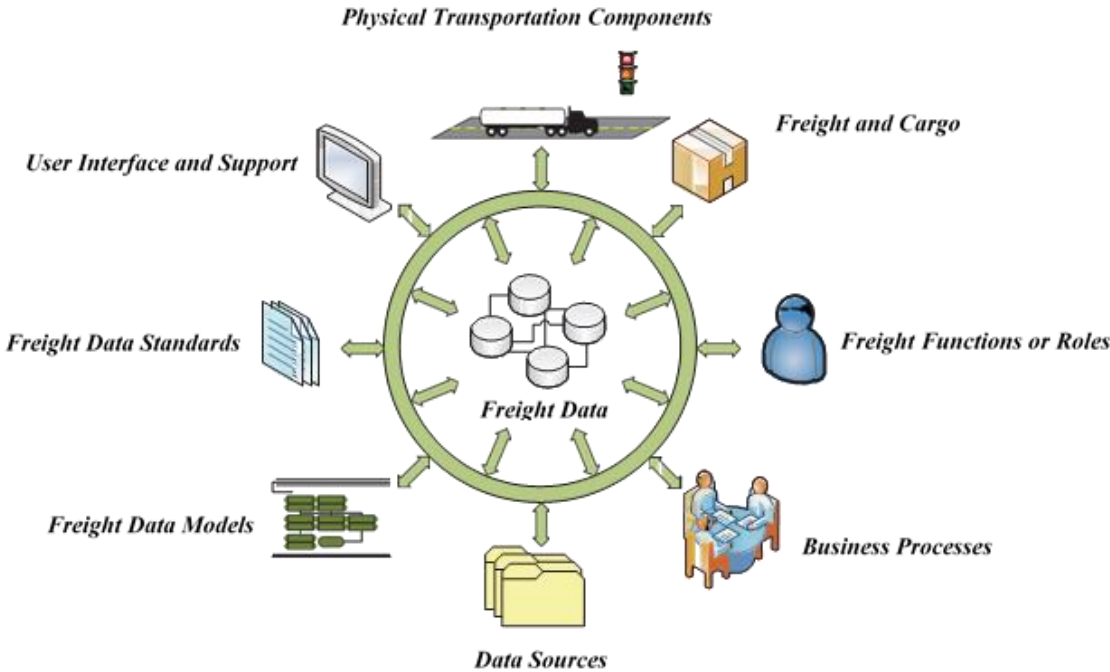


Figure 7: Intelligent Transportation System Data Architecture (Chowdhury et al., 2017)

This figure represents an interconnected network of enabling technologies, computer, data centers, communication and transportation infrastructure, as well as actors of the supply chain. They are creating huge quantity of data referring to the appendix 2. This huge quantity is sometimes difficult to consider for manager because their visibility on these data are limited or these don't have the necessary tools to extract relevant information from it. The following chapter will offer insight on managers data visibility extend and also in new way of analyzing and processing data: Big Data Predictive Analytics.

III – Big Data Predictive Analytics: Lever of Performance

Globalization of supply chains, increasing demand and supply uncertainty, supply chain network complexity, product proliferation, process risks, changes in environmental rules and regulations, extreme weather, big risks and Big Data, supply chains dynamics have changed significantly (Schlegel, 2014).

3.1 Unsufficient Visibility for Supply Chain Executives

Gatepoint Research Survey

To understand the current state of visibility in supply chains and help to oversee the eventual issues, research methodology is required. A study was made by Gatepoint Researching on the behalf of E2Open concerning “*Trends in Supply Chain Visibility*” conducted between December 2015 and January 2016. They question 101 supply chain executives about the current visibility level in their own supply chain. These respondents represent a large variety of industries (general manufacturing, high technology manufacturing, retail trade, wholesale trade, telecom services, primary manufacturing and media). This is the most up-to-date, and relevant study concerning supply chain visibility. The following table transcribes the results of the survey conducted by Gatepoint Research.

Questions	Answers
How far into your supply chain do you have visibility?	41% until Tier 1 21% until Tier 2 16% until Tier 3 23% until Tier 4 (of which 76% are general and high technology manufacturers)
Which data elements do you have visibility into?	80% have access to order data 78% have access to inventory levels 54% have access to capacity data 23% have access to upside data

<p>Do you have in-transit visibility? If so, between which nodes of the supply chain?</p>	<p>20% have no in-transit visibility 66% have in-transit visibility between Tier 1 and themselves 20% have in-transit visibility between Tier 2 and 1 12% have in-transit visibility between Tier 3 and 2 7% have in-transit visibility between Tier 4 and 3</p>
<p>How timely is your visibility data?</p>	<p>14% have real time data 18% have less than 8 hours old data 36% have less the 24 hours old data 17% have less than 72 hours old data 7% have less than one-week old data 6% have less than one-month old data 1% has more than one-month old data</p>
<p>How do you use your visibility data?</p>	<p>78% use data to ensure continuity of supply 70% use data to get early warning of supply chain problems or disruption 46% use data to enable agile response to unexpected changes in supply 40% use data to enable agile response to unexpected changes in demand 28% use data to monitor trading partner compliance with commitments</p>
<p>Who has access to visibility data?</p>	<p>79% The logistics team 60% Supply chain line personnel 51% The supply chain executive team 51% Operations executives 31% The Chief Supply Chain Officer (CSCO) 14% The senior executive team</p>

Who actually uses visibility data?	<p>70% The logistics team</p> <p>55% Supply chain line personnel</p> <p>53% The supply chain executive team</p> <p>53% Operations executives</p> <p>16% The Chief Supply Chain Officer (CSCO)</p> <p>6% The senior executive team</p>
Does anyone in your organization have an end-to-end comprehensive view of supply chain visibility data?	<p>81% No, visibility data is fragmented and scattered through the organization</p> <p>19% Yes, the director of logistics team, supply chain director, supply chain executives and teams, systems/IT and planning warehouse personnel</p>
How satisfied are you with your level of supply chain visibility?	<p>11% are very satisfied with their current supply chain visibility</p> <p>54% are somewhat satisfied with their current supply chain visibility</p> <p>26% are somewhat unsatisfied with their current supply chain visibility</p> <p>9% are very unsatisfied with their current supply chain visibility</p>

Table 2: Trends in Supply Chain Visibility (E2Open, 2016)

Conclusions of the survey

Before going into details about the results of the survey a brief clarification about Supply Chain Tiers is necessary. Tiers can be seen as a multitude of layer operating in a same line of resources based on information flow. The decomposition of each layer is indeed called “*tiers*” (Appendix 3). Referring to the answers of the survey, the following conclusions can be drawn:

The respondent’s visibility is considerably limited in the supply chain. Only 41% of them reported to have visibility until Tier 1, which is the primary supplier for a company. It shows that there is either a lack of existing enabling communication systems, or collaboration and exchange of information between partners. In this context, when visibility is insufficient

potential key data for management decision are invisible for managers. Additionally, it shows that as the supply chain extend the degree of data visibility decrease, and it's even worse when it comes to in-transit visibility.

In the second question 20% of the respondent have no exchange of in-transit data with their supply chain partners. There are indeed unable to manage and plan efficiently their operations, which can lead to bullwhip effect. Even if the level of in-transit data visibility is acceptable with 66% of the respondent getting information with the first layer, only 7% have access to the last one. Considering this result, we can say that in transportation domain the visibility is still low and further development are needed to enable more and more data interexchange. The necessity to obtain in-transit information is determining for the elaboration of reliable prevision plans.

The time-update in term of visibility is a key factor. As explain through chapter 1 about ITS, real-time data collection is one of the most accurate and efficient method. Even though, only 14% of them are using real-time data. Potential opportunities for responding to changes rapidly and implementing adaptive strategies, are possibly missed without using real-time data. Nonetheless, most the respondents use data within a 24hours update, which is acceptable and non-restrictive for an adequate allocation and distribution of resources.

Another interesting thing in this study is that 31% of chief supply chain officers access to visibility information, but only 16% employ them. Access to larger visibility of information doesn't necessarily imply an efficient usage of it. Therefore, this shows that there is a lot of potentially critical data for decision making that is going untouched (Lemoine, 2016). Finally, just 19% of the interviewees have a complete end-to-end supply chain visibility.

Based on these conclusions, we can see that there is certain lack of visibility from some corporate entities in supply chains. As matter of fact, visibility is closely related to collaboration between the different actors of a supply chain. The lack of trust and communication of data between the supply chain executives is obviously an obstacle to achieve end-to-end visibility in the supply chain. However, the lack of visibility is not the only issues that arise. Sometimes data are accessible but companies doesn't have sufficient knowledge and technologies to

process these very large amounts of data and it can infringe on performance enhancement. Additionally, the majority of the questionnaire sample (54%) are somewhat satisfied with their visibility level in the supply chain which show clearly that improvements can be made (Trends in supply chain visibility, E2open, 2016). Supply chain managers need to find other way to access information. Process larger amount at the same time to obtain sufficient and reliable information. In this way, they had try to develop new tools and methods to analyze the big quantity of data that is within each company and which is called Bid Data, and will be developed further in this chapter.

Interview

Based on these survey, an interview has been conducted with a current supply chain manager. The objective of this interview is to obtain more information about the questions developed in the survey. Thus, to developed an accurate view of the issues and challenges for supply chain managers. It has been conducted on the 03/05/2017 using a skype interview in a professional environment setting. The interviewee is Mr. Cyrille Maunoury, Supply Chain Manager for Make-Up Division at Chanel Global Warehouse, in Le Meux (Appendix 4). The interview was conducted in a semi-directive way, in the language of the respondent which is French.

In this interview Mr.Maunoury describes briefly the simplified supply chain of Chanel. Le Meux, is the global centralized stock for cosmetics and perfumes in the world. Every product sold by Chanel transit through this warehouse. First there are the raw material supplier which provides essence extract to the three global manufactures located in France for both fragrance and make-up. The finished goods transit to the general stock based in Le Meux near Compiègne where they wait before to be redistributed to Chanel subsidiaries warehouses platforms in other countries such as United States, United Kingdom, China for example. The end actors of supply chain are retailing stores and distributors that sell the products to the end-customers.

Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Raw Material Suppliers	Global Manufacture	Global Warehouse	Chanel Subsidiaries	- Retail - Distributors

Table 3: Chanel Simplified Supply Chain

Chanel visibility extend is direct between the manufacture and the subsidiaries warehouse as symbolized by the blue color on the table X below. Which mean that when n order leave from Chanel Subsidiaries stock, Le Meux loose the visibility on this product stock. However, point of sales are essential for Chanel, they can be acquired through “*consumers and retail panels*”. This data collection method is “*costly*” but helps in “*ensuring a better supply and accurate forecast*”. The remaining issue in this type of data is that it lack from a crucial information to Mr.Maunoury’s operations, the lifetime of the product sold after leaving Tier 4. It’s impossible to know whether the product sold to a customer is one day or one year old.

Concerning the in-transit visibility in Chanel supply chain depend on which contracted carrier is used to vehicle the goods to the destination point. As an example in France Mr.Maunoury as no issue to obtain information through the national post and delivery services, La Poste. They provide online information about the current state of the package in every step of the process. It is scan from the pick-up time, to entry and exit of warehouses, in transit real-time position, until the final delivery. Additionally, La Poste provide even photography of goods in transit to ensure package safety and conditions. On the other hand, in the case when Chanel ship products to U.S or China, product in considered to be arrived in subsidiaries warehouse at the time the container is sealed and on the boat. Which is not very accurate because lots of unexpected events can cause delays in transportation or loss of goods or example. Nonetheless the interviewee expressed the necessity of more knowledge and information about in-transit visibility.

Information update flow is relatively slow in Chanel as global structured exchange of information for all Chanel actors is made once a month. Even though, Mr.Maunoury was also saying if he need one information at a particular time he is able to reach it via punctual information request. The information is disseminated to “the logistics team, the planning and forecasting team, customer service and the global supply chain team”. These data are access though data queries in Chanel information system. Usage of the global data monthly exchange allow management and logistic team to plan and pilot stocks, especially in providing accurate estimation of order for subsidiaries’. That’s is to say, when an order is placed by one of Chanel subsidiaries, it will be control and adjust to previously elaborated forecast. It ensures an

adequate management of inventory level, furthermore recommendations are made to subsidiaries concerning the way to manage efficiently their stock based on these forecast.

Lastly, the actual satisfaction of the interviewee regarding its accuracy and volume of information is relatively good for quality, whereas likely unsatisfying in quantity. As said by Mr.Maunoury, the exchanges are made in formalized, electronic and automatic way, when data process settings are defined in the software it ensure reliable and accurate information. However, acquiring final client's information is something that he looks forward to obtain, not especially him but Chanel in general. These data could benefit each layers of the supply chain. As stated by Mr.Maunoury : Anyway, the more visibility and data accessibility, the better is once it has been filtered it is a considerable competitive advantage over those which doesn't have this information.”

Regarding the results of the survey and the interview, it is clear that supply chain and logistics managers need to have access to wider range of information. From the first supplier to the end customer. Having an end-to-end visibility is a source of competitive advantage and improve processes flow in supply chain. The need for more information and for accurate visibility along the supply chain can be achieved though emerging collection process and analysis method.

3.2 Predictive Analytics and Big Data: Factor of Visibility

In simpler words, the term Big Data refers to the tremendous volume of both structured and unstructured data within companies, it was first mentioned by the Gartner research firm in 2008. Big Data is so large that is it difficult to analyze these data with conventional database software. Most of companies aren't able to extract relevant information from this huge amount of data. It is the reason why research and development created predictive analytics tools to analyze and exploit Big Data. The Association for Operations and Supply Chain Professionals or APICS defines Predictive Analytics as a variety of techniques from statistics, data mining, and game theory to analyze current and historical facts to make predictions about the future. In business, predictive models exploit patterns found in historical and transactional data to identify risks and opportunities (Schlegel, 2014).

According to Boyd and Crawford (2012), Big Data is a cultural, technological, and scholarly phenomenon that rests on the interplay of:

1. Technology: maximizing computation power and algorithmic accuracy to gather, analyze, link, and compare large data set.
2. Analysis: drawing on large data sets to identify patterns in order to make economic, social, technical, and legal claims.
3. Mythology: the widespread belief that large data sets offer a higher form of intelligence and knowledge that can generate insights that were previously impossible with the aura of truth, objectivity, and accuracy (Russo et al., 2015).

According to the Leadership Council of Information Advantage, Big Data is also seen as data sets that are growing exponentially and that are too large, too raw, and too unstructured for analysis using classic relational database techniques (Schlegel, 2014).

These definitions highlight the complexity related to “*The Big Data Era*” especially that have to develop complex and expensive capabilities in order to take advantage of Big Data opportunities and to cope with misalignment between Big Data and knowledge creation processes (Boyd, Crawford, 2012 in Russo et al., 2015). Big Data is unique because of the volume, variety, velocity and veracity of the data and has become a reality as complementary technologies (cloud computing) and platforms emerge, and accurate predictive analytics become more commonplace (Russo et al., 2015). According to Gregory L. Schlegel, Big Data inspire new ways to transform processes, organizations, industries, and even society itself.

IBM first synthesizes Big Data in terms of the “4Vs”, however a second version from Wang and Alexander in 2015 is more up to date. IBM describe it such as, the volume is the mass quantities of data that organizations are attempting to harness to improve decision making. The variety means that Big Data comprises many different types of data and data sources. Velocity refers to the speed at which data are created, processed and analyzed. Finally, the veracity is the level of reliability and predictability of data. In this way, Big Data systems can help to streamline and optimize the process of creation, management and diffusion of information relative to decision-making itself (Elbashir et al., 2008 in Russo et al., 2015).

Thus, companies have to learn how to take advantage of Big Data, balancing technical and business features, in order to use real time information from sensor, radio frequency and other identifying devices. It can be helpful to understand their business environments, developing a new knowledge to sustain the creation of new products and services and responds to changes in usage patterns as they occur (Russo et al., 2015).

At a conceptual level, there are several applications of Big Data to logistics and supply chain (Russo et al., 2015). Volume can occur in many ways: there are more data because the data is captured in more details. For instance, instead of just recording that a unit is sold at a location, the time it was sold and the amount of inventory at the time of the sale is also captured (Waller, Fawcett, 2013 in Russo et al., 2015). According to Esther Lutz, an efficient Big Data approach in the supply chain goes by the collect of quality data, their analysis 24 hours a day and 365 days per year, and the quick implementation of corrective actions (Calais, 2014). However, this number of updates on analysis is nearly impossible to reach as the amount of data is growing exponentially

Automatic analysis of data improves accuracy of supply chain management transportation processes; thus contributing to supply chain performance by minimizing delivery attempts, and ensures higher customer satisfaction (Russo et al., 2015). An efficient and effective Big Data analytics could help manufacturers to reduce costs and to early respond to customer satisfaction or dissatisfaction at a real time. Moreover, Big Data can optimize the routing processes: such a concept has to allow organizations to link upstream and downstream data on a granular level for each entity. This concept can be used to improve supply chain performance (Weltevreden, 2008; Shekhar et al., 2012; Engel et al., 2014 in Russo et al., 2015). Big Data have many characteristics, and researches prefer to add 2 section to the original “4Vs” of IBM which can be described by the 6Vs as follow. (Wang, Alexander, 2015)

Volume

Describes the amount of data produced, and which is growing exponentially for transportation systems. Its scales vary from petabytes (10^{15} bytes) to Zettabytes (10^{21} bytes) and even to Yottabytes (10^{24} bytes). And the volume of exchange in industry such as transportation is expected to increase sharply in the coming years.

Velocity

It describes the speed at which the data is generated. As seen before data can be generated continuously and in-real time, or on an update basis. It is for sure that real-time data is likely able to provide fast and timely information to support supply chain managers.

Variety

Data variety describe the large panel of data collection sources which are transmitted in numerous formats in various domain. In Intelligent Transportation Systems acquisition is made via advanced roadway and vehicular devices, GPS, internet and social media (Chowdhury et al., 2017). In variety the data can be unstructured, semi structure or unstructured.

Value

Big Data collects a huge amount of data. Most of it is valueless, but there is some golden information to extract. As seen in Chapter 2 the value of information is something essential for decision-making and management. Reliability and accuracy is key factor to coherent and well-establish plan and models.

Veracity

Veracity contains two aspects: data consistency and data trustworthiness. There are several elements that ensure data veracity. The origin and integrity of data is essential to ensure data authenticity Also, the database platform trustworthiness or reputation can infringe on the veracity of the information provided.

Variability

During processing and lifecycle, the data changes over time, which can reveal valuable information. On the other hand, sometimes loss of data can be also expected.

The biggest challenge for supply chain managers is to leverage Big Data (Schlegel, 2014). A few companies developed tools to limit risks and in the same way measure the impact in the supply chain. For example, Schneider National implemented in 2005 a computed model that mimics human decision making to be the most cost-effective possible and a “Dynamic Programming” that allows the company to take into account the presence of uncertainty. These predictive analytics tools have saved the company a lot of money. Dell too utilized an instrument that captures, tracks and processes data in order to be able to use the right data into the database (Schlegel, 2014).

In the recent report of IBM, a Big Data/Predictive Analytics process map has been developed. This one encompasses four steps, the 4-E's: Education; Exploration; Engagement and Execute. Education is focused on awareness and knowledge development and organizations can study the potential benefits of Big Data and how it can help address important business opportunities. Exploration defines the business case and roadmap to allow companies to use Big Data and Predictive Analytics to solve important business challenges. Engagement is about embracing the data in order to define scope to understand and test technologies. And execute is an indicative stage of Big Data and Predictive Analytics capabilities that are more widely operational and implemented across the organization. Here, companies are leveraging Big Data and Analytics to transform their businesses to derive the greatest value (Schlegel, 2014).

Referring to Peter Martin thoughts in Schlegel, 2014, a good analytics manufacturing system has to show what is out there, what information is available, what it means, how to react to that data, and then predict what is coming next. Companies should be along with P. Martin, especially in terms of leveraging Big Data and Predictive Analytics to identify, assess, mitigate and manage supply chain risks in order to foresee them and reach supply chain performance as quick as possible and in the best possible way.

Big data is an opportunity for supply chain management. The huge amount of data than can be collected hides golden information, and after processing, allows supply chain executives to obtain accurate predictive analytics. It is valuable tools for supply chains, especially those evolving in highly volatile environments or facing severe bullwhip effects. As a matter of fact, the predictive analytics increase the supply chain visibility since it gives wider information, and implicates the actors of the supply chain.

As demonstrated by the Gatepoint Research survey, supply chain executives today have a limited visibility, and it is a big dissatisfaction for them. Also, in some cases, supply chain executives do have access to information but do not use it sufficiently. Though, visibility is real vector of performance in the supply chain, and is an opportunity to, improve transportation systems, and logistics also as the costs related to it, and improve the reliability and predictability.

The Gatepoint Research survey demonstrated also that most companies do only share information with their immediate suppliers. Ensuring an end-to-end visibility is vital for supply

chain executives to reduce risks. Achieving end-to-end visibility requires changes in the organizational management, and collaboration a key component of success.

As for any tool, there are limits to predictive analytics. The major challenge obviously to capture the necessary data, and to process it accurately. The “*garbage-in garbage-out*” also works for predictive analytics: asking the wrong questions will lead to inaccurate information, and supply chain executives might be put on wrong tracks for their decision making. In highly volatile environments, the information has to be accessed as quickly as possible, so as to be able to adopt a proactive behavior. This is also a limit of predictive analytics: they become obsolete quickly. Finally, one of the limits, and it’s an old-established topic, is the lack of collaboration between the actors of the supply chain. Each actor adopting different methods, different software or data coding results in a bigger difficulty to obtain data for the predictive analytics. The lack of collaboration results definitely put a spanner in the works of predictive analytics and consequently supply chain visibility. Ensuring close relationships with the different members of the supply chain is too often the missing step to achieve visibility in the supply chain, and it would result in an asset, a competitive advantage on competitors.

Recent searches show a link between Big Data, predictive analytics and supply chain performance, which is the research objective of each company. The supply chain department needs to be performant because it is a central service of the organization which is oriented towards the internal environment (internal clients of the company) but also towards its external environment (suppliers, outsourcers). In order to increase this supply chain performance, several factors of performance are used as part of predictive analytics. One of these vectors of performance is the visibility that is foreseeable thanks to a joint effort between the different actors of the supply chain.

3.3 Visibility: Vector of Supply Chain Performance

Supply Chain Performance

The supply chain performance involves all the activities across the supply chain until satisfy the final customer needs. The process includes all the referent about transforming the components and raw materials into an end-product with value for the customer and also the information across the chain. For that reason, in order to improve the performance of the

companies, it is crucial to obtain precise information in the right moment to implement in their strategies. And that information could be found in Big Data.

Nowadays “*companies have global networks comprised of thousands of different partners*” (Field, 2014) and there is not just one owner of the data that flows through the supply chain. For that, it is essential to collect all the information and dates about their supply chain, to adapt the activities of the company to the conclusions generated in the analysis of that information and create value. In order to achieve a good performance across the supply chain, it is necessary to structure the dates you could find interesting for the company and for all the partners involved in the supply chain. The Big Data offers a huge quantity of dates that have to be analyzed to obtain a competitive advantage in the market.

The main benefit of Big Data analytics in the supply chain performance is to “improve operational efficiency” improving the quality of the process and performance optimizing the resources consumption (Field, 2014). A company also can optimize: The customer service and consequently they will obtain more loyal clients and more precision in the segmentation of their clients by improving the delivery time and the resources they use. The Big Data also helps to have more precision in activities as products placement, the pricing policies, decrease the operational risks. It integrates the logistics solutions into the production and distribution processes (Field, 2014)

The Concept of Visibility

The concept of visibility in the supply chain management is based on the Bullwhip effect demonstrated by Forrester in 1958 that explains the development of the variability of the demand in the supply chain by an absence of communication between the various links (Lee et al., 1997 in Evrard, Ruel, 2016). Visibility allows the sharing of information between the members of the same chain and improves the coordination between these members (Brusset, 2016 in Evrard, Ruel, 2016). However, as far as the visibility allows to get the evolutions of the market and to handle the rowdiness, it contributes directly to organization’s resilience (Ngai et al., 2011 in Evrard, Ruel, 2016).

The definitions suggested for the visibility concept have trouble to find a satisfactory consensus as far as the notions of connectivity and traceability get mixed up with (Hoffman, Hellström,

2008 in Evrard, Ruel, 2016). Nevertheless, having and giving the access to information between the links of a supply chain in order to take better decisions (Evrard, Ruel, 2016) allows to deduce that it is a non-negligible factor and a vector of performance. Visibility is the control of specific information related to product orders and physical shipments, including transport and logistics activities, and the statuses of event and milestones that occur prior to and in-transit (Russo et al., 2015).

Gaining visibility requires much more than basic track-and-trace functionality across the supply chain. According to Aberdeen (2013), it involves a control tower approach and closing the loop between planning and execution and synchronization of end-to-end activities from raw material to the delivery to the end customer across the supply chain (Russo et al., 2015).

The notion of visibility has progressed to a solution logistics that involved actions to implement (Thompson et al., 2000; Joshi, 2000; Reyes et al., 2002 in Evrard, Ruel, 2016), and then to an attempt of display of the supply chain which leans on the architectures in information systems (Jeyaraj et Sethi, 2013 in Evrard, Ruel, 2016).

End-to-End Visibility is vital for Supply Chain Executives

As seen in the “*Trends in Supply Chain Visibility*” report (Gatepoint Research, 2016), most companies share a lot of information with their immediate suppliers, but as soon as they extend down in the supply chain, information are more and more difficult to access. The same conclusion can be drawn from the results of the interview with Mr.Maunoury. However, having visibility with non-immediate suppliers is a real asset, especially to detect issues faster and react to changes in demand. (McCrea, 2016). The following elements will show the key elements to obtain end-to-end supply chain visibility.

The visibility has to be implemented after having taken some crucial decisions for the performance of the business. Firstly, they have to consider where are they are going to carry out their activity and then decide who will be in charge of each activity and what activities are going to be outsourced. To make this step easier, it is essential to have a “*comprehensive and global view*”.

The analysis and the sharing of data between the different links of the chain suppose a will on behalf of the involved businesses. This will is a first step to the implementation of the various

technological means that allow the decision-making in every link of the supply chain (Evrard, Ruel, 2016) and so to obtain an end-to-end supply chain visibility.

It is essential to consider that the visibility in the supply chain is possible through sharing information, which involves a transmission-receiving process, in other words a reciprocity in the exchange, fundamental thing in case of flows rupture (Lee, Whang, 2000 in Evrard, Ruel, 2016). This spirit of collaboration and sharing information is working in any industry. For example, in the food and beverage industry, the impact of cooperation in the supply chain is high. Indeed, according to John Haggerty, Vice-President of Burriss Logistics, “*cold logistics partnerships can create substantial value.*” These partnerships bring a better visibility and transparency to the supply chain. In addition, new and emerging technologies allow for real-time visibility, as well as time, place and temperature validation. These various tools permit to reinforce the visibility and to insure it in the whole supply chain (Sowinski, 2015).

At an operational level, increase the visibility in a supply chain involves an access to information about the flows and the nodes between the flows. Upstream, information is mainly about the stocks of finished goods, the available capacities, the shipping and receipt orders and the availability of raw materials. Downstream, visibility is focused on the returns on quality, the real sales with regard to the planned sales, stocks in the distribution network and the demand in points of sale (Evrard, Ruel, 2016). To obtain this kind of information, a combination of processes and technologies is necessary in order to exchange quality information, in other words reliable, just, in due course and utilizable information (Zhou, Benton, 2007 in Evrard, Ruel, 2016). Indeed, in order to aim at an end-to-end supply chain visibility, the data incorporated have to be well done to obtain quality final information all along the supply chain process. The data collected can be done thanks to manual means, autocomplete mean or automatic means (Evrard, Ruel, 2016). To obtain a good end-to-end visibility, data applications should be developed between various information systems used by the actors of the supply chain. Having a good visibility with the supply chain allows to apprehend risks too. The actual situation leads to increased risks in the organizations and in the supply chains and that creates a need for information sharing in the supply chains (Lavastre et al., 2014 in Evrard, Ruel, 2016). A good visibility allows a collaboration between the members of the supply chain (horizontal or vertical one) which reduces considerably the potential risks.

Conclusion

Businesses and technologies are changing every day and transportation has known huge shift overtime. The deployment of Intelligent Transportation Systems and enabling technologies aimed at fluidification transportation infrastructure and networks constitute a revolution in freight industry. The first chapter of this study focused on the components and required technologies for the use of freight ITS. Interoperability and implementation challenges are key factors the establishment of long-term vision and operations. The information which circulate through this interconnected computers-based system is key to efficient transmission of knowledge to support decision-making in supply chains. The second chapter emphasize the importance and need for valuable information collection and communication through the supply chain. As we have seen predictive real-time information is the best way to provide accurate and timely information. Then the research was dedicated to the assessment of the state of visibility in supply chain. Referring to the results of the interview and analysis of the survey, it is easy to say that managers doesn't have sufficient visibility along their supply chain. This lack lead to unreliability in data, possibly missed information, inaccurate planning and forecasting. Additionally, conventional data analysis and processing tools are undated to face to the exponential growth of data, called Big Data. In the last chapter, we have discussed the insights of Big Data and Predictive Analytics and their effects on the supply chain visibility enhancement. Moreover, it has been proven that visibility is a factor of performance in supply chain. Thus, we can say that of Big Data and Predictive Analytic is a vector of performance for companies. The accuracy and timeliness of information allow supply chain to adapt and change their strategy in real-time based to match with their data analysis. The automatization of this data analysis process could in the future, in line with the development of artificial intelligence. However, for now data analytics offer numerous optimization solutions for Intelligent Transportations Systems implement and freight- or logistics-related area. It is for sure that their development will be bring out concrete applications in our everyday life such as emerging technologies for an efficient allocation of management and information resources.

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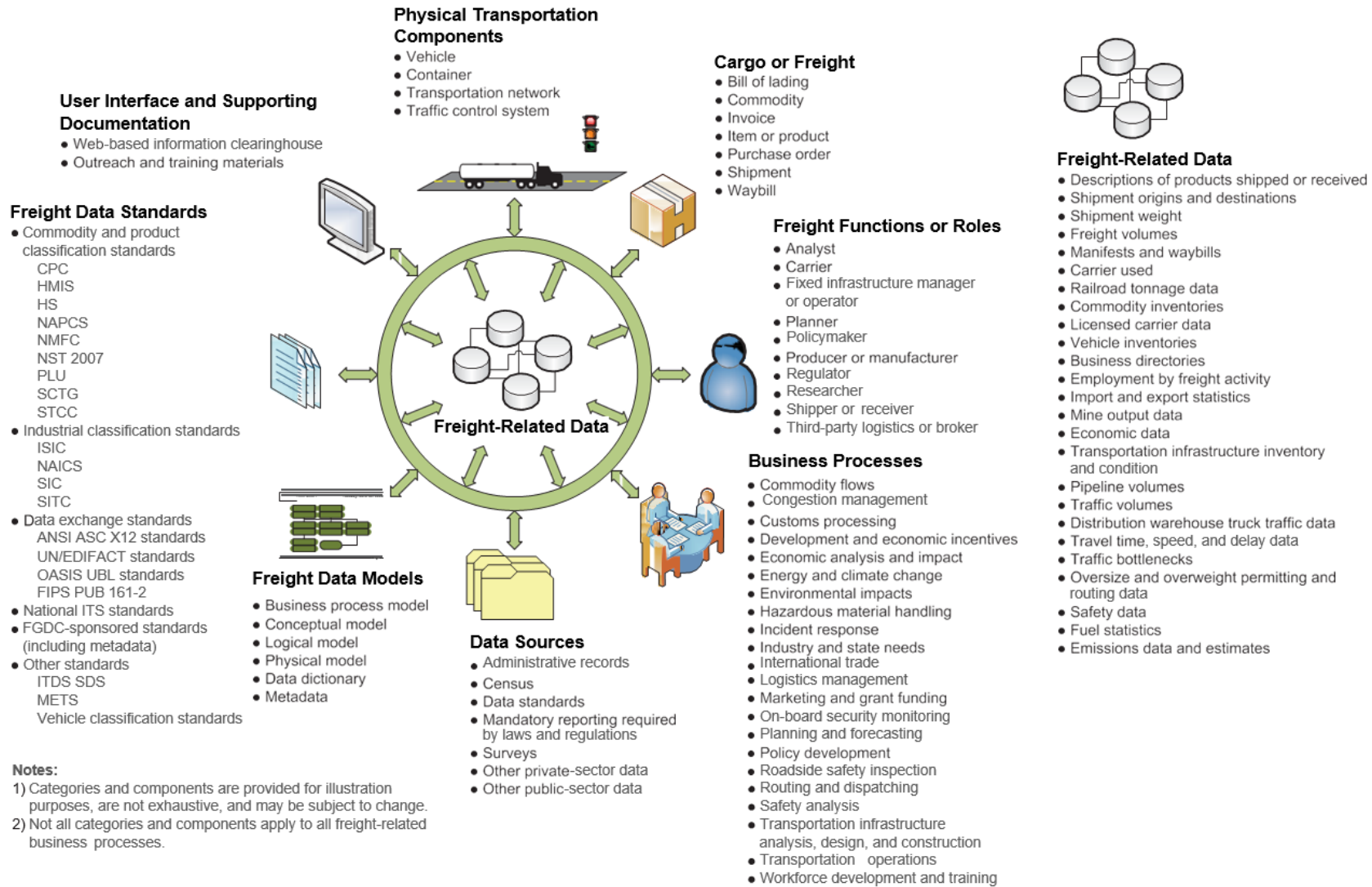
Appendixes

Appendix 1: Taxonomy of ITS (AECOM, 2015).

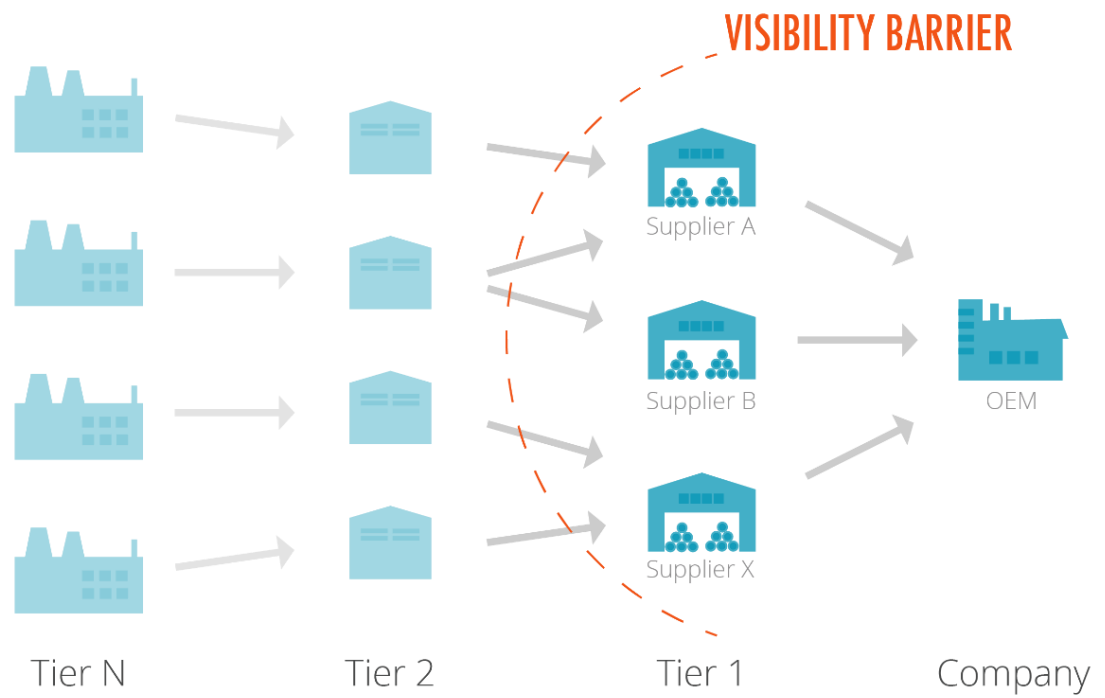
Level 0	Level 1	Level 2	Level 3	Level 4	
Optimal Use of road traffic and travel data	Public Transport services	Public Transport Management			
		Demand Responsive and Shared Transport			
		Public Transport (Integrated) Electronic Payment		Smart card	
		Communication Systems			
	Traveller Information Services	Pre-trip traffic & travel Information		Internet Journey Planning and phone line	Trip Planning Support / Journey assistance
				Smart phones based Journey Planning	
				TV/Radio	
				Kiosks pages	
				Social Media / Social Data functions	
				Mobile Internet/Wireless page	
		On-Trip traffic & travel Information		Radio	
				Roadside variable Message Signs	
				Public transport & multi-modal information displays	
				In-vehicle Systems / navigation and route guidance	
		Social Media / Social Data functions			
Continuity of traffic and freight management ITS Services	Freight Transport Management	Commercial Vehicle Pre-Clearance			
		Commercial Vehicle Administrative Services			
		Management of Dangerous Freight			
	Transport-related Electronic Payment services / Tolling	Transport-related Electronic Financial Transactions			
		Integration of Transport Related Electronic Payment Services			
	Traffic Management and Operations Services	Traffic Management and Control		Traffic Flow Control	Dynamic lane management
					Ramp metering
					Travel guidance using variable message signs (VMS)
					Co-ordinated traffic management
					Traffic management for specific vehicles (dangerous, wide loads)
			Adaptive Traffic Control at Intersections		
			Parking Facilities management		
	Information Infrastructures	Traffic monitoring			
		Weather monitoring			

Level 0	Level 1	Level 2	Level 3	Level 4	
			Environmental Conditions Monitoring	(Real Time) Traffic Information Services	
			Traffic Information centres		
			Traffic Control Centres (TCC)		
			Planning and forecasting traffic conditions		
		Incident Management			
		Demand Management			
		Transport Infrastructure Maintenance Management			
		Policing/Enforcement		Weigh in Motion Speed Enforcement	
ITS road safety and security applications	Emergency Services	Transport Related Emergency Notification and Personal Security	eCall		
		Emergency Vehicle Management			
		Hazardous Materials and Incident Notification			
	Road Transport Related Personal & Freight Transport Safety		Public Travel Security		
			Safety Enhancements for Vulnerable Road Users		
			Safety Enhancements for Disabled Road Users		
			Safety Provisions for Pedestrians Using Intelligent Junctions and Links		
			Commercial Vehicles Secure parking (Information & Reservations)		
	Disaster Response Management and Coordination Services		Road Safety Related Traffic Information		
			Disaster Data Management		
			Disaster Response Management		
	Driver Assistance & Vehicle Control		Safety Readiness	Coordination with Emergency Agencies	
				Driver impairment	Alcohol Interlock
				Intelligent vehicle safety systems or eSafety systems	Adaptive Headlights
					Local Danger Warnings
Linking the vehicle with the transport infrastructure	Intelligent Vehicle Services	Automated Vehicle Operation		Collision avoidance	
			Co-operative Systems	Vision Enhancement	Lane keeping
				Speed control (including ISA, Intelligent Speed Adaptation)	Blind spot monitoring
				Platooning	
			Vehicle 2 Vehicle		
			Vehicle 2 Infrastructure		
			Vehicle 2 X		
			Value-Added services		

Appendix 2: Freight data architecture framework and components. (Quiroga, (2011))



Appendix 3: Supply Chain Tiers Model



Source : <http://cd2.hubspot.net/hub/329424/file-1491079648-png/ntiervisibility-01.png>

Appendix 4: Cyrille Maunoury resume and interview transcribe.

Cyrille Maunoury

Supply Planning Manager - Make up at Chanel

Experience

Supply Planning Manager - Make up at CHANEL

December 2015 - Present

In charge of supply planning for Chanel Make up. Manage a team of 4.

Demand Planning Project Manager at CHANEL

April 2015 - January 2016 (9 months)

Implementation of a new forecasting system (Futurmaster). Functional project lead within the team (demand

planners, AMOA, IT and FM consultants)

International Demand Planner at Chanel Parfums Beauté

July 2012 - April 2015 (2 years 9 months)

In charge of scaling Eyes and Face new launches at global level

In charge of Fragrances, Make up and Skincare range forecasting for the UK Local Market and the UK Travel Retail Market.

Supply Chain Project Manager at L'Oréal New Zealand

June 2010 - July 2011 (1 year 1 month)

Conducted several projects in Supply and Demand Planning, Customer Service and Distribution

Education

University of Cambridge

Master, M.Phil in Industrial Systems, Manufacturing and Management, 2011 - 2012

Ecole nationale des Ponts et Chaussées

Master, Industrial Engineering, 2008 - 2012

Activities and Societies: President of the Art and Culture Society, Member of the organisation team of the Forum Trium 2009 (career fair), Member of the jury of the French "Grandes Ecoles" Literary Awards

Source : <https://www.linkedin.com/in/cyrillemaunoury/?ppe=1>

Interview Transcribe

Intvr : Mr.Maunoury pouvez-vous me décrire la supply chain de Chanel et comment elle se décompose, s'il vous plait ?

Resp: Alors, sur la supply chain globale de Chanel nous avons donc l'usine ensuite le stock global, qui est au Meux. Ensuite on a le stock qui est dans la filiale et qui reste du stock chanel. Et ensuite on a le stock qui est, soit dans les boutiques soit dans les entrepôts des distributeurs.

Intvr : Quelle est votre niveau de visibilité sur la supply chain ?

Resp: Et du coup nous on a notamment une visibilité complète sur tout ce qui est stock Chanel, c'est-à-dire stock usine, stock entrepôt central et entrepôt filiale. Donc une visibilité complète sur stock, article niveau de couverture, voilà euh, prévisions de sortie de cet entrepôt, tout ça. Donc là on est sur un partage des données complètes, avec euh ... avec un, avec un même référentiel article qui est partout et partagé par tout le monde avec les mêmes définitions des indicateurs partout.

Intvr: Si je vous ai bien compris ce partage est unifié sur toute la Supply Chain ?

Resp: Oui exactement. Malheureusement, en revanche, une fois que nos produits quittent nos entrepôts et passent dans les entrepôts de nos distributeurs, alors on perd toutes visibilité par rapport au niveau de stocks.

Intvr: Vous n'avez plus du tout de visibilité sur ces produits une fois sorti de votre stock ?

Resp: Effectivement, la seule chose que l'on récupère et ça c'est en les payant via, les euh, des panels de consommateurs ou panels de distributeurs c'est comme ça qu'on peut s'avoir combien « Sephora » a vendu de nos produits ce mois-ci par exemple. Ce qui est très important pour assurer un meilleur approvisionnement et des prévisions plus précises

Intvr: Est-ce que ces données de panels de consommateurs/distributeurs sont stratégiques pour vous ?

Resp: Oui tout à fait. Mais je n'ai aucune idée pour savoir si c'est du stock que j'ai vendu y'a un an, ya un moins ou du stock qui sera sorti hier par exemple. Avec cette information complémentaire je serais plus à même déterminé les produits sensibles, ceux qui restent en stock et ceux qui se vend mieux, en prenant en compte leurs répartitions géographique.

Intvr: Pouvez-vous me donner plus d'informations concernant la visibilité des produits en-transit ?

Resp: Ça dépend de nos prestataires de transports avec qui on traite. On a une très très bonne visibilité, par exemple quand on utilise la Poste sur du e-commerce, notre colis est scanner à tous les moments de rupture de charges, au moment de rentrer dans l'entrepôt, au moment de la livraison et on a des mêmes photos qui nous sont envoyées lors du trajet de notre colis donc ça va assez loin. Et on a d'autres prestataires pour lesquels on a juste un container que l'on scelle ici, et qui ensuite est envoyé sur le marché asiatiques ou US quoi. Et qui est scanner ensuite pour la fois suivante. En fait il est scanner au moment où il rentre sur le bateau et c'est le moment où il arrive dans l'entrepôt us quoi. J'aimerais beaucoup avoir plus d'information sur les produits en transit parce que c'est super important si jamais j'ai des problèmes de délais ou que j'ai la nécessité de répondre rapidement à des changements. De plus dans certains cas on va pouvoir avoir des niveaux de détails et savoir exactement où est chaque article, et des et des prestataires ou on va être plus à l'unité de transport. Que ce soit la palette ou container.

Intvr : Les données sur lesquels vous travaillez sont en temps réel ou datés ?

Resp: On a un échange de données mensuelle. Oui, on a une mise à jour globale en tout cas l'information elle est partagée une fois par mois. Après si j'ai envie d'y avoir accès à un instant T, je peux m'arranger pour y avoir accès en contactant les personnes qui sont aux entrepôts locaux mais l'échange globaliser et formaliser il se fait une fois par mois.

Intvr : Qui a accès à ces données ? et par quel moyen y accédez-vous ?

Resp: Il y a la logistique, y'a la supply chain globale, y'a le Customer service, et y'a les prévisions. Et on y accède grâce à un requêteur de base de données qui nous donne accès à ces données sur nos serveurs.

Intvr : A quelle fin et comment utiliser vous ces données ?

Resp: Notamment pour assurer une meilleure prévisions et planification, en pilotant le stock qu'on va envoyer dans nos filiales. C'est-à-dire qu'aujourd'hui si jamais une de notre filiale veut passer une commande de 2000 alors que je vois que dans son entrepôt elle a assez pour tenir 6 mois, je ne vais pas lui servir sa commande. Parce que je vais considérer qu'elle n'en a pas besoin ou alors qu'elle doit mettre ses prévisions à jour avant que je lui donne. Mais avec les prévisions en l'état elle n'a pas besoin d'un aussi grand stock. Ça permet donc de faire du

contrôle et d'anticiper sur valeurs en stocks. Ça permet aussi au-delà de faire du contrôle de générer des propositions pour eux quoi. Donc c'est-à-dire que lorsque une fois par mois on utilise ces données pour renvoyer au pays une proposition de la façon dont ils devraient gérer leurs entrepôts. C'est-à-dire à la Ref. "H" vous devriez commandez 200 pièces de cette référence-là ce mois-ci. Donc après ils les suivent ou ils ne les suivent pas mais y'a une proposition qui leurs est envoyé. Et ça je ne le fais uniquement avec mes filiales, pas avec mes clients en dehors de Chanel C'est pour gérer quand on gère notre stock de manière interne entre nos filière et l'entrepôt centrale. Ça nous permet en fonction du stock de nos filiales de générer des plans d'achats pour ces mêmes filiales.

Intvr: Avez-vous une visibilité complète de bout-en-bout sur la Supply Chain de Chanel ?

Resp: Pas jusqu'au client parce que notre vision reste dans la filiale mais sinon notre service enfin la supply chain à accès aux données de la production au stock de la filiale chinoise par exemple. En revanche quand la filiale chinoise vend à un client chinois je perds la vision du stock.

Intvr: Etes-vous satisfait de la qualité et de la quantité de données auxquels vous avez accès ?

Resp: Qualité oui, Il n'y a pas de soucis parce que c'est des échanges qui se font de manière formaliser informatique et automatique, donc une fois que la qualité des données a été réglé dans les spécification informatique ont à pas de soucis, ils sont mis à jour tous les mois et y'a globalement pas d'erreurs. En revanche sur la quantité moi je serais ravi d'obtenir les données de mes clients finaux. A la limite, euh, ce serait moins à la Supply Chain globale d'avoir accès à ça que à la filiale locale. C'est-à-dire que moi savoir ce que le client en bout de chaine qui est mon N+2 elle m'est beaucoup moins utile que mon N+1. A la limite ça serait sympa, mais je sais pas si j'en ferai grand-chose, car c'est plutôt sur des points très critiques quand je suis en rupture particulières sur une référence et que j'ai besoin de contrôler l'ensemble de ma chaine, sur du process normal je n'ai pas besoin de le savoir, vraiment sur du point critique. Alors que je pense que la filiale chinoise, elle, serait ravie de les avoir de manière quotidienne. Dans tous les cas plus on a de visibilité et plus de données accessibles le mieux c'est parce qu'une fois triés on a un avantage considérable sur ceux que n'ont pas cette info.