Instituto Politécnico de Coimbra
Instituto Superior de Contabilidade
e Administração de Coimbra

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Logistic Operators- Operational Planning Performance & Decision Targets

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Relatório de estágio submetido ao Instituto Superior de Contabilidade e Administração de Coimbra para cumprimento dos requisitos necessários à obtenção do grau de **Mestre em Management Information Systems**, realizado sob a orientação da Professora Doutora Ana Cristina Santos Amaro e supervisão de Dr.ª Cristina Maria Falcão.

Coimbra, outubro de 2017

TERMO DE RESPONSABILIDADE

Declaro ser o autor deste relatório de estágio, que constitui um trabalho original e inédito, que nunca foi submetido a outra Instituição de ensino superior para obtenção de um grau académico ou outra habilitação. Atesto ainda que todas as citações estão devidamente identificadas e que tenho consciência de que o plágio constitui uma grave falta de ética, que poderá resultar na anulação do presente relatório de estágio.

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RESUMO

Este relatório apresenta uma perspetiva global sobre o estágio realizado no grupo Luís Simões, S.A., registando as atividades planeadas e as desenvolvidas.

O impacto alcançado pela logística, nesta "Nova Era" de dimensões mundiais, de tecnologias e de mercados inovadores, induziu uma progressiva motivação para esta área. Investigadores e profissionais reconheceram essas oportunidades e os novos paradigmas sociais associados, apresentando-os em diferentes artigos científicos e trabalhos técnicos. Desses destacam-se as contribuições com impacto no planeamento e escalonamento associado aos operadores logísticos. Estes registos foram importantes incentivos para o desafio proporcionado pela Luís Simões, S.A.

As principais atividades desenvolvidas durante o estágio centram-se no funcionamento regular de um operador logístico, como sejam: *planeamento e agendamento de frotas*, *controlo de armazém*, *monitorização*, *programação de clientes e de pedidos*. Além disso, faz ainda parte dos objetivos definidos o desenvolvimento de alguns *indicadores-chave de desempenho* (KPIs). Posteriormente, pretende-se que esses indicadores sejam integrados no novo sistema de informação, Sistema de Gestão de Transportes (TMS), cuja implantação foi iniciada na Luís Simões, S.A. Neste âmbito, conclui-se ser possível alcançar algumas melhorias relativamente a parametrizações, medições e monitorizações. Globalmente, trata-se de requisitos de personalização do TMS para as práticas diárias adequadas ao grupo na região de Coimbra.

Palavras-chave: Logística, Planeamento, Escalonamento, Otimização, Indicadores-chave de Desempenho (KPIs).

ABSTRACT

This report presents a global perspective on the internship carried out in Luís Simões, S.A group and it also registers the planned and the enrolled activities.

The impact reached by logistics, in this "New Era" of worldwide dimensions, technologies and novel markets, introduced a progressive motivation to this area. Researchers and practitioners have recognised these opportunities and the new related social paradigms, presenting them in different scientific and technical papers. A special focus is devoted to the contributions emphasising the impact of planning and scheduling of logistic operators. These contributions were important incentives to the challenge provided by Luís Simões, S.A.

The core activities developed during the internship concerned the regular operation of a logistic operator namely, *fleet planning* and *scheduling*, *warehouse control*, *monitoring* and *programming of clients* and *orders*. Besides that, the development of some *Key Performance Indicators (*KPI*)* was also part of the objectives. Moreover, these desirably would be integrated within the new information system, Transportation Management System (TMS), implemented in Luís Simões, S.A. Herein, some improvement can be achieved concerning parameterisations, measurements and monitoring being reportable. These can be considered as TMS customisation for the practices of the group in Coimbra region.

Keywords: Logistics, Planning, Scheduling, Optimisation, Key Performance Indicators (KPIs).

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List of abbreviations

1PL	First-party Logistics
2PL	Second-party Logistics
3PL	Third-party Logistics
4PL	Fourth-party Logistics
5PL	Fifth-party Logistics
APD	Absolute Percentage Difference
BCM	Business Control Model
CSF	Critical Success Factor
DC	Distribution Centre
DEA	Data Envelopment Analysis
DISC	Distribution Scheduling
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FSP	Fleet Scheduling Problem
FTL	Full Truckload
GDP	Gross Domestic Product
GIS	Geo-Information Service
GPS	Global Positioning System
GSM	Global Systems for Mobile
JIT	Just-in Time
KPI	Key Performance Indicator
LS	Luís Simões
LSP	Logistics Service Provider
LTL	Less than Truck Load
MIS	Management Information Systems
MRP	Material Resource Planning

OR	Operations Research
PI	Performance Indicator
PM	Performance Measurement
POS	Process Operational Structure
QMS	Quality Management System
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SKU	Stock Keeping Unit
TM	Transportation Management
TMS	Transportation Management System
TQM	Total Quality Management
VRP	Vehicle Routing Problem
VSP	Vehicle Scheduling Problem
WMS	Warehouse Management System

1 INTRODUCTION

This internship report is part of the Master program in Management Information Systems (MIS) carried out at ISCAC | Coimbra Business School. The internship has to fulfil the non-lecturing component of the Master, and it has the objective of providing students with valuable first-hand work experience in the field of studies of their masters' branch and in this case, the logistics' branch.

The internship was accepted in the group Luís Simões, *Logística Integrada,* S.A., at their office of Taveiro, Coimbra region and it lasted between November 2016 and June 2017. This period was held under the supervision of Dra. Cristina Maria Falcão, Manager of Luís Simões for Coimbra Region and with the academic guidance of Doutora Ana Cristina Amaro from the Master in MIS, of ISCAC | Coimbra Business School.

The internship took place for six months with a weekly workload of 40 hours, within a total of 960 hours, in accordance with the regulation stated for the second cycle courses of ISCAC | Coimbra Business School (e.g. article 21, paragraph 4).

The title adopted for the internship is *Logistic Operators- Operational Planning Performance & Decision Targets*, accordingly with the desired core subject. So, to fulfil the theme and the Master course requirements, a Logistics and Transportation company, was required to overlook the operational activities and challenges involved in the daily decision management.

Therefore, a proposal was submitted to the group Luís Simões, *Logística Integrada* S.A., for the theme. The Group recognised the interest of the subject, accepted the internship proposal and accordingly, the collaboration was established between the Coimbra Business School and the company.

So, the internship as a practical first-hand approach started in a broad reputed Logistics and Transportation Company in the Iberian Peninsula, the group Luís Simões. S.A.

1.1 Problem Statement

In last few decades, business globalisation and the new worldwide trade opportunities introduced significant challenges to companies. Under this scenario, managers had to fight against price pressure, product quality, variability and availability within strongly competitive markets. Globally, new management paradigms arrived from the new and emerging business perspectives. In here, the assurance of service levels to worldwide

customers represents a competitive advantage that strongly impacts companies' performance. Logistic operators emerged in this context as essential chain links to ensure the commitment of customer requirements within feasible target levels. These are important motivations focused especially on the role of logistic operators. In the following paragraphs, the remaining key-words defined for this internship subject are also justified.

Therefore, concerning the *operational planning* of logistic activities through an integrated Supply Chain Management (SCM), it is a recognised research topic in both perspectives, technically and scientifically. Thus, the detailed optimisation of logistic operators' activities is essential not only to enhance their business consolidation but also to achieve resource savings and improve the entire chain operation. *In practice, great expectations are placed on planning*.

In literature, several contributions cover planning problems subject. Typically, in supply chain management, decisions cover three planning levels (Bertrand, 2003; Manzini, Gamberi, Gebennini, & Regattieri, 2008), namely, i.) Strategic; ii.) Tactical and iii.) Operational. The significant differences amongst these planning levels are related to the planning horizon or time frame and with the details included in the problem description to management goals.

Moreover, the measuring and control of *Key Performance Indicators* (KPIs) assume an important role in companies' managing strategies. This is due namely to the possibility of separate valuable information from unimportant, simplify complex subject matters and create transparency. KPIs are the basis for analysing and improving processes as well as benchmarking. The most commonly recognised functions of KPI are: i) support planning in various areas (e.g. strategy and budget); ii) requirement to set goals and to control the implementation; iii) basis for decision making within a company; iv) incentives especially for the top management, but for employees as well.

Also, the *Information Systems* (IS) play an important role to integrate the whole supply chain operations and give a competitive edge to enhance the efficiency and create higher client satisfaction. It is also possible to have a real-time monitoring of the logistic operators through the integrated information systems which provide agility, flexibility, and reliability in the operative functions of the firm.

In due course, *various tools and planning/ scheduling applications were studied* during the internship which was helpful for: **i.)** Logistic Operators – Characterisation of their

operational problems, metrics and available planning tools, decision support applications and information systems practices; **ii.)** Developing Key Performance Indicators for the operational activities; **iii.)** The exploration of scheduling proposal and **iv.)** The *decision framework* that supports Logistic Operators' managing and daily work decisions.

Globally, the operational planning of logistic activities is an important research subject for the integrated Supply Chain Management (SCM), recognised in the literature review and also known as a *key topic* in the organisational and technical fields.

1.2 Objectives and Methodology

The main objectives set for this internship project can be defined as follows:

- *Logistic Operator* – global characterisation covering the identification of: operational problems, available metrics, existing planning tools, current information systems, decision support applications and practices;
- *Operational Planning Problem* – Definition, settings and involved data (e.g. activities or tasks in the defined problem);
- *Scheduling Tools* – Study to support *Logistic Operator* decision processes;
- *Decision Framework* –Analysis concerning the daily management of logistic operator.

Concerning the methodology used to achieve the research objectives, the process followed during the internship consisted of three key steps. First, at the initial stage, the problems were identified from the preliminary state of art literature review. This process involved study in determining the gaps that were identified within the interest of research area. Several key research questions were generated from the research problems. The literature was thoroughly studied to determine whether those research questions had been answered. The research aim was recognised based on the final selection of research questions, and the research objectives were derived from the main aim of the study.

As a result of the earlier step, it was necessary to study the information systems in the industrial environment. The Management Information System was explored, and the study resulted in the identification of the planning and scheduling problem involved in the transportation and logistics industry. Also, an exhaustive literature review was done to the information system employed in the case company. Hereinafter, Luís Simões, S.A. company will be referred to as "case company".

Finally, during the last step of the research, the scheduling tools were explored. The data collection exercise involved a qualitative approach using interview and meetings with the logistic operators' employees as a primary data gathering method. In this study, qualitative data and participative observation are primarily accommodated to ascertain the issues pertaining to transportation planning and scheduling in the case company. Besides that, some research design methodology was also explored.

1.3 Report Structure

This report is organised into six chapters that reflect the course of the work carried out in achieving the defined objectives.

In this chapter, as previously stated, the problem statement, the objectives and the methodologies implemented to achieve them were presented. Chapter 2, *Literature Review*, is composed of a review and analysis of the state of art literature concerning the theme of the internship.

Chapter 3, titled *Case Study*, describes the case company and examines the competition, resources and capabilities. Also, a detailed analysis is presented concerning the organisation and the involved operations.

Following the company presentation, Chapter 4 introduces the *Core Concepts & Facility Tools*. In here, the concepts of transportation scheduling in relation to the objectives as well as the tools employed in the case company are explained. In Chapter 5, named *Internship Activities*, the development of the key performance indicators carried out in the case company is presented, and the subsequent objectives are explained.

Finally, in Chapter 6, the *conclusions* are presented, and the final considerations are summarised, as well as the expectations and the achievement of the objectives. Furthermore, some *future developments* are also proposed.

2 LITERATURE REVIEW

This chapter describes the literature within the research area involved in the internship objectives. The main aim is to provide the foundations and to introduce the scientific and the technical contributions proposed so far in these fields. The first section of the chapter presents the literature concerning logistic operators and the planning parameters for the operational transportation planning. After that, the Performance Measurements (PMs) and decision support tools for the enterprise managers are presented.

2.1 Logistic Operators

According to the *Council of Supply Chain Management Professionals*[1], logistic operators can be defined as, "*Logistic operators own trucks to move goods or pick up freights, rail cars and the locomotives to move the freight across long distances on the land. They possess and operate ships or aircrafts to move bulk cargoes across the ocean and also via the air, and also to other continents. Some logistic operators do not possess a fleet of vehicles but act as an intermediary to provide transportation to clients. All are essential links in the global supply chain that moves the good and freight to provide services to clients.*"

Morgan Stanley's report[2] (2010) explains the concept of logistics and defines logistics as an integral of the supply chain process. The supply chain processes plans, implements, controls, and executes the effective and efficient flow of materials, storage of items, and the associated information from the point of source to the point of consumption to meet clients' necessities.

The Morgan Stanley report extensively elucidates the logistic operators systematically in five considered categories namely- First-party Logistics (1PL), Second-party Logistics (2PL), Third-party Logistics (3PL), Fourth-party Logistics (4PL), and Fifth-party Logistics (5PL). The progressive augmentation of a numeric issue in PL designation is mostly related to the continuous trial of enlargement and integration of logistics service providers.

[1] Council of Supply Chain Management Professionals- https://cscmp.org/

[2] Adapted from - https://www.morganstanley.com/views/perspectives/China_Economy_2020.pdf

2.2 Transportation Planning and Vehicle Scheduling

Along a supply chain, several key decisions have to be made and coordinated according to the clients' demand. These decisions are of different importance in different stages. They may comprise the rather simple question "Which vehicle has to be scheduled next on a respective route?" as well as a grim task whether to open or close a distribution centre (DC). The important decisions to be made is akin to being prepared beforehand. The preparation involves the job of planning. The planning process in the logistics and transportation industry consists of different recurrent tasks traditionally maintained subsequently. This planning process starts at the strategic level with collecting or forecasting data of client demand (Bunte & Kliewer, 2009). The planning supports decision-making by identification of alternatives to the future activities and selecting the optimal, or at least, the best possibility in the absence of optimal modelling (Domschke & Scholl, 2005).

Domschke & Scholl, (2005) further classify the planning process in different phases, namely: i) The identification and analysis of a decision problem; ii) The characterisation of the organisational objectives; iii) The future developments forecasting; iv) The identification and evaluation of feasible activities (solutions); v) Also, the selection of alternative solutions for informed decision-making.

Supply chains are very sophisticated in nature. Not every detail has to be agreed upon, but it should be respected in a plan and during the planning process. Therefore, it is perpetually essential to obscure from reality and to use an uncomplicated model of the realm, a so-called model, as a basis for building a plan. The art of "model building" is to characterise the real-world problem without merely ignoring the constraints of the real-world (R. E. Hall & Lieberman, 2012).

Forecasting and simulation models attempt to make an effort to anticipate potential developments and to describe associations between input and output of complex systems. However, they do not support the selection of one or a few solutions that are good regarding predefined criteria from a broad set of feasible activities (Nahmias & Olsen, 2015). These are the purposes for optimisation models, recognised a long time ago (Bertrand, 2003). Based on the length of planning boundaries and the significance of the decisions to be made, planning tasks are generally categorised into three different planning levels (Manzini et al., 2008).

Therefore, planning levels go from *Long-term* to *Mid-term* and from there to *Short-term*. Following this of all levels, the main characteristics of planning and sequencing are the reduced planning horizon (e.g., feasible time frame) and the increased operational details, the time required to accurately describe the operational policies (e.g., measuring frequency, monitoring, etc.) (Kreipl & Pinedo, 2004).

On the other hand, transportation arises to ensure physical flows and the interaction between different SC clusters, namely from suppliers to manufacturers and from them to final customers, while accounting for other intermediate chain partners (e.g. distribution centres, retailers, etc.). Usually, manufacturers require transportation services to transport raw materials and other products to geographically dispersed location, and also to distribute finished products in order to achieve client demands (Amaro & Barbosa-Póvoa, 2008a). The demand for final products with its regional and sequential distribution is exogenously defined as for the multitude of transportation planning process (Chopra & Meindl, 2015). However, the recognition for protecting the environment and the societal awareness towards the carbon emission levels, the researchers and practitioners have placed importance on the planning and scheduling of the transportation activities (Crainic, 2003).

The operational transportation planning focuses on lean operational decisions determining the mode and the carrier choice (Stank & Goldsby, 2000). The execution of shipment schedules and their modification are also part of the operational transportation planning process (Crainic, 2000). The transport planning task is also characterised as operational. It is also one of the major misunderstandings in operational transportation planning that vehicle schedule is only accomplished if the vehicles are solely used for the supply chain under consideration (Fleischmann, 2010).

As Crainic (2003), asserts while road transportation concerning the planning and scheduling perspective, a more interesting and practical classification differentiates them: i.) Long-haul transportation and vehicle routing distribution, VRP problems; ii.) The multi-modal transportation system of a region, irrespective of its dimensions; iii.) Consolidated transportation wherein vehicle or fleet of vehicles serve different clients with different starting point and destinations, also door-to-door deliveries to a particular client in case of customisation of services.

The strategic and tactical ends of the planning level can draw up guide operatives to handle the business, but the operational planning capabilities ultimately define the performance of the logistics and transportation industry.

Different issues are addressed at the operational planning levels in order to ensure the client demand is satisfied by optimising the efficient utilisation of available resources. Most importantly, time plays a crucial factor in the operational planning (R. Hall, 2012). Thus, in the real-time situation, the conformity to the time restrictions, integrating and optimising decision-making with the possible impact on the performances emphasises the critical aspect of the operational planning in the transportation industry.

Traditionally, the models in the transportation planning often use known static data called as input. The formulations for tactical plan consider aggregated forecast demand as "known." Consequently, in the real-world problems, these models are subjected to constant changes and optimal solutions cannot be implemented as planned (Crainic, 2003). The set of uncertainties in the model are characterised by the real-world problems as these uncertainties are reflected in the operational planning models such as- vehicle scheduling problem, vehicle and crew scheduling problem, empty vehicle distribution and repositioning, terminal and linehaul operations, and dynamic allocation of resources (Amaro & Barbosa-Póvoa, 2009).

Vehicle Scheduling

The vehicle scheduling problem arises when the logistic operators or logistics service providers (LSPs) of transportation network must manage a fleet of vehicles to serve the clients in the present prospects of client demands. The *capacities* of the fleet are directly associated with the *number of availability of vehicles*. Thus, the optimal size of the fleet for a transportation network requires certain *trade-offs to garner benefits for achieving the targeted demands, the fixed costs of vehicles or fleet of vehicles and the penalty that will cost for not meeting the demands*. However, for serving demands, the assignment of vehicles and each reallocation (i.e. vehicle is in a different location) has to account for the fulfilment requirements, using the vehicle in a particular location. This assignment of vehicles or fleet of vehicles is part of the so-called vehicle scheduling in transportation perspective (Amaro & Barbosa-Póvoa, 2008b).

Generically, vehicle scheduling problems are commonly classified into three groups that is vehicle routing, fleet sizing, and fleet assignment. In the recent past, many types of research have been carried out on vehicle route optimisation, especially focusing on vehicle routing problem (VRP) with soft window (Hou, Jia, Tian, & Wei, 2013). Larsen, Madsen, & Solomon (2008) proposed an exact algorithm based on set partition to balance

the minimum number of vehicles required and the client demand satisfaction. Authors as Luo & Wu (2015) assert the integrated problem of vehicle scheduling and allocation.

Besides that, fleet sizing is one of the problems existing in the real-world scenario and requires important decisions for significant investments as is the case in any business entities. Many researchers have conducted researches on fleet sizing problem (FSP). Żak, Redmer, & Sawicki (2011) studied the fleet sizing problem in a transportation and logistics firm with a heterogeneous fleet. Rahimi-Vahed, Gabriel Crainic, Gendreau, & Rei (2015) discussed the problem of the most desirable optimal fleet sizing for the vehicle routing problem, i.e., *periodic VRP, multi-depot VRP, and multi-depot periodic VRP*.

Moreover, some research papers are focused on the fleet assignment or vehicle scheduling problems addressing from the perspective of optimisation of transportation model and the solutions. Xia, Li, Ma, & Xu (2015) addressed a comprehensive model that provides a solution for optimal fleet deployment, optimisation of speed and vehicle allocation is proposed while accounting for profit maximisation. *Simão et al.* (2009) proposed a model for large-scale dynamic fleet management and presented a dynamic programming to solve dynamic problems in the real-world. Also, Topaloglu & Powell (2007) introduced the concept of how to coordinate decisions to solve the issues related to pricing and vehicle scheduling of a carrier.

2.3 Performance Management

By its nature, the term "performance" is a diverse subject. Any business enterprise whether private or public has to remain within the boundaries of financial constraints and deliver the perceived value or money to its stakeholders. The term "*performance management*" is a continuous process of identifying, measuring and developing the performance of personnel, business teams and aligning overall performance with the strategic goals and objectives of the organisation (Lydenberg, Rogers, & Wood, 2010).

In performance management, the Key Performance Indicators (KPIs) are in focus for estimating the efficiency of the organisation. The role of KPIs can be described in a performance management process (also called *performance measurement process*).

These can be summarised as i.) KPI definition; ii.) Monitoring and Compliance; iii.) Data analysis; iv.) Improve business processes; v.) KPI Refine.

The KPIs should be evaluated any time when the Critical Success Factors (CSF) are reviewed. KPI also should be flexible in terms of any relevant changes in environment, processes, and conditions (Parmenter, 2015).

2.3.1 Performance Measurement

Performance measurement characterises the method of quantifying the efficiency and effectiveness of various processes and operations. The effectiveness signifies how the client requirements meet and the efficiencies signify how effectively the organisation resources and assets utilised to ensure the service level (Neely, Gregory, & Platts, 1995). For a brief understanding of performance, there is always a better way to start with a definition. According to Dwight (1999), "*the performance is a degree to which the goals attain*." Authors like Meier, Lagemann, Morlock, & Rathmann (2013) states, "*the performance is an ability of the firm to attain goals and objectives." In pursuit of realisation and evaluation of goals, performance measurements must quantify the effectiveness and efficiencies*. On the other hand, Samsonowa (2011) assumes that the effectiveness signifies the level of goal fulfilment and the efficiency indicates how well the corresponding processes perform to meet those goals.

The performance indicators of the specific process remain the same irrespective of how an organisation measures their performance and which system they may use (Parmenter, 2015). According to Jordan & Messner (2012), the basic function of performance indicator is to facilitate the management for necessary action and provide means of control and enhance to meet the strategic objectives. Waal (2003) states that the measurement influences the action plan which generates a behaviour pattern to align the business environment, culture, and strategic objectives of an organisation. It is extremely important that performance indicators require strong association with the business strategy to ensure efficiency of an organisation and create a positive environment which aligns the corporate culture.

The concept of performance measurement originated in the early 1980's in Manufacturing industries. The conceptualisation and development of PMs through varieties of innovations such as Just in Time (JIT), and total quality management (TQM) took place (Wong & Fung, 1999). Supply Chain Management is an integrated structure with a primary goal to link business operations with business functions and therein to provide a platform for performing cohesively and building a high-performance business model.

There is one crucial aspect which deems necessary for an organisation to benefice from PMs is to have a strong connection to the organisation strategy to ensure the applicability (Neely et al., 1995). The organisation requires correlating its mission, vision, and objectives to align PMs with company strategy successfully. The step an organisation must consider is to identify its critical success factors (CSFs) and appropriate PMs and derive those measurements into company's vision, mission, objectives, and core values. One of the difficult task for managers is to derive these measurements into strategic form and making those measurements as tangible as possible (Franceschini, Galetto, & Maisano, 2007). Choosing a right indicator is a daunting task and as authors Franceschini et al., (2007) further asserts, "A strategy without indicators are useless; and indicators without a strategy are meaningless."

The indicators form a foundation of PMs in the evaluation of how well the organisation is adhering to its strategic goals and objectives. The metric, unit, type of PM varies in the literature of PMs, and there are various definitions found in the literature which describes measurements that evaluates the degree to which the goal fulfils. There are several measurements commonly identified in the literature are: "performance metrics", "critical success factors", "key result indicators", "key performance indicators", "key success indicators", "success measures", "strategic measures", "performance criteria", and "indexes" (Samsonowa, 2011). Furthermore, the terms which are relevant and are of interest in recent years among academicians and practitioners are, "performance indicators", "key performance indicators", "performance metrics", and "performance measures" (Stadtler, Fleischmann, Grunow, Meyr, & Surie, 2014).

Although the term performance indicators differ between academia and the practitioners, this is mainly due to the existence of priority where academicians concern with definition, evaluation, validation, and generalisation of the process of measurement and evaluation of performance. Whereas, practitioners deal with the applicability and usefulness of the specific business arena. In actual practice, a combination of a technical reference and what is practically feasible is relevant in the industrial world. It is therefore extremely essential to analyse the theory suggested and understand the practical relevance. The non-parametric practices existing for performance measurement such as Data Envelopment Analysis (DEA) would be challenging to adapt and make the high applicability of it. According to Franceschini et al., (2007) states that the indicators as a tool for performance measurement are of great interest both to the academicians and the practitioners.

2.3.2 Key Performance Indicators (KPI)

In any business enterprise, it is indeed crucial to establish and gauge the efficiency to find out that whether the enterprise is operating according to the established standards and operating procedures while identifying the actions required to enhance the performance levels to meet those expectations within an organisation. Key Performance Indicators are often termed to be an essential instrument for measuring the business activities, as they are quantifiable and required to achieve business goals and objectives.

The success of an organisation in the fast-growing businesses, it is required that corporate management must understand their strength and weaknesses. Key Performance Indicators (KPIs) are the quantifying parameters that reflect the success factors of the business environment. For effective supply chain integration, the KPIs are vital tools for monitoring and improving the efficiency to gain competitiveness in the global market (Taylor, 2010). Also, Chae (2009), addresses that a well-built performance indicator (PI) is an essential factor for competitiveness in the global market. There are quite a many measures in the literature discussing the means to improve SCM system (Folan & Browne, 2005), while few of them in the literature discuss having a clear view and avoid ambiguity. Also, many SCM performance indicators are static and on many occasions lag behind in the distinctive working contexts of the supply chains (Neto & Pires, 2012).

There can be many types of indicators that can be employed in an organisation. However, Folan & Browne (2005) are critical in terms of viewing the maximum number of indicators as fallacious and asserted that there are a minimal number of indicators that improve the efficiency of an organisation and they named it as key performance indicators (KPI). Van der Vorst (2000), categorises the performance indicators into three levels, namely: i.) The supply chain level; ii.) the logistics level; and iii.) the process level. Also, Pettersen (2009) asserted that in order to have an effective and efficient supply chain management, it is necessary to measure the performance indicators with four levels- profit, time, delivery promptness, and waste elimination.

Authors as Wong & Wong (2008) made a critical analysis of the literature and indicated that the performance measurements are not viewed as a whole supply chain entity and further indicating the fact that performance measurement is difficult with multiple inputs and outputs. The supply chain performance indicators that are measured in the form of output-input ratios provide robustness, reliability, and flexibility in the supply chain (Asadi, 2012).

2.4 Management Information Systems

The information system in logistics presents an integral part of any logistical system, providing the functional area of logistical management. The objective of the information logistics are the information flows, reflecting the material movement, finance, and many other operations related to the logistics.

A necessary condition for the coordination of all units of the logistics system, turns out to be the existence of information system, which should be capable, to process, to provide quickly and economically the right signal directed to the right point at the right moment (Bowersox, Closs, & Cooper, 2011).

Management Information Systems (MIS) are composed of computing and communication hardware, operating systems, and applications to support business processes (i.e. wide array of business functions) which aid to accomplish the goals and objectives of an organisation (Surwade, 2016). In Portugal, the use of computerised planning systems in the industrial environment is nonetheless limited (Azevedo, Romão, & Rebelo, 2012).With the increased complexity and global demand for large varieties of products, dynamic supply chains need to be coordinated without comprising the flexibility of the networked organisation (Verwijmeren, 2004).

The concept of a supply chain is in fact based on the value-chain network comprising of the functions directed towards providing available resources and the information to achieve objectives of an efficient supervision and management of the suppliers as well as the flow of supplies (Lau & Lee, 2000).

Global supply chain networks cannot entirely rely on a particular technology or the platform. The literature review classifies functional technologies in the supply chain into sections that specify issues associated with the characteristics of collaborations are evaluated. The challenges of implementing new technologies in these groups to existing platforms are analysed and exploited.

2.4.1 Transportation Management Systems (TMS)

The commercial software suites applied to operate an enterprise's transport services are designed primarily to satisfy the requirements of standardised and dynamic carrier communication. They are mentioned as "*transportation management systems*" (TMS). Nevertheless, these systems are designed to manage the manufacturers' interfaces to the

logistics service providers (LSPs) and are therefore largely transaction-based (Caputo, Pelagagge, Scacchia, Caputo, & Scacchia, 2003).

In recent years, transportation management systems (TMS) have earned significant recognition across all industries (House & Jackson, 1995). They are characterised as "software applications that expedite the procurement of transportation systems, the short-term planning process and optimisation of shipping activities, and the implementation of consignment plans with continuous analysis and collaboration" (Helo & Szekely, 2005). Transportation Management processes are determined by a transportation demand, which in turn is deducted from goods demand (Hall, 2012). Also, while in the past, the information availability has been a significant obstacle in many cases to performing high-quality transportation planning (Stank & Goldsby, 2000), with the implementation of TMS, this information does become accessible at high-quality standards. In the consumer goods sector, the industries have been aware of the importance of transport challenges for quite long time, and as such has been the first to implement the TMS application for greater ease in the operations.

The TMS application suites are well integrated and have extended functionalities to cover the transportation management problems from planning to real-time tracking and tracing, and from payment services to freight tendering (De Muynck, 2015). Nowadays, the cases in which Enterprise Resource Planning (ERP) software vendors develop some extended TMS functionalities, these have been acquired through mergers and acquisitions. Most probably, the main being the G-log by Oracle and the most recent one being the acquisition of i2 by JDA.

De Muynck (2015) explicitly differentiates between exact TMS solutions, fleet-based routing and scheduling software. On the other hand, McLaughlin, Motwani, Madan, & Gunasekaran (2003) present a case study on the implementation of a TMS application, although they do not use the term TMS but refer to the implemented system as a "business process tool for freight management", which further implies that today's TMS suites are transaction-based order management tools.

In the past, demand for TMS services was mainly triggered by managers of extensive transportation networks but now, due to the innovation focus has shifted from strategic planning processes (e.g., total cost sourcing decisions) toward improving the effective operational planning and scheduling features, are largely available (Capgemini, 2011). However, the number of TMS merchants that operate favourably on a worldwide scale is

very confined (Connaughton, 2008). The leading global vendors of TMS are currently i2 and Oracle (G-Log), closely followed by JDA (Manugistics) and Manhattan Associates (Connaughton, 2008; De Muynck, 2015). Lauterbach & Metzger (2015) indicate that SAP introduced the first release of its TM (Transportation Management) module (release 6.0). However, Connaughton (2008) states that the consumer base is still minimal and business feedback from consumers is limited. However, there are also a substantial number of small TMS vendors that claim these software companies are successful in their home markets. Since the regional TMS markets have been controlled by a large number of local players who are best at understanding the specifics that concern to the transportation markets in their home regions (Capgemini, 2011).

2.4.2 Warehouse Management Systems (WMS)

Warehousing is known as an essential competitive component of a supply chain. Consequently, Warehouse Management Systems (WMS) have, in most applications, become necessary to efficiently achieve the increasing levels of warehouse performance required (Faber, Koster, & Velde, 2002). WMS have frequently not kept up with changes inside and outside the warehouse, nor reflected relevant developments in Operations Research (OR) (Lahmar, 2008).

A WMS is a software package that gathers, scrutinises, and communicates the information necessary to move goods or items through a warehouse or distribution centre (DC). From this information, a WMS can guide employees on the best ways in which to perform warehouse activities (e.g., where to put or where to find an item), and, as such, governs the flow and storage of products through the facility.

Like ERP systems, WMS software is provided as a set of modules from which the organisation in question must choose. Common to all modules is the ability to review and communicate activity information, such as product activity, facility performance, and inbound and outbound movements. The overall role of WMS has also extended, with some systems offering capabilities related to import-export, coordination of multiple warehouses, full accounting systems, labour planning, the ability to connect with the advanced planning tools, returned-goods management amongst others (Richards, 2017).

Potential benefits of WMS implementation have been reported by authors such as Min & Zhou (2002) and Faber, Koster, & Velde (2002). Piasecki (2007), however, notes that the size of this reduction in comparison to total inventory often is minimal because ‘‘the

dominant factors that control inventory levels are lot sizing, lead times, and demand variability. It is improbable that a WMS will have a significant impact on any of these factors.''

A WMS application is distinguished as a ''logistics execution system.'' Moreover, it is designed for day-to-day operational planning activities. A WMS plans at a reasonably low level, typically not extending beyond the facility walls. The primary function of a WMS is not an optimisation of the process; instead, it performs a supervisory function concerned with the activities within the warehouse with the goal of making the best use of the resources (capital and labour) (Ballard, 1996).

Planning at a level higher than that of the WMS needs a software that is not confined to the analysis of one particular area. For example, the Advanced Planning and Scheduling Systems (APS) make available the Operations Research (OR) competencies in the optimisation package that are required in WMS and other planning systems (Green, 2001).

A WMS has developed autonomously, and hence have a unique association with, enterprise resource planning (ERP) systems. As Frazelle (2001) explains, in ERP systems, the warehousing module ''is typically an afterthought application for these software providers and the full-suite provider.'' As a consequence, most ERP systems require the functionality to aid the warehousing and transportation activities adequately (Frazelle, 2002; Handfield & Nichols, 2002; Spiegel, 2003). Lacefield, (2005) states that several ERP vendors now claim their systems to be capable of handling supply-chain processes.

The market for WMS and many other logistics execution systems is mature; it is hard to differentiate warehouse software based only on processes ''inside'' the facility. This situation has led the WMS developers to focus on the issue of product flow. Applications have been added to better coordinate warehousing with other activities in the supply chain (Poirier, 2016).

3 CASE STUDY

In this chapter, the case company "Luís Simões Logística Integrada, S.A." is presented. The company's mission, vision, values and policies along with the SWOT analysis and the competition in the Iberian Peninsula are presented. Also, the organisational operations are explained below in detail.

3.1 Organisation Description

The Luís Simões Logística Integrada S.A. is a subsidiary company in the transport and logistics industry of Luís Simões group. It is business entity founded in 1948 in Portugal, and 100% of its capital belongs to Luís Simões family. The organisational structure of Luís Simões is presented in Appendix 1. The core business of LS is transport and logistics, but the company has been expanding its business to other areas such as Rent a Cargo and Technical Services (RETA), Corporate Management, and Real Estate Businesses. The market of Portugal and Spain are the focus of company's operations. Moreover, having founded in 1990, the LS spread across Iberian Peninsula which can be seen on the map below-

Figure 1 - Iberian Network of Luís Simões Group

The details of group are enumerated in the table1 below-

Table 1 - Luís Simões Logística Integrada S.A. details

Administrator/Manager	Cristina Maria Falcão
Address	Mercado Abastecedor da região de Coimbra, modulo 8 3045 Coimbra- Taveiro Portugal
Coordinates	40.18901839999999, -8.5129455
Specialisation	Logistics & Transportation
Business Turnover 2014	219M €
Business Turnover 2015	220M €
Business Turnover 2016	222M €
Number of Employees	1578

3.2 Mission, Vision, Values & Policies

It is essential to know the Mission, Vision, Values and Policies that guide the company and all its employees because they are part of the organisation's purpose.

i. Mission

The purpose of the mission is to explain to its employees and stakeholders the purpose and rationale of the organisation in a transparent way (Johnson, Scholes, & Whittington, 2008). For Luís Simões, its mission is to "Ensure efficient and competitive transport, Logistics and supporting service solutions, promoting the client satisfaction and that of society in general, from the economic, social and environmental point of view."[3]

[3] Extracted from Luís Simões Website - http://www.Luís-simoes.com/uploads/Relatorio08EN.pdf

ii. Vision

A vision is something that organisation aspires to be in the future (Johnson et al., 2008). LS has the following vision: "To be the Iberian company of reference in terms of quality of service for Transport and Logistics sector."

iii. Values

The values are the "principles" that guide the organisation's strategy (Johnson, Scholes, & Whittington, 2008). The organisational values of Luís Simões presented below, are in line with the Mission and Vision, thus serving a guide for all its collaborators-

- **Client Orientation**: To exceed client expectations by providing value-added services supported by flexible, innovative and technologically advanced solutions;
- **Respect for people**: To guarantee the continued qualification of all employees, developing their skills for different and challenging performances of their activity, with quality and security;
- **Sustainability**: To support the organisation's sustained development through transparent and socially and ethically responsible conduct;
- **Trust**: To instil group and employee performance with respect towards colleagues, clients, and suppliers, believing in each other's working skills and the advocacy of LS values;
- **Loyalty**: To base day-to-day practice upon the professionalism, operational rigour and transparent relationships, placing LS interests above personal interests, in order to protect institutional credibility and positive image;
- **Innovation**: To focus management on structured processes, supported by modern technological systems, contributing to the development of competitive advantages in relation to the market;
- **Environment**: To implement sound environmental practices, reducing the adverse effects resulting from our activity and protecting the surrounding environment;
- **Concern for safety**: To guarantee the best working conditions through preventive measures, in order to eliminate risks inherent to the activity and preserve the employees' well-being.

iv. Policies

The Luís Simões organisation makes some commitments based on its values (table 2)-

Table 2 - Policies of LS Group

<table>
<tr><td colspan="2">Comply with appropriate statutory and regulatory requirements, as well as other subscribed requirements whether the environment, food safety, other plans of their responsibility to society.
Promote awareness among company's employees in the implementation of LS policies actively involving them in this process and ensuring the dissemination of its primary results to all the agents involved.
To develop the competence and motivation of employees concerning the business goals, concerning quality, safety, hygiene, and health at work, environment, and food safety.</td></tr>
<tr><td>Quality and Food Safety</td><td>Provide relevant resources to increase business quality and continuous improvement;
Privilege the efficiency gains and the efficiency of processes, as a competitive advantage of the companies and added value to the customers, with view of loyalty;
Ensure compliance with customer requirements by assessing their satisfaction and managing their expectations;
Preserve the quality and safety of food products, in the operations and services provided, ensuring communication with all parties involved in the food chain: suppliers, employees, customers and competent authorities.</td></tr>
<tr><td>Environment</td><td>Define and implement measures to minimise the environmental impacts resulting from the activity in line with the objectives and</td></tr>
</table>

	targets defined and revised on a regular basis taking into account the most significant environmental aspects, measuring and evaluating the results obtained to ensure their effectiveness continuously; • Continuously improve the environmental performance of the company to prevent pollution, reduce waste, atmospheric emissions, and energy consumption, using natural resources rationally.
Health and Safety at Work	• Provide the necessary resources to prevent occupational hazards, improve safety conditions in the performance of the activities and to monitor the health of the employees, to develop their skills and to raise awareness on occupational safety and health.
Social Responsibility	• Promote a transparent relationship with stakeholders and society in general, whether through the commitments expressed above or through the development of targeted actions, to promote personal, professional, family valuation, information, raising awareness and of solidarity directed towards external entities.

Source: http://www.luis-simoes.com/uploads/Relatorio08EN.pdf

3.3 PEST Analysis

i. Political/Legal[4]

In Portugal, the evolution of the legislative framework for road transportation activity took place in the following stages:

a) In the first half of the 1980s, total liberalisation of transport within a 50-km radius granted the fleet to work for others, and also to operate in the long haul led to the concentration of transport operators in this type of traffic;
b) In the second half of the 1980s, there was no increase in the range of distribution (i.e.,> 50km), which meant that the transport in private fleets was carried without restrictions. Even though being the case of lower returns, these legislative developments led to the decrease in the rate of global fleet usage;

In 1986, Portugal joined the European Economic Community (EEC).

c) During the 1990s, national and international licenses were granted based on the experience and/or size of the fleet. While the national market was accessible to the majority of transporters, who were asked for more than three years of experience in the local market and the possession of a minimum Social Capital equivalent to the value of two lightweight trucks. While access to the international market to the companies with more than three years of experience at national level and a fleet of summation of the gross vehicle weight with more than 22 tons totalled and less than 220 tons;

This internationalisation took place in 1995 with the Schengen agreement which ends control of Europe's internal borders.

d) In 1999, private transport and carriage were not subject to any legislation. For transport on behalf of others in heavy vehicles, the legal framework was embodied in Dec. Law no. 38/99, with national and international licenses being granted by compliance with three requirements, designated by conditions of access to the profession: Suitability, Professional Capacity, and Financial Capacity. Upon verification of these conditions, the licenses were granted to access the market

[4] The Information for Political/Legal analysis was adapted from Associação Nacional de Transportes Públicos Rodoviários de Mercadorias (ANTRAM) documents

through vehicles that were identified correctly and licensed for the public transport, after registration with the competent authority Directorate-General for Land Transport (DGTT)[5].

Currently, market access is regulated by Decree-Law no. 257/2007 of 16th July, which established the legal framework governing the issuance of licenses and access to freight road transportation on a contractual and initial fee basis and is regulated by the Institute of Mobility and Land Transport, (IMT). The digital tachograph became compulsory on vehicles weighing more than 3500 kg and with registration after May 1, 2006, is a fundamental tool in the control of driver schedules.

Specific labour laws for professional drivers are increasingly demanding (EC Regulation 561/2006) and its increasingly heavy penalties (Law no. 27/2010).

This situation among the highly competitive market and the fuel prices in recent years (e.g., since 2005, the fuel price was increased by 50%, and it peaked in 2015, 1.52€ and also in 2016 by 1.50€) led to cause of obstruction in this sector. Also, the maximum paralysis caused by the financial crisis of 2008 and during the rise of fuel prices in 2011.

ANTRAM[6], the National Association of Road Transport is the most significant employer association in this sector. The association has successively called for a reduction of petroleum products, something that the government has not yet conceded.

With regard to incentives, there are several programs that the sector can take advantage of, such as SIMIAT, PRIME, SIME, and SIPIE.

ii. Economical[7]

Europe

Eurozone Gross Domestic Product (GDP) will have grown by 1.7% year-on-year in the first quarter of the year, Eurostat said on 3 May in its first estimate of the economic performance at the start of 2017. The figure was in line with expectations and reinforces the continuation scenario of the Eurozone's slow recovery this year.

[5] Information extracted from - Direcção-Geral de Transportes Terrestres (DGTT)
[6] ANTRAM - http://www.antram.pt/
[7] All data for economic analysis were adapted from Banco de Portugal- https://www.bportugal.pt/

The EU as a whole will have grown by 1.9%. If these figures are confirmed, Portugal should have grown more than the average of the monetary union. INE released the first estimate on 15 May.

"Compared to the same quarter last year, seasonally adjusted GDP grew by 1.7% in the Eurozone and by 1.9% in the EU to 28 in the first quarter of 2017, after 1.8% and 1.9% in the quarter ", the Eurostat (2017) statement said.

"Seasonally adjusted GDP increased by 0.5% in the Eurozone and by 0.4% in the EU-28 during the first quarter of 2017 when compared to the previous quarter, according to the rapid estimate published by Eurostat, the statistics office of the EU ", reads the press release.

The figures are in line with forecasts of a slow recovery in the Eurozone. The European Central Bank (ECB), which updated forecasts in March, expects Eurozone GDP growth of 1.8% this year and 1.7% in 2018, after 1.7% in 2016. The European Commission, which will update forecasts this year (December 2017), pointed in February to a growth of 1.6% this year.

Portugal

In the Stability Program, presented at the end of April, the Government revised the economic growth forecast upwards for 2017 from 1.5% to 1.8%, aligning its estimate with that of the Bank of Portugal. In February, however, the European Commission, pointed to 1.6%.

iii. Socio-Cultural[8]

At the socio-cultural level, in order to demographically characterise the country, the Portuguese population at the end of 2011 totalled 10,561,614 people, of which 48% are male and 52% female.

Region wise, the Alentejo has misplaced populace in the remaining of last decade (-2.5%), and the Central region also confirms a slight reduction of population (-1%). The Algarve and the Autonomous Region of Madeira have very significant increases in population, compared to 2001, respectively + 14.1% and + 9.3%. In the North, the

[8] Data from the socio-cultural analysis were taken from Instituto Nacional de Estatística (INE) documents

population steadied, and Autonomous Region of the Azores shows a small upsurge of 2%.

The country strengthened the pattern of growth and development of the previous decade and further expanded the concentration of the populace in the large urban zones of Lisbon and Porto. The most of the municipalities of the interior lost population. In 2011, 198 municipalities registered decreases in population compared to 171 municipalities in 2001 (INE, 2011).

When analysing the behaviours and lifestyles of the national population, taking into account which may influence the road transport sector, it is national road haulage that is well above the average European Union, as well as the development of the consumer society it uses with commercial areas to meet their needs.

There are high rates of accidents mainly due to the low level of safety measures adopted by national drivers who do not practice defensive driving. On the other hand, the alcohol consumption in Portuguese society, many drivers exceed the statutory value (0.5 g / l) when driving. It is, therefore, necessary to implement a set of measures into the dangers of their actions, as well as more stringent legal and enforcement measures.

iv. Technological

In a business world where R&D is increasingly decisive and consequently technologically innovative for cost reduction and productivity of road haulage is no exception. With regard to technological innovation, it is relevant to mention four critical vectors of development: security, communication, logistics, and Environment. Of these four vectors, we highlight transport vehicles - where the significant advances are seeking to investigate and develop economic resistance with respect to complying the strict anti-noise and low pollution standards imposed by the European Union.

Security

Being considered the most important vector for road transport companies, since it is ultimately about the integrity and well-being of its members. Employees, notably drivers, necessary measures have been taken in order to ensure the standardised manufacture of vehicles on the road and to ensure the safety of crew as well as the safety of third-party drivers. Thus, it is exemplified that the installation of automatic control devices and onboard devices such as the black box (allowing, as in other transport, in case of accident

establish the reasons and causes of a road accident, facilitating the investigation process and seeking to avoid similar future situations).

Two other examples are- the approval by the European Commission in 2001, and other being the imposition of the installation of speed limiters in all vehicles of more than 3.5 tons or having more than nine seats. However, the introduction of an electronic driving license which exchanges information enables the authorities for identifying the offenders more quickly.

Regarding innovation, an agreement is being programmed to design to ensure the presence of active safety system installed in all vehicles. These safety systems may include- vehicle distance control, vehicle collisions avoidance, the physical state of drivers, progress related to the type of composition of tires, less water projection, factors determining the adhesion of tires to the ground, and alerts for pressure loss in tires.

Communication

Advances in communications are equally important in this sector, not only in enabling remote monitoring of the fleet and their recovery in case of theft but also in the control of consumption and distances. One example is the installation of GPS systems in the vehicles, thus strategic analysis of a Transportation Company with better management of routes and vehicle traffic, also trying to avoid potential congestion, minimising the danger of accidents, and allowing the reduction of fuel consumption. Another case is the use of GSM mobile phones, the features offered by this type of portable device are- permanent contact between the base/seat and the vehicles and avoidance of unnecessary routes. Wherein this portable device permits better assistance and control of the service provided as well as minimising the potential delays in deliveries.

Logistics

Associated with transportation, is the logistics through which the goods pass, from the place of manufacturing, through loading, transport, unloading, and to the point of sale. The Internet and other means of support are increasingly being used, with the aim of integrating the communication systems between the companies responsible for transport/logistics and the final customer, thereby being an existence of a permanent monitoring and control of stocks, eliminating the surpluses of warehouses of distribution companies.

It becomes more frequent in transport sector that to overcome the competition in an attempt to the inclusion of services provided in the logistics component for a vertical integration of a supply chain process, elimination of one of the intermediaries of the

freight transport becomes necessary. This elimination might facilitate an integration of transport and distribution of goods functioning as a competitive advantage.

It should also be noted that there are currently robotic solutions at the logistics level, allowing the transport of goods, for example from the interior of the semi-trailers to the warehouse, and the optimum allocation method for reducing the space utilised.

3.4 SWOT Analysis

Times are uncertain for business around the world. If a reflection has ever been necessary, then there are several factors that that has become essential to any business. The increase in the customers and their lack of loyalty, as well as the climate of economic deceleration, are just a few examples. Close attention to the analysis of an organisation in its environment is mandatory.

The SWOT analysis was developed by two professors from Harvard Business School. The term SWOT results from the combination of initials of the Anglo-Saxon words- Strengths, Weaknesses, Opportunities and Threats (Christensen & Andrews, 1982).

Thus, the SWOT analysis corresponds to the identification by an organisation and the main features of its strategic position in a specific time, both internally and externally (how it is related to its surroundings), the synthesis of the external and internal position analysis.

Therefore, we point out the SWOT[9] analysis of Luís Simões group below-

Strength

- Communication and reputation in the Iberian market;
- Training and talent retaining;
- Investment in transportation with fewer greenhouse gas emissions;
- Innovation and internationalisation;
- Client satisfaction;
- Financial health;
- Road Safety;
- Environmental management.

[9] The SWOT analysis of the Luís Simões Group was extracted from the website- http://www.Luís-simoes.com/uploads/Relatorio08EN.pdf

Weakness

- Environmental impacts of the activity – fossil fuels consumption;
- Community impacts – noise, traffic, and parking on the roads;
- Labour stress (driving profession);
- Access to the facilities by public transport;
- Internal communication;
- Variations in driver conduct – LS fleet versus third parties' fleets;
- Lack of strategic communication with the clients in Spain.

Opportunities

- Development of Information and Communication Technologies for the business support;
- Extension of the Quality Management System (QMS) to the occupational safety and environment fields;
- Intermodal, break-bulk cargo and the urban delivery;
- Environmental performance and effectiveness as a way of making a difference in a society with a growing environmental awareness;
- Development of technologies for renewable energies;
- Implementation of driver support systems;
- Standardisation of arrangements in Spain;
- Strengthening of relationships with the universities.

Threats

- Supply surplus on the market;
- Current crisis;
- Financial liquidity of outsourced transport companies;
- Fuel price fluctuation;
- Low availability of qualified labour in the market (mechanical engineering technicians and drivers);
- Inflexible labour laws;
- Peripheral position (Iberian Peninsula) regarding the legislation concerning driving times;
- Pressure from legislation and society.

3.5 Organisational Operations

The Centre for Logistics and Transportation in the national region fulfils various operations which are briefly explained below-

The main activities of Luís Simões are the freight transportation, the logistics, warehousing, and the maintenance and commercialisation of vehicles. The case study concerns only the transport sector, whose objective is substantially the transport of goods by road. It is made up of three companies operating in Portugal and Spain (Luís Simões Logística Integrada SA, Transportes Reunidos Lda., and Transportes Luís Simões SA). Moreover, it is responsible for managing about 900 daily trips. For some years now, these have been leading the flow of goods by road transport in the Iberian Peninsula, and despite an extensive group of 1471 customers, 7.2% of these accounts for 80% of sales (Luís Simoes, 2017).

The organisational structure of the company in the Iberian Transportation sector is presented in Figure 2, in order to represent the organisation that supports the 'Operations' department where fleet and cargo planning is done.

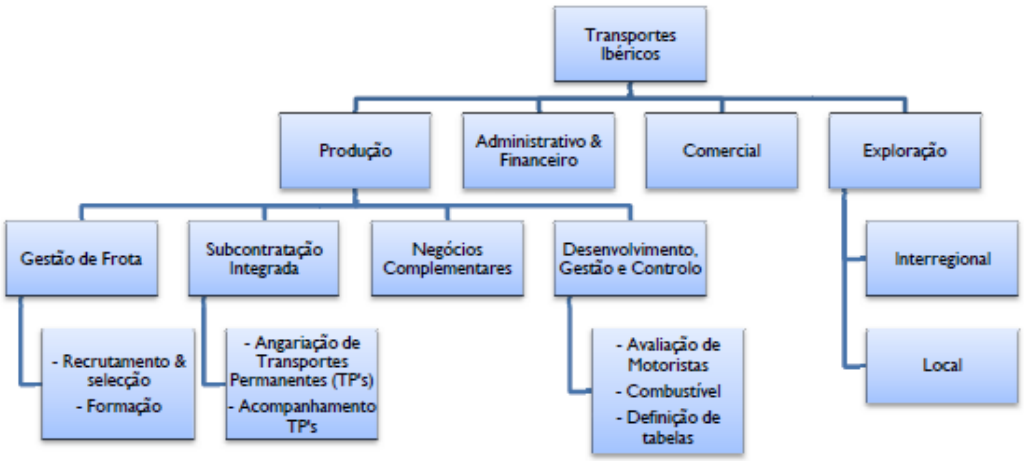


Figure 2 - Organisational Structure of Iberian Transportation of Luís Simões

There are three types of transport: Own Fleet (FP), Transport Partners (TP) and External Transport Partners (TE). These have to respond to the existing demands and try to compensate the imbalance of flows. The distributions within the types of transport and services are roughly represented in Figure 3 below-

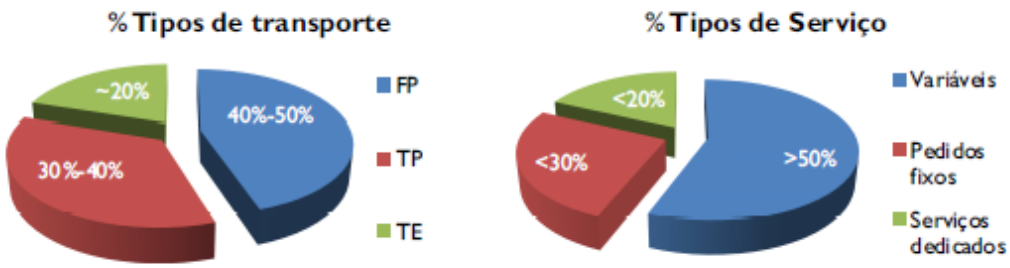


Figure 3 - Transport types in Luís Simões

The own fleet, which was once the most significant component of the company's transport, has been reducing in favour of balance with permissible transport. These are seen as advantageous and economical because of the minor concerns implicit in their process. There is a contract that guarantees them a minimum level of service and a similar treatment by the 'Operations' department. On the other hand, occasional transport will help resume services, whenever necessary, in order to compensate for possible imbalances.

The type of service is mainly the transport of full loads over Iberian Peninsula; thus, it can be said that the imbalance of flows becomes one of the most challenging difficulties. In order to facilitate the management of resources in this sector, planning is divided between the Local, Regional, National and Iberian Peninsula service with direct flows to the other centres (routes between distribution centres), as shown in Figure 4.

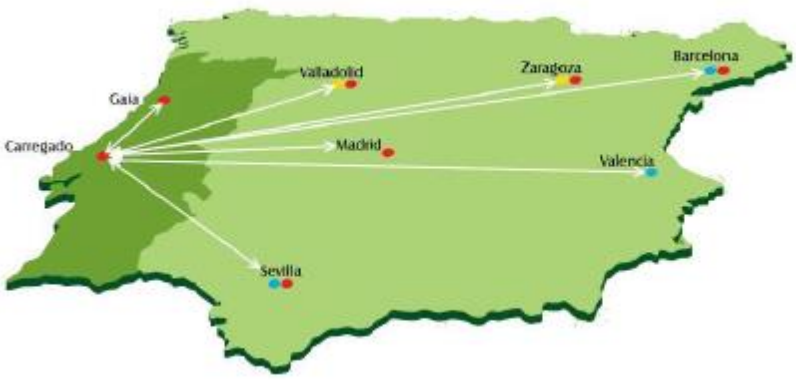


Figure 4 - Exemplification of the plant and other centres

In all, there are twenty-six operational centres; eight are situated in Portugal and eighteen are situated in Spain. The largest national service centre is situated in Carregado, as mentioned above, and it is distinguished by its volatility, given the need for rapid response. This characteristic also motivates a greater need for permanent contact with the commercial department to enable immediate solutions. The latter is the one who

introduces the orders, with the inherent constraints, into the system, so that they are available in the ERP to process at the planning level.

Planning Model in Luís Simões

The main responsibility of an assistant working in 'Operations' department is to allocate the right trucks/drivers for services, taking into account the hourly restrictions, schedule of the deliveries, and client demands in order to minimise the empty running of the vehicles and to balance the driving schedule of the driver. Despite this, the separation between the centre of transportation and the national service, during the planning phase, there is a communication between those responsible for combining possible compensations. The process in question may be described in a way abbreviated, Figure 5.

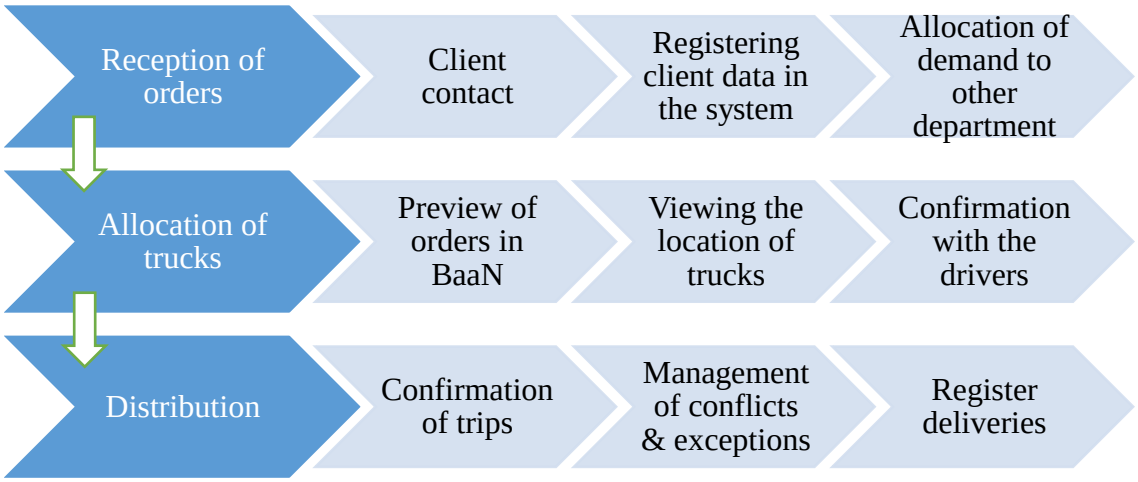


Figure 5 - General Functions of Planning Process

The assistants from the 'Operations' department who support the performance of a planning of fleets should mainly meet the three most significant constraints: driving times, location and loading/unloading times.

Within the first limitation, it is necessary to consider the driving schedule of a driver in the performance of both the service in question and the possible achievements. At present, it is possible to access a chart of the register, made by the driver in his on-board computer,

and elaborated by the on-board computer system (XTraN), and to make the planning trying to reconcile the availabilities of the drivers.

Then, for the location problem, it is necessary to consider the zone of the last stop of the truck and the location of loading and unloading. These factors are essential to enable overall minimisation of the number of empty kilometres, but they have implications for the remaining restrictions.

Finally, the loading and unloading times, despite being devalued, are known by the experience acquired by those responsible and are also of high relevance in the process. The reason is that they are accounted for the driver's working time and the schedule. The truck loading process is almost non-limiting since they are full load services where the customer is responsible for this execution.

The planning scale then results from manual assignment by the assistants, based on information supported in the ERP system. Route Planning is performed by an application whenever there is a new point in the system. The set of shorter paths is defined between the possible points, so that in the insertion of a new order- the size, cost and specific route of the connection are already established.

4 CORE CONCEPTS & FACILITY TOOLS

This chapter contextualises the functionalities and concepts in the scope of internship objectives related to transportation management system (TMS). Furthermore, the facility tools are described to get acquainted with the objectives.

4.1 Functionalities of TMS

The transportation operations are quite often complex dynamic processes. Typically, large freight carriers must manage multiple fleets of heterogeneous resources to serve client demands. However, even relatively small transportation service providers face challenges managing the resources. The focus of this internship is identifying the operational planning problems in the transportation industry. The fleet management problems might take varieties of form, and the term "fleet" might represent several types of companies' resources. For example, truckload companies manage the fleet of vehicles, and trailers to serve point-to-point full truckload (FTL), point-to-point less than truckload (LTL) demand for customers. However, less than truckload (LTL) may face additional complexity since at times goods which are required to transfer between different locations based on client requirements are served through cross-docking methods. Cross-docking operations require planning tool to ensure the delivery at the right time to the clients. The alliance carriers and the associated carriers, such as the express parcel services, and less-than-truckload (LTL) trucking companies usually manage multiple fleets for different transportation roles. For example, an LTL company will use a fleet of vehicles and drivers for long-haul services between terminals, as well as for local pickups and delivery services from terminals.

Transportation management processes are determined by a transportation demand, which in turn is deducted from goods demand (R. Hall, 2012). The demand for final products with its regional and sequential distribution is exogenously defined as for the multitude of transportation planning processes (Chopra & Meindl, 2015). The shortening of the planning horizon will usually increase the number of exogenously defined planning parameters. As for transportation control processes, decision freedom is usually minimal, and these processes are subject to effective communication and exceptional handling. From the viewpoint of a clients' goods manufacturer, the involvement in transportation execution is minor and unusually restrained to loading and unloading operations.

The operational planning in the transportation industry mainly focuses on the short-term decisions based on the freight orders. A plan is no longer performed based on constant material flows but on shipping orders that quantify source, destination, quantity, and date of a transportation task. The availability of this information defines the planning horizon, which ranges typically from a few hours to a couple of days. Operational transportation planning focuses on lean operation decisions determining the mode and the carrier choice (Stank & Goldsby, 2000). The execution of shipment schedules and their modification are also part of the operational transportation planning process (Crainic, 2000).

As for the described case study, the transport planning task will have to be characterised as operational. It is possibly one of the major misunderstandings in operational transportation planning that vehicle scheduling should only be accomplished if the vehicles are solely used for the supply chain under consideration (Fleischmann, 2010). This usually is the case if the transportation services are carried out by own fleet. However, the LSPs can use a vehicle for multiple clients outside the considered supply chain, and this might be a significant contribution to the performance of the transport process, scheduling objectives from the shipper side and also increase the overall efficiency of the supply chain.

The most critical decisions in the operational planning of transportation include- the vehicle repositioning, scheduling of vehicles, crew assignment, allocation of resources. These issues are similar in comparison with those at the tactical level. Moreover, the tactical planning is concerned with "where" and "how" issues (mainly the selection of LSPs, the route determination), the operational planning is more concerned with "when" issues (particularly when to start a service, when the vehicle arrives at port or distribution centre or intermediary terminals) (Crainic & Laporte, 1997).

The problem of planning the carrier from source to destination is a complex task. The transport planning aims to build plans for the trucks, such that all client needs are met on time. In Portugal, several companies plan their log shipping by various means; some let the drivers decide their schedules, while others try to propose the whole schedule at an extraordinary level in the organisation. The most popular means is traditional manual planning prepared by experienced transport managers. Manual preparation is however very exhaustive and unproductive, and transport managers usually work under pressure.

The practice of computer-aided systems to aid planning problems in international locations such as Finland and Chile have demonstrated numerous benefits (Weintraub, Epstein, Morales, Seron, & Traverso, 1996). These involve shorter trips, fewer carbon emissions, a high percentage of fulfilled consumers, and better-operating environments for the motorists. Besides that, a computer-aided planning system provides the higher capability for dealing with the data and helps to visualise the problem, and therefore it helps the managers to a better understanding of the problem. However, new possibilities are feasible by the newly built Transportation Management Systems (TMS) which includes information about client demands, available time-frame, transportation providers, and enhanced reporting of delivery means. This is however the case in Luís Simões nowadays, and efforts are made to improve the TMS system in the company environment.

There are two methods for dealing with everyday planning, particularly dispatching and scheduling. Dispatching is the generation of a plan in real time, while scheduling deals with the planning problem sometime in advance, for example, one day ahead or week ahead. In the case company, the dispatching involved planning a vehicle for loading at least a day beforehand (sometimes a week ahead).

Basics of TMS-

The TMS process can be described as a six-step process, as follows:

1. Based on the material movement triggered in ERP system, a transportation order is generated. It includes the material movement origin, destination location, the planned dispatching and receiving time are consolidated. In addition to this, a specification can be added to the material (e.g., hazardous material, temperature restrictions, etc.). While the transport order coming from the ERP system, a great deal of information is discarded as the transport order may contain (in many cases) some goods information which will only be considered if they are relevant to the business process (McLaughlin et al., 2003). Therefore, the TMS need not require all the details in most cases.
2. Mode and carrier selection is performed once the order is entered in TMS. Modes and carrier selection are based on costs, delivery timeframe, service (transit time) and other criterion specified in the order (lead time, equipment details).

3. The information which is entered in the system creates a load building process for a defined lead time- once the carrier provider receives the order and with timeframe mentioned above, the carrier provider has to release the confirm or reject orders.
4. This step includes a physical execution of the order. This step may also include process deviations due to production delays, product damage, and waiting times. This information can be used to add the surcharges or discounts at the dispatching or receiving ends. Moreover, these reasons may provide necessary information for the cause analysis of the transport order irregularities (Thonemann et al., 2013).
5. When the actual transportation is concluded, the billing process generates the freight rates, discounts, rebates (based on reasons) as well as further company terms and conditions (based on terms of payment or modes of payment). The TMS application incorporates several billing processes. However, the standard ranges from freight bill auditing (carrier invoice) to self-billing. The former is time-consuming and error-prone if conducted manually (Sheffi, 1990), TMS implementation can increase not only process efficiency but also error-free invoices.
6. The final step includes the freight invoices through payment. This step involves the second major break because the settlement of payments usually takes place within the company-wide system (Helo & Szekely, 2005). Therefore, all the payment information is transferred from TMS.

Key Functions of TMS-

1. **Order Management & Tracking**-

   The vital function of TMS in Order Management & tracking are order input, order specification, and carrier selection (House & Jackson, 1995). Order input and generation takes place in an interface of ERP system. Order specifications are based on products (e.g., chilled products, hazardous materials, client location that can be served only with small trucks) and may contain information regarding transportation equipment and delivery timeframes. Order management includes transportation planning, freight rates, carrier communications, loading, and unloading times (Stank & Goldsby, 2000). Since status tracking requires a wide range of frequently updated information, interfaces to IT surroundings are of vital importance for consistent and valid status reports (Helo & Szekely, 2005). Order

management also refers to shipping documentation and may be forwarded towards carrier provider for handling units.

2. **Freight Rate Management, Cost Management & Billing-**

   The freight rates are usually different for different carrier providers or LSPs depending upon the contract structures. This function enables to perform for long-term and short-term carriers or LSP contracts. Short-term contracts or spot sourcing focuses on the limited time frame for transportation planning and is different from the long-term contracts and considered to be a core functionality (Stank & Goldsby, 2000). So, this interface allows the case company to manage the carrier for load in a short timeframe. The extended functionality of TMS allows non-assets based LSPs to bill their clients with the opportunity of splitting costs between different clients and carrier providers.

3. **Performance Measurement-**

   The TMS function primarily clusters around transportation controlling and focuses on costs and budget alignment. TMS provides an opportunity for assessing service provider and location-based performance measurement. This may include carrier performance focusing on On-Time performance, damage evaluations. Also, the network controlling may provide vital information on KPI such as carbon footprint.

   TMS solutions in many cases are enriched with unique add-ons such as, for instance, strategic network planning capabilities, or packaging monitors organising the inventory management and distribution of empty containers. Still, TMS can be recognised as a transaction-based tool for order management that lacks features for transportation planning.

Extended Functionality of TMS-

The key functions of TMS focus on the order management throughout their lifespan, however, some TMS add-ons feature extended functionality in the organisation. The form and degree of these add-ons vary from their vendors. In many cases, useful extensions are software products supplied as an add-on by vendors other than the TMS vendors.

Geo-Information Services (GIS)-

A prevalent form of an extension for TMS implementation is Geo-Information Services (GIS). These are built around geographical representation and can be further dissected into three sub-parts:

- **Geo-Encoding Services**: Based on the geo-data such as country, city, zip code, and street name, the coordinates are determined. Geo-coordinates are the primary source to display the correct location on the map and extend common location master data (House & Jackson, 1995).
- **Vehicle Routing Services**: Geographical information of locations can determine transportation routes between two cities. This feature provides different routing parameters such as transit time, distances, avoidance of toll sections, and so on. Distance information is particularly relevant as transportation costs are the distance-dependent component. This particular feature provides different route parameters such as distance, travel time, and avoidance of toll. The distance parameter is hugely significant for this feature as the cost of any transportation is a distance-dependent component. The routing information provides driving instruction for delivery execution.
- **Mapping Services**: This feature allows the presentation of locations, transport information, and relevant routes on maps. This further enables to provide decision-making for carrier and route selection.

Planning & Controlling Function-

The current focus of TMS is on transport order management and LSP management. However, they lack transportation planning approach. Although, such functionality can be enabled by software add-ons supplied by other vendors. The functionality may include-

- **Advanced Transportation Controlling**: The essential functionalities may include the extensive standardised controlling features and reporting tools. These may be the same ones as in ERP system and are following the company's reporting standard. This functionality is beneficial for measuring transportation performance and also serves as an indicator for network design.
- **Network Design**: Based on the available information, network design measures may be investigated and implemented. The client or Distribution Centre (DC) may be assigned, for instance, due to the capacity shortage in DC, a client can be

assigned. In contrary, some clients may be reassigned to other DCs. The parameters can be changed or adjusted in TMS (also in ERP, if required).

- **Tactical Transportation Planning**: In case of continuous material flow with little uncertainty, tactical transportation planning add-on can be implemented for measures like transportation mode, routes, or a number of trips required. Since planning, tasks are very specific in nature, and their implementation is usually not subjected to substantial standardisation but individual system adaptation. As for non-continuous material flow, these features lack applicability.
- **Transportation Tendering**: Tendering add-ons are subjected to support large transportation tenders (e.g., annual tenders).

Track & Trace Function-

In the transportation industry, status tracking data plays an invaluable role for all the involved parties in the shipments. The timely knowledge of the potential delays may allow the low-level managers to early countermeasure, such as for instance, production. Furthermore, the detailed status report helps to monitor the On-time performance of carrier or service providers (LSPs). Moreover, such data can be valuable information to avoid penalty charges or in the calculation of penalty charges. In TMS implementations, status tracking can be divided into two parts-

- **Integration of Service Provider Service Tracking**: Many shipping companies offer shipping status information via their website. The information is obtained from identification process that takes place where the shipment or load is handled. This information may not be accessible at shipping company's website, but it may be accessible from the proprietary interfaces and for that reason can be made available without delay into the TMS application. This information may further add value by providing details about vehicle speed and vehicle location. This data can be obtained using telematics' information systems.
- **Implementation of Independent Tracking Technology**: The shipper can further tag a Geo-RFID system into the shipment to be independent of flawed carrier information. If a transmitter is added is added to the shipment, it will display its location using mobile-communication networks at pre-defined intervals. By providing these details, the TMS applications increases shipment visibility independent of the assigned carrier.

4.2 Information Systems in the Case Company

The Luís Simões currently employs the ERP system in the organisation to facilitate the order management system to take into account the client requirements and subsequent deliveries. Also, due to the high competition in the market and the need to integrate the whole supply chain, ERP system bridges the gap between the manufacturers and the final customers and delivers final consumer satisfaction.

Supply Chain Management (SCM) requires continuous and mutual interaction between all the players; therefore, there is a requirement for dependency on the information and communication systems to connect geographically dispersed and often located all over the world actors in the supply chain. It means the evolution of the SCM concept requires the development of the productive supply chain information system solutions.

The global nature of the modern market demands active players to internationalise their operations. In the past, the companies were competing based on the few relative objectives such as- price and quality. However, currently, the market demands both price and quality in addition to flexibility, reliability, and transparency in the whole supply chain. Thus, all enterprises compete based on these objectives. In order to perform on such simultaneous objectives, the organisations worldwide have outsourced activities by decentralising the operations. This puts enormous challenges to the organisations to coordinate and integrate the whole supply chain. The emergence of technologies such as- Electronic Data Interchange (EDI), ERP systems and world-wide-web have facilitated the need for integrated supply chain management to become responsive and agile in the operational activities of the organisation. Also, in particular, the Material Resource Planning (MRP), as well as Enterprise Resource Planning (ERP), have gained importance in the organisations to facilitate the necessary support for agile and integrated supply chain management.

The logistics and transportation industries started implementing ERP systems in the 1990s to have uniformity in the information systems in their organisations and enhance their business process activities. The ERP system comes as a packaged software solution which has many advantages of cost reduction, rapid implementation, and higher quality in the business operations. These ERP systems have wide-ranging benefits over the custom-designed software, but the packaged software have the tendencies of problems arising from the uncertainties in the acquisition and the hidden costs involved in the implementation of the whole package. The ERP system implementation requires a

specific initiative rather than a just a mundane installation effort. Some efforts must be taken to project a clear objective for installation of such systems in the organisation. With the ERP systems in the organisations, the management requires changing the organisations' socio-economic system, which is resistance to such software installation. So, the efforts required for installation and also the resistance to change in the industrial environment plays a critical success factor in the more extended run.

There are numerous ERP systems accessible in the market, and the main features are given below-

- The automation of the enterprise operations and activities;
- Easy and timely access to the management information;
- Effectiveness and efficiency in the supply chain by the usage of e-communications and e-commerce.

In the case company "Luís Simões," the current ERP system employed is developed by the Dutch company "BaaN" and acquired by Infor Global Solutions. Although there are many vendors for ERP system in the market, there were five major ERP vendors and offer ERP solutions to the companies worldwide. The players in this field are: 1. SAP; 2. Oracle; 3. Sage; 4. Infor Global Solutions (BaaN); and 5. Microsoft.

The scope of this chapter is to focus on the ERP system "BaaN" since the case company "Luís Simões" has employed BaaN in their organisational environment. The ERP model is built intuitively by the BaaN[10].

In this, the managerial model can be designed on the map. The user can select a widget to represent the business unit from the library. The further step in the modelling process involves identifying the relations of the business units.

The user can model the relations concerning: a.) Order flow; b.) Cash flow; c.) Material flow; and d.) Information flow.

Moreover, the user can model various types of flow for each view of the business unit model. For each business unit, the user must define some data types such as: *Name and description of the company; Financial company; Transportation and Logistics company; Reference model for the company;* and *Quantitative data such as business volume and the frequencies.*

[10] Extracted from ERP BaaN- www.baansupport.com/docs/erpln/P3496F%20US.pdf

When the enterprise units are entirely determined and characterised, it will be up for assessment which is saved in the repository of the ERP enterprise modeller. The decision made in the enterprise structure model will interpret into consequences for the interfaces within the enterprise units. These consequences may include-

- Parameterisation of processes
- Selection of processes
- Configuration of the involved settings

After the identifying and defining the Enterprise structure model, ERP application architecture is carried out.

Business Control Model

A Business Control Model (BCM) can be defined on a conceptual level, wherein it is determined the order flow, and material flow within an enterprise unit is managed and controlled effectively and efficiently. A BCM characterises a business unit in terms of-

- Processes (routing)
- Customer order decoupling point
- Management and control of manufacturing unit
- Management and control of logistics level (material flows)
- Management and control on accumulated level (objectives and goals defined)

Business Function Model

The business function model is a functional decomposition of the company to the primary levels of the functions. This model covers the implementation parameters that schedules the following-

- Best practices and the business knowledge by the experts or consultants.
- Guide to support the dialogues between the management and the consultants.
- Finally, the process selection and the resulting configuration.

Link to Business functions/process model

Before the actual design process proceeds, the best practices, alternative solutions, and the alternative methods that are available to exploit the ERP software are built-in as the main processes. A client decides on which alternative option is best for the appropriate situation.

The main process is outlined in the functional model as the main function. Also, the alternative methods and solutions are assigned as main functions in the implementation decisions.

The implementation decisions for each process cycle are decided in the functional model.

Business Process Model

The business process model serves the following purposes-

- Classification of business processes to capture the process control cycle.
- To document each process from the starting point for each activity, roles, authorisations, and the instructions to perform the job.

Business Organisation Model

The Business Organisation Model defines the structure of the organisation concerning business units, and departments. A fundamental concept in this is the identification of roles in the company. A role defines which activities/tasks in the process execution are usually assigned to one person or group. Besides, the hierarchical and functional relationships can be described between the departments.

Business Data Model

The graphical data model editor permits the user to edit an Entity Relationship logical data model to create a new conceptual database design or document in an existing one. It contains the following-

- One-to-One relationship
- One-to-many relationship
- Many-to-Many relationship
- And the optional. It usually signifies that the relationship does not always exist.

In relation to the transportation and logistics industry, the following features of the BaaN are explained below-

The ERP BaaN Freight Management uses general master data, such as countries, business partners, addresses, items, departments, distances, and so on. In addition, the necessary transport-specific master data can be set up, such as types of transport, routes, fleet data, and so on.

The core of the package is formed by the functionality for freight order management, load building, and planning, supported by a graphical planning board with drag-and-drop possibilities.

Finally, functionality is available for estimating freight-related costs and revenues, and a link to the ERP Central Invoicing for handling invoices from carriers or to charge transport services to clients is illustrated in Figure 6.

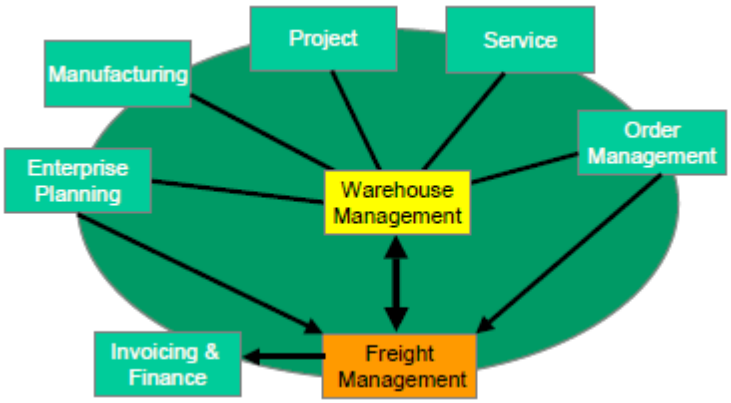


Figure 6 - Freight Management module of ERP

Warehousing

The integration of Freight Management in the ERP enables the user to copy warehouse orders, which can be inbound, outbound, transfer orders, loading data, in order to efficiently handle the movement of the materials involved. The transportation order can go through a load consolidation and planning process, of which the warehouse personnel can recover the results to serve as the instructions to prepare the issue or receipt of goods.

Enterprise Planning

The Enterprise Planning model delivers the freight orders by planned item transfers between warehouses (planned distribution orders). This enables the users to perform a thorough transport planning, even before the warehouses are actually involved.

Purchase Control

If an enterprise is in the business of transporting goods from the firm's suppliers to the warehouses, a link between ERP Order Management (Purchase) is available in the module. This link generates freight orders by purchase orders, which enables the users to perform load consolidation, planning, and shipping items to the appropriate warehouses for the planned deliveries.

Sales Control

This functionality enables a shipper to create freight orders on the basis of sales orders. For generating freight orders straight from sales orders, before the warehouse is involved, allows for a more thorough (and time-consuming) transport planning process.

The following figure illustrates the business process with the configuration of ERP sales control with ERP Freight Management, including a connection to the ERP Warehouse Management module:

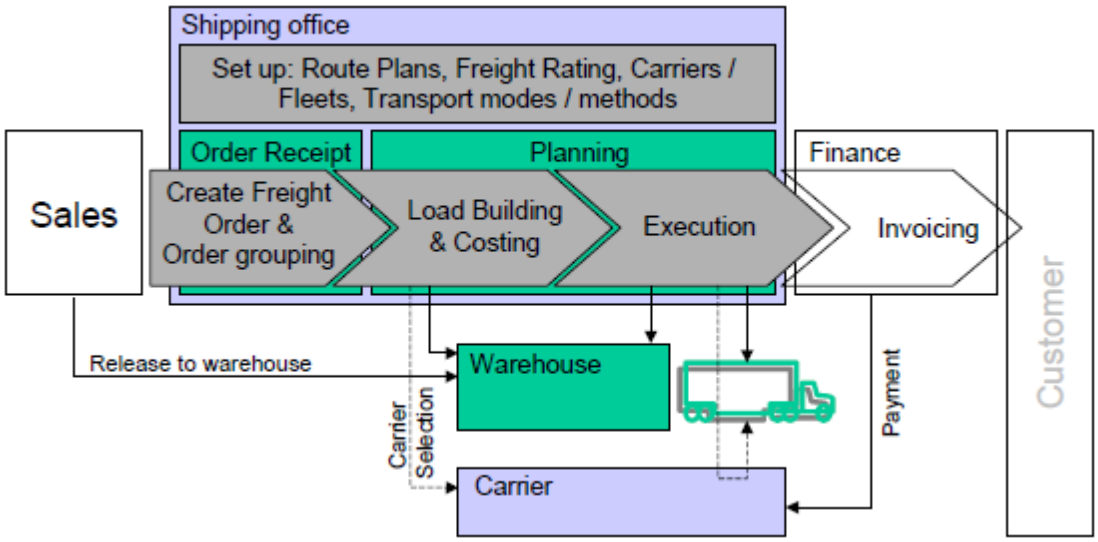


Figure 7 - ERP Sales Control integration with ERP Freight Management

The functions and the features of the module are further illustrated below-

Freight Master Data

Freight Master Data must be defined before Freight Management can be applied. The majority of the basic data is defined in the module, but also some master data from other modules will be included such as-

- ✓ General Freight Master data
- ✓ Addresses and items
- ✓ Transportation master data
- ✓ Freight order master data
- ✓ Load building master data
- ✓ Freight order control
- ✓ Subcontracted Freight order data
- ✓ Freight order history
- ✓ Freight Invoicing control

Load Building

In this module, if a shipper goes further than freight order control, but also wants to be involved in the planning process and perhaps even execution of the transport activities, the load building of the ERP Freight Management must be applied. By running this planning module in the Freight Management, for example for a range of transport orders in a particular period, will result in a transport plan containing loads and shipments. Freight Management loads can best be summed up as truckloads or trips, while a shipment is usually the delivery made at a particular address visited during a trip.

Plans, Load, and Shipments

The procedure starts by generating the transport plan. This generates an application run for each shipping office or planning group combination and also for a period or a range of orders. Working with simulations and alternative transport plans is possible until the user selects a plan to be executed.

Freight or a transport plan consists of loads and shipments. In order to generate these loads and shipments, the system takes into account, the information such as delivery dates, transport types, combination codes, service levels, routes (depending on the algorithm), Incoterms (points of title passage), transport means groups, capacity, and so on.

Price Control

The freight rate scales determine the cost and possible revenues that can be achieved for transport-related activities. The user is not required to have the system calculate freight costs, however, nowadays for most shippers keeping track of the costs of transporting goods is essential and enables an enterprise to stay competitive in market. In Freight Management, costs are based on the carrier freight rates, and revenues are calculated using customer freight rates.

The freight rates are calculated based on following parameters-

- Distances or zones
- Quantities and weights
- Carrier involved.
- Service level
- Items
- Business partners
- Delivery terms

Freight invoicing control

If a transportation company chooses to charge customers or other business partners for which the carrier arranges transportation, the user must set up the required rate scales and release freight orders for invoicing. The latter action enables the ERP Central Invoicing module to handle the invoicing procedure further

The user can easily access freight invoicing data from the freight orders lines to gain insight into the status of the invoice, the amounts, currencies, terms of payment, the invoice address, the open balance, and so on.

The ERP Central Invoicing also handles processing the invoices received from carriers for services rendered.

4.3 Visual Mapping of Routes

The case company "Luís Simões," utilises the Visual mapping of routes for transportation through the Microsoft AutoRoute Mapping Software and also through Google Maps[11]. The Microsoft AutoRoute[12] application allows the users to visualise the routes available for shipments.

One of the benefits of having a mapping software like Microsoft AutoRoute is that the users can customise to the suit the needs for transport planning and visualise the alternate routes in order to optimise the total distance travelled. So, for example, if a transportation and logistics company is planning a week before for fleet planning in the national or international region and also a return trip, then it is possible to create a map for each trip, and it is easy to customise the trip tailored to the requirement of the transport fleets.

The trip planning tools in AutoRoute enables to determine the most optimal routes for vehicle trip and deliveries, calculate the distances between source and destinations, and provide driving instructions for the drivers.

Several key features of AutoRoute include:

- Turn-by-turn directions;
- Routes that can be manually selected by moving the direction to new destinations;

[11] Google Maps - https://www.google.com/maps
[12] Microsoft AutoRoute was discontinued in 2014- https://www.microsoft.com/en-gb/autoroute/home.aspx

- Prioritising travel over highways, allowing for quicker routing over long distances;
- Creating a direction report for the drivers;
- Support for nationwide trip planning to several destinations for efficient deliveries;
- Visualisation of multiple routes in a single map

When a trip involves several stops or waypoints, AutoRoute enables the users to choose the best optimal order in which the vehicle can visit them. Most importantly, AutoRoute lets the user choose what type of route the user requires:

- The shortest route;
- The quickest or fastest route;
- The planned route (when visits or deliveries must be conducted sequentially);
- The route that returns to the source (convenient in fleet management);
- The route that user interactively adapt

Often the best route means that the one is the quickest, while others prefer the path that is smallest in terms of distance or a tour that exploits the use of highways, or avoids inhabited regions:

- A planned transportation might consider to set up an agenda for less driving time and more time with clients.
- If a chemically hazardous transportation is to be carried, then the user may plan the transport using the road where there is less concentration of population.

AutoRoute uses an authentic and up-to-date street database and checks one-way streets, and helps display of these on the map. The users can quickly start scheduling the route by just clicking on a map of all the locations to visit. Also, the user traces stop or waypoints by typing an address and zip codes, or automatically by using locations in an Excel spreadsheet or any other database. If the users have a point layer of the clients, then the user can select the clients that can be visited and then have AutoRoute determine the optimal route to visit them.

There are also additional tools for finding optimal routes in AutoRoute that enables: i.) To create rings (radius) to display driving time or the distance from one or more locations; ii.) To create terrains on streets using travel time to serve the clients.

Also, these optimal routes and the alternative routes can be exported in Office Suite and shared with the transportation companies and clients.

5 INTERNSHIP ACTIVITIES

In this chapter, the internship activities are explained along with their own objectives. The host company, Luís Simões- Logística Integrada, SA, is presented and shortly characterised in terms of the core issues embedded within the internship plan. Some analysis is done in order to understand how the organisation is structured, what measurements are required, which metrics are being used and how the scheduling approach is conducted in the fleet management.

The presentation of this chapter will follow the four primary objectives defined as internship goals. These are organised as follows:

5.1 Logistic Operators – Characterisation of Performance Metrics

One of the defined objectives is related with the characterisation of the operational problem embedded in the Logistic Operator (e.g. Luís Simões, SA) and the involved metrics, in order to capture the practices implemented to support the operational planning activities. In this sense and as a primary key issue, the Key Performance Indicators (KPIs) were identified and classified accordingly with the impact they had in company concerning the capacity to measure and verify the established goals and objectives. Besides that, the monitored values have to be also checked and compared with the defined target performances.

An initial evaluation of the implemented KPIs in Coimbra region was done through a set of semi-structured interviews (see Appendix 2). These interviews were done with the logistics manager of Coimbra Region, Dra. Cristina Falcão, as well as with the employees. The observations indeed clear that the formulated KPIs were more of economic-centric than concentrated towards the holistic approach of the overall organisation.

Those observations were compared with the set of KPIs formulated by LS group to the Coimbra region. Globally, the performance indicators required to the regional administration, a continuous management and a mutual feedback from the employees of the region is necessary in order to be aligned with the company's goals and objectives (Appendix 3 presents the set of KPIs formulated by the LS group at Coimbra region).

In order to accommodate the links that can facilitate LS group to align the company's objectives, a *set of novel KPIs were developed and integrated as a proposal of the current internship.*

Those developments were done based on an exhaustive literature review. A special focus was placed on the contribution of Frazelle (2002), due to the advised integrative perspective. Accordingly, with the author, the KPIs can be classified into four main categories: i.) *Cost*, ii.) *Quality*, iii.) *Responsiveness* and iv.) *Productivity*. Concerning this categorisation, while accounting for an integrative standpoint, the new KPIs were developed. This involves the performance indicator definition, the development and structuring of the formula of calculus with the identification of the necessary measurements and evaluations. Below, these developments are detailed for each KPI category previously considered, as follows:

i.) Cost-Based KPIs -

Freight Cost

Description

A cargo or a freight can be divided based on volume or weight to cover the transportation cost. The basic idea is to divide transportation costs into the maximum volumetric capacity of the truck, or into its maximum weight capacity. Assume the truck has the volume capacity of $\overline{V}$ [m^3] and a weight capacity of $\overline{M}$ [kg]. If the cost of a given transportation assignment is $\overline{K}$, the unit price based on volume and on weight can be calculated:

volume-dependent unit price $P_V = \frac{\overline{K}}{\overline{V}}$	weight-dependent unit price $P_M = \frac{\overline{K}}{\overline{M}}$

Therefore, the cost of freight (PF) per truck based on:

Volume is $PF_V = v\,P_V$	Weight yields: $PF_M = m\,P_M$
Formula of Calculus:	
The volume and the weight are normally combined, and so, the total income or freight cost can be expressed as: $PF = PF_V + PF_M = vP_V + m\,P_M$	

By finding the suitable combinations of volume and weight loads, paying freight can be maximised, and it is what transport companies are striving to gain a situation that freight cost (PF) is higher than the transportation cost ($\overline{K}$) which consequently implies that the transport company would be profitable.

Turn over per Km

Description

This indicator gives a precise detail of the turnover per km that illustrates explicitly a truck that makes a trip from origin to destination to serve client(s). It becomes essential for managers to know if a particular route for the trip is profitable or not and also it gives indications of how much each truck makes per trip.

Formula of Calculus

The Turnover per km can be calculated by determining the operating cost for a given trip and dividing it by a number of kilometres travelled for that trip.

$$Turn\ over\ per\ km = \frac{\sum Turnover\ per\ trip}{No.of\ kilometres\ travelled\ for\ a\ given\ trip}$$

The turnover per trip determines how much revenue a company is generating for the services it provides.

This indicator categorically gives an idea about the price rate to be fixed for each client(s). It may further ensure the stratification of the clients based on the business volume they provide annually.

Profit per Client

Description

This indicator is crucial to determine the profitable client(s) from a pool of clients. It is required to assess the current policies towards those clients which brings profits to the company.

The profit per client can be determined from the total revenue generated and comparing it with total revenue generated without the individual client(s).

Formula of Calculus

$$Profit\ per\ client$$

$$= \boxed{= \sum[Total\ Revenue\ Generated - Total\ Revenue\ Generated\ without\ individual\ Client(s)]}$$

This indicator provides an insight to the managers to provide best services to the clients and prioritise the services to those clients.

Total Warehousing Cost

Description

The total warehousing costs account for all costs associated with the warehousing parameters such as the labour costs, warehouse lease or rent, monthly utility bills, equipment, and material & information handling systems. It also includes costs related to supplies and other material required in warehousing. This indicator is usually measured annually.

This indicator is calculated as the total cost of warehousing per piece/SKU/product/line by dividing the total cost by the quantities of stocked items in cubic meters (m3), per storage area (m^2).

Formula of Calculus

$$Warehouse\ Costs = Sum\ (labor, space, utilities, material, equipment, information\ systems, etc)$$

$$Total\ Warehouse\ Cost = \frac{Warehouse\ Costs}{Quantities\ of\ stocked\ unit\ in\ m^2\ or\ m^3}$$

Using this indicator, the administration can monitor the costs of supplies and equipment in a warehouse, as well as compare costs that with the different facilities. It can help identify the most cost-effective warehouses, and can also lead to an analysis of best practices.

Dividing warehousing costs by units or area can also indicate storage usage, cost-effectiveness, etc. By dividing the warehousing costs per SKU, it determines the excellent details of cost visibility of the warehousing to the management team.

ii.) Quality based KPIs

On-Time Arrivals

Description

This indicator provides the percentage of consignments, deliveries, and shipments arriving on-time for a set delivery date during a defined period.

Formula of Calculus

$$On - Time\ Arrivals = \frac{No.of\ Shipments\ arrived\ at\ agreed\ time\ window}{Total\ No.\ of\ Shipments}$$

Late deliveries can cause stock outs, not only at the receiving facility but throughout the supply chain network. This indicator can also provide insights such as- the condition of vehicles, steep terrain- indicating the need to adjust schedules accordingly or driver performance issues. It can be applied to the facilities, products, routes, or the depots.

Order Compliance

Description

This indicator provides the percentage of orders (POs) that meet the set criteria (e.g., right products received at set amounts, at the right time, in the right packaging; undamaged, shelf life of product intact; quantity transported equals quantity received, etc.) out of all orders fulfilled during a set timeframe.

Formula of Calculus

$$Order\ Compliance = \frac{No.of\ orders\ meeting\ all\ criteria\ defined\ in\ purchase\ order\ or\ contract}{Total\ no.of\ orders\ fulfilled}$$

This indicator is beneficial for the procurement and warehouse staffs to hold their suppliers responsible for not meeting the requirements specification in the POs or contract. Through the monetarisation of this indicator, managers can access the supplier performance and take necessary action required to address the lack of order compliance. The logistics managers can have a decision criterion to choose the most critical measures to evaluate whether the supplier is complying with set standards.

Shipping Accuracy

Description

This indicator measures the percentage of lines or stock-keeping units (SKU) that were distributed error-free from the SKUs or all the lines shipped during a defined period.

Formula of Calculus

$$Shipping\ Accuracy = \frac{No.of\ lines\ or\ SKUs\ shipped\ without\ error}{Total\ number\ of\ lines\ or\ SKUs\ shipped} * 100$$

This indicator measures the accuracy of shipments concerning the products and quantities shipped. This is another measure that procurement staffs and warehouse managers can

use to monitor supplier performance and shipper performance if the shipment is contracted separately.

iii.) Responsiveness based KPIs

The Key Performance Indicators (KPIs) based on responsiveness factors which are explained below-

On-Time Delivery

Description

This indicator estimates and provides the percentage of all orders transported by the requested distribution date, as indicated in the PO or agreement contract during a distinct period.

Formula of Calculus

$$On - Time\ Delivery = \frac{No.of\ orders\ delivered\ by\ requested\ date}{Total\ no.of\ orders\ delivered} * 100$$

This is particularly important for logistics managers to monitor supplier responsive performance over shipments in a defined period.

Supplier Lead Time Variability

Description

This indicator is the average of the absolute percentage differences (APD) between the suppliers' forecasted lead time and the actual lead time for each order placed with the supplier. This indicator is calculated as for any supplier that supplies product to the requesting client(s) facility. It can be measured over any period, but one year is typical and measured in days.

Formula of Calculus

$$APD = \frac{Forecasted\ lead\ time - Actual\ lead\ time}{Actual\ lead\ time} * 100$$

During the quantifying process in the management, it is crucial for evaluation of the expected lead time to find when the next procurement cycle should commence. If the forecasted lead time fluctuates significantly from the actual lead time, client service may be delayed, stock excesses or shortages may occur.

In actual practice, this indicator only measures suppliers' lead time, and it does not measure the total PO or contracted agreement cycle time, which is defined as the time from the quantifying process of the PO commences until the warehouse facility receives the consignments. It includes time on the front-end to put together the PO and time on the back-end to the get the consignment from the port to the warehouse.

iv.) Productivity based KPIs

The performance indicators developed based on productivity factors are presented below:

Container Capacity Utilisation

Description

This indicator provides measures of the percentage of vehicle/container capacity utilised out of the available volumetric capacity (m^3) or weight of vehicle/container.

Formula of Calculus

Container Capacity Utilisation, CCU:

$$CCU = \frac{Total\ kgs\ or\ m^3\ shipped}{Theoretical\ maximum\ capacity\ for\ each\ type\ of\ vehicle} * 100$$

From this indicator, managers can identify the container capacity utilisation for given route, clients, region, or district to ensure the efficient use of vehicles and available resources in general. Therefore, managers can strive to increase capacity utilisation to eliminate waste and improve service level to clients.

Vehicle Availability

Description

This indicator measures the amount of time vehicle was available for use during a defined period because it was out of service.

Formula of Calculus

$$VA = \frac{Total\ no.of\ days\ in\ period - Total\ no.of\ days\ unavailable}{Total\ no.of\ days\ in\ period} * 100$$

The availability of vehicles in the fleet is an indicator of the condition of the overall fleet and reflects how the vehicles are maintained and utilised. The low availability implies that it can impact the delivery performance. However, it is a most significant factor to

note that the maintenance of the vehicle is a critical issue, a target for such indicator can be between 80-95% availability.

Fleet Yield

Description

This indicator estimates the average quantity of products by Kgs delivered per personnel-hour (part-time or full-time) during a defined period.

Formula of Calculus

$$Fleet\ Yield = \frac{Sum\ of\ quantities\ of\ products\ or\ Kgs\ delivered}{Personnel\ hour\ (part-time\ or\ full-time)}$$

In order to improve efficiencies in the use of personnel's and vehicles, this indicator can be measured on a trimester basis.

Average Number of stops per route

Description

This indicator makes available the measure for the average number of stops for delivering shipments per route in a given region or district during a defined period.

Formula of Calculus

$$Avg\ no.of\ stops\ per\ route = \frac{Sum\ of\ no.of\ stops\ for\ all\ routes}{Number\ of\ routes}$$

It is required to ensure the resourcefulness of the fleet and the efficient utilisation of resources; the managers have to monitor the average stops per route in the trips made to serve the clients. Moreover, the managers can optimise the transit time on the given trip to reduce the costs and the time involved in the distribution of products.

5.2 Definition and settings of the operational planning problem

In accordance with the objective of this internship, the operational planning problem in the logistics and transportation, operator should be characterised.

A) Definition of the planning problem:

Giving:

The Planning Horizon (*Timeframe*);

Partners' Geographical Mapping (*Locations Network)* (e.g. logistic operator warehouse, clients' location, etc.)

Logistic/ Transportation *(Process Operational Structure):*

> ***Resources:*** *Equipment, facilities and tools; human operators (e.g. drivers, pickers, etc.)*
>
> - Owner and/or Contract (e.g. 3PL)
> - Capacities, types, number and other pre-conditions;
> - Operational policies (e.g. truck return to the warehouse or stay as is).

Clients *(Markets) - general characterisation in terms of:*

- Order *regularity* (e.g. how frequently orders are placed to the Logistic Operator)
- Orders *amounts'* (e.g. number of pallets, boxes, etc.)
- Order *due date*, if any;
- *Economic evaluation* of clients (e.g. yearly returned value);
- *Prioritisation* of clients, if any.

Determine in a coherent time frame

- The operational details for orders' fulfilment (e.g. capacities, number of items, timetables, etc.);
- The assignment of resources (e.g. trucks, warehouse equipment's and facilities, operators, etc.);
- Materials' existences, availability, capacity and measurement.

In order to:

Satisfy clients' orders in the due date time, with the required amounts while accounting for clients' prioritisation within the considered feasibility limits and to improve the economic return for the Logistic Operator.

B) Global settings and operational planning problem characterisation:

The *Process Operational Structure* (POS) of the logistic operator, Luís Simões, S.A., in the region of Coimbra, comprises three types of fleet, namely: i.) *Own fleet*; ii.) *Franchised fleet* and iii.) *Subcontracted vehicles* (or Logistics Service Providers).

Concerning the *own fleet*, at Luís Simões it comprises different capacity vehicles ranging from *Normal*, *Tautliners* to *Gigaliner* vehicles. Those included in the *Normal* category usually have a capacity of 24 tons within a vehicle length of 13.60 metres. On the other hand, the *Tautliner* trucks have a whole capacity of 40 tons and a standard length of 15 metres. Finally, *Gigaliner* usually has a whole capacity of 60 tons (40 tons for cargo), and the vehicle length is about 25.25 metres.

Whereas the *Franchised fleet* provides service to clients and acts as an external partner on the basis of agreed upon contract with Luís Simões, SA. These are logistics service providers (LSPs) which operate explicitly for Luís Simões. Also, the subcontracted vehicles are arranged to serve the clients based on the business volume they provide to the case company. These subcontracted vehicles can be a simple van or truck.

These subcontracted vehicles are arranged to serve the clients mostly through Wtransnet Portal[13]. Through this portal, the transporters are auctioned and based on the previous delivery performance, the logistic operator "Luís Simões" assigns the logistics service providers (LSPs) to serve the clients.

The main advantage of the Wtransnet Intranet Transport service is that the transport operator of a company through the introduction of cargo or truck needs in the portal, in a matter of seconds, can assign the trucks, in real time, a decision depending on the availability of the company, the group's branches and the market (Wtransnet, 2007). The advantages and features of Wtransnet are explained in Appendix 4.

The clients of Luís Simões are stratified based on the business volume they provide (see appendix 5). In Luís Simões, the clients are classified as- Client types (Premium, A, B, C, D, E, F). Based on the contractual obligations and the business volume that the client provides, Luís Simões provides fleet accordingly. For example, the client type- Premium and type A requires a large number of fleets, so in accordance with the fleet demand, the logistic operator is required to provide own fleet and the franchised fleet in order to satisfy the demand as well as higher profitability.

Operational planning in transportation & logistics industry has quite a lot of challenges amongst which vehicle scheduling poses a significant challenge for the managers to tackle

[13] Wtransnet Portal for Freight and Truck Exchange in South Europe- http://www.wtransnet.com/en/

to stay competitive in the market. The logistic operators "Luís Simões" faces a daunting task for scheduling vehicles to serve the clients.

In the operational planning process, the clients' demand is forecasted on a weekly basis. This data which is gathered from the client demand is responsible for modelling the vehicle scheduling process in the company.

Based on the demand matrices, the transportation networks are defined. This plan establishes routes and stops for client deliveries. In the further level of the planning process, particular trips are defined for a given route. For each given trip to service the clients, the schedule specifies a departure time and arrival time as well as the starting location and the destination location. Moreover, further, the planning process focuses on efficient use of available resources. It especially assures that the vehicles or trucks and the crew serve all the client sites. However, it is also important to consider that the optimal use of resources is a hard problem in combinatorial optimisation and hence has been the subject of research in the field of Operations Research (OR).

Relatively, the Vehicle Scheduling Problem (VSP) has been extensively researched in last few decades. The logistic operator must undergo many plans to overcome these challenges. In particular, through the course of the internship, it was identified that the logistic operator Luís Simões and its managers' face the challenge of scheduling vehicles to serve the clients.

Before the optimisation of the scheduling problem, it is necessary to identify the data that is important to solve this problem. The pre-requisite to understanding the problem is to analyse the data for a given problem. The vehicle scheduling problem (VSP) requires namely:

- *Data on the problem as*: **a.)** Vehicles availability (N); **b.)** Starting time of the trip (STt); **c.)** End time of the trip (ETt); **d.)** Starting point of the trip (L1); **e.)** The endpoint of the trip (L2); **f.)** Set of timetabled trips (T); **g.)** Travel time from starting point (L1) to endpoint (L2).
- *Compatibility relations* (e.g. specifying for all, whether trip (*i*) can be served after the trip (*j*) by the same vehicle).

For the most cases, the above data was found minimally in the logistic operator (LS-group) database. As for the Coimbra region, the fleet managed for serving the clients is through *Logistics Service Providers* (LSPs). Moreover, concerning the own fleet of Luís

Simões, the fleet size is 38 vehicles. Also, these vehicles are explicitly assigned to the higher level of clients having higher annual business volume. However, still, the vehicle scheduling problem exists in the fleet management to serve the clients.

The logistic operator, Luís Simões in Coimbra, operates explicitly more of the subcontracted vehicles to serve the clients. The reason for managing fleet through logistics service providers (LSPs) to serve the clients is to have the economic trade-offs in the functioning of organisations' logistical activities. This trade-off implies that the logistic operator Luís Simões for the Coimbra region is still analysing the investment in own fleet and, so far, is dependent on the resources of other LSPs.

Moreover, concluding the fact that the substantial investment in the transport equipment and machinery were not possible while handling clients' requirements and increasing the overall efficiency of the supply chain. The last one is of paramount importance to the case company.

Furthermore, the identification of the scheduling problem for the logistic operator plays a critical role to stay competitive in the global market. The logistic operator through their fleet manages to serve the clients, and for the economic trade-off. This logistic operator relies heavily on the other logistics service providers (LSPs). The primary concern for the problem is to increase the client service level through the LSPs. Other concerns are namely, vehicles availability, timely delivery, delivery documentation, security, the safety of goods, and timely delivery of the documents. In order to analyse such problem, it is essential to focus on the service level.

During the internship, it was noticed that a vehicle schedule takes into account the sequence of tasks to perform, and for which a vehicle should start from the depot and terminate at the same depot. Each task is defined by a starting and a destination location, among other issues related to the flow of materials that ensures the connectivity of vehicles for serving the clients taken into account the start and end locations. Moreover, in vehicle scheduling, other parameters such as- loading, unloading, and transit times, as well as the idle time spent during loading and unloading activities, should be considered. The cost structure of the problem is separable by vehicles and depends upon vehicle fixed costs, total distance covered, travel times, and waiting times in between successive tasks. In a real-world scenario, the transit time or waiting time costs significantly when the time windows are vast. Thus, the logistic operator faces this challenge of scheduling the

vehicles and efficiently manage the available resources and also, optimise the whole supply chain network.

5.3 Scheduling Proposal

In this objective of the internship, after identifying the problem in terms of scheduling approach (e.g. short-term or operational planning), the modelling and implementation of the characterised problem were designed for the next stage. Based on the literature review done for this planning level (chapter 2), different contributions were analysed, and small tests were done. Independently of having an economic or operational criterion, the problem has a considerable number of constraints commonly. So, in optimisation approaches, these planning proposals result typically into large problem dimensions

In terms of operational criteria, when companies face significant problems or challenges, it is mandatory to analyse how effectively, robustly and efficiently the resources are utilised. This requires the evaluation of the implemented fleet management using appropriate processes, policies, and procedures to serve clients. To improve efficiency, some trade-offs in due-dates, vehicle load capacities, amongst other, should desirably be decided optimally.

In Coimbra region, Luís Simões serves the clients using a combined solution that involves other logistics service providers (LSPs). This implies that LSPs can serve the clients in those regions without the case company investing in the infrastructure, resources, fleet, and the crew. The economic analysis by the logistic operator in Coimbra found out the client delivery frequency was low. Thus, it was necessary to explore the logistics service providers (LSPs) for the economic trade-offs.

While analysing the algorithms concerning the Vehicle Scheduling, for developing the model to optimise the solution, the logistic operator invested in the total transportation management solution. This application also called Transportation Management System (TMS) already has an optimiser to solve the various transportation problem. The Macro-Structure of *eTMS platform* previously presented and detailed in Appendix 6.

The TMS solution provides planning solutions for transportation concerning the vehicle routing and driver schedules on a real-time and forward-planning basis. The forward scheduling involves the scheduling of trucks for the next day or week (or more extended period) and can be optimised using vehicle routing and distribution scheduling systems in the TMS. Moreover, the daily assignment, forecast or actual orders to drivers and

vehicles can be solved in order to maximise resource utilisation or balance driver workloads.

The Luxemburg based TMS vendor AndSoft[14] developed this TMS solution. Also, the TMS application consists of a Distribution Scheduling (DISC) package specifically designed to solve the problems of scheduling and to optimise large complex logistics operations. The application comprises: 1. *Multi-depot logistics*; 2. *Delivery Scheduling*; 3. *Driver/Vehicle Scheduling*; 4. *Integrated Distribution Logistics Optimisation*; 5. *Load Planning* and, in the last module, 6. *Strategic Logistics Optimisation*. The detailed content is presented in Appendix 7.

After carefully analysing the TMS solution, the revision of the objective was made to accommodate the study of TMS software for vehicle scheduling problem.

5.4 Decision framework to help and support daily management

In the initial proposal, the development of a dashboard for the logistics managers was considered. The dashboard parametrisation was thought and formally structured during the internship, in accordance with the *performance indicators* previously identified and accepted by the company as the KPI relevant for the operational goals and objectives. Besides that, in the ongoing study, the operational strategies should be visible to managers and to the involved employees, due to transparency reasons.

Therefore, a dashboard framework based on *Microsoft Excel* spreadsheet was considered as a primary solution. The decision was supported by costless, accessibility and availability reasons. Different templates[15] were experienced, diverse charts and data analysis were also tested and incorporated into KPI managing.

Afterwards, the previous dashboard experiments have been reset in accordance with a company decision related to their strategy and operational management policies. In fact, Luís Simões, SA decided to invest in a Transportation Management System (TMS). This TMS solution, as described in chapter 4, provides an *integrated dashboard* which offers access to high-level data in a real-time. The new system represented a stay up-to-date with the organisations' goals and objectives.

[14] Information extracted from TMS vendor "AndSoft"- http://www.andsoft.com/
[15] https://www.smartsheet.com/free-excel-dashboard-templates
https://exceldashboardschool.com/cat/free-templates/

Besides that, the TMS dashboard is a centralised management tool that also allows a snapshot of the data, permitting managers to make crucial decisions easily and accurately.

Based on the TMS solution implemented by the company and considering the feasibility and availability of the incorporated dashboard, the ongoing internship study was turned to the TMS facilities in this field.

Moreover, the integrated dashboard is user configurable. The users can select from a portfolio of the available widgets. The screen is built to suit the needs of logistics and transportation industry, and it is quite intuitive concerning user access to reports and graphs, customarily used in daily and quick demanding decisions.

Below, some core benefits of the TMS dashboard are pointed out. These are presented in four dimensions, as follows:

Data Visualisation

Easy to read graphs and reports, users can easily see and analyse team's data. Quickly drill down to additional data when necessary. Also, the eTMS dashboard offers a portfolio of *Mobile solutions* designed to work with the organisations' requirements and infrastructure. These can be perceived namely, in the incorporated *ease-to-use data conversion tool* which allows the user to import asset data, operations' information, order data and other important evidence into the corresponding screen or codes into the platform. These procedures analysis the data as often as required.

Performance Monitoring

The dashboard monitors not only the team's performance (e.g., warehouse, operations and commercial department's team performance) but also key asset performance (e.g., the fleet of vehicles, infrastructure, equipment and machinery, and other materials available in the organisation). In case of theft or accident of vehicles, the real-time monitoring of vehicles allows for the management to track the driver and vehicle in extreme conditions. Similarly, the real-time monitoring of the trucks can be enhanced through this platform, and immediate corrections can be made when required using the *eTMS* platform.

Improvement in Decision Making

The capacity to make critical decisions at the right time requires an ability to access and analyse key metrics efficiently. With the centralised TMS solution, the application

provides an effective management that supports multiple departments and depots. Also, it emphasises data synchronisation and enhances centralisation of data, which further results in better communication among all departments. Particularly, the databases allow users to structure and report the data easier. Wherein the application permits the manipulator to use the common segments of the data to share codes across the departments.

Find Relevant Data

The dashboard is highly personalised and user-friendly concerning the access to relevant data visualisation. Besides that, some data filtering is accounted to eliminate unnecessary data (e.g., trip code, supplier code, etc.) and emphasise significant data. This way, an improvement is reached in what concerns the decision-making (e.g., trip cost, consumer requirements, loading/unloading times, etc.).

In Luís Simões, the *eTMS* platform is still in a starting stage of implementation, and the extraction of dashboard snapshots was not allowed due to confidentiality reasons.

6 CONCLUSION & FUTURE DEVELOPMENTS

In this chapter, a summary of conclusions about the internship realised are presented and analysed against the objectives considered. Furthermore, after those appreciations, in the second part of this chapter, some recommendations are considered, as a result of the developed internship study. These will be, expectantly, useful for future advances in the company.

6.1 Conclusions

This internship report explains the main activities carried out in the Luís Simões, Logística Integrada, S.A. This internship was carried out as the non-lecturing component of the Master's degree in Management Information Systems.

Concerning the objectives that had been proposed for the internship theme, some of them were fully achieved, while the other objectives needed to be reworked as a consequence of the company's situation and the involvement in the Information Systems implementation (TMS).

One of the objectives of the internship was to develop the key performance indicators for the logistic operator. In this way, the first step towards measuring transportation activities is to fully understand what factors that influence the performance of a transportation and logistics industry as a whole. In accordance with present research, one of the crucial factors is the capability to view the organisation goals and objectives with a holistic approach. When all actors in the chain interact together with common goals and objectives, the opportunity for the achievement raises. The recommendation for KPIs is based on a thorough evaluation of all the metrics that are currently measured within the Luís Simões organisation. This evaluation is included in chapter 5 and is based on the following perspective: quality, responsiveness, cost, and productivity.

The suggested recommendations might be further associated with other measurements in the future with additional metrics. Nevertheless, this can require work improvement to enhance the quality of possible measures. Some work over measuring inconsistency can be implemented to ensure the quality of measurements. So, it is advised to work on further development of the measures to calibrate the quality of metrics before they can be considered reliable enough to be displayed on the *dashboard*.

Later during the internship, while observing the operational activities and information systems, the idea of developing the dashboard was not a really unique and interesting tool for the company, at least regarding dynamics of the dashboard as is the case in the Transportation Management System (TMS) application.

Besides that, in the operational planning and scheduling model, the decision was to explore the scheduling optimiser that was turned available by the TMS solution in the company. This was done in order to check the robustness, effectiveness, efficiency and flexibility of the commercial system available on the market. The solution being implemented in Luís Simões, S.A. already accounted for a block called optimiser. Therefore, the former tests exploring planning algorithms implementation were left to explore the scheduling optimiser and see which kind of problems can be solved using the optimiser. In this way, we can identify which are the issues that are not yet covered or accounted by the optimiser and afterwards, we can propose to improve the efficiency or to turn the solutions most robust than the one that is considered for the current solution.

Also concerning the operational planning and scheduling approach for the transportation and logistical activities changes were justified by the introduction of TMS solution which comes with the package of the optimiser that further allows efficient analysis for the whole supply chain. It was interesting to notice the optimiser during the internship that it covered broad aspects of the transportation problems, namely: crew scheduling, vehicle scheduling, vehicle routing and so on. Through this objective, it was noticed that how Luís Simões prioritised the client stratification or classification in terms of the business volume, they bring about to the organisation and this is explicitly introduced in the modelling proposal to a scale where all client parameterised. Also, the clients are prioritised through this TMS application.

6.2 Further Developments

In order to look at the results critically, it is recommended to implement the KPIs in the organisation to have a deeper understanding of the organisational performance. The depth of this internship objective would be increased if an additional enrolment in the implementation and evaluations of TMS were feasible.

It is recommended to include the KPIs and the measurements in the further stages of the implementation process through TMS application. Also, some measures may also require, in addition, an improvement to increase the quality of the metrics before they can be

regarded as reliable, and beneficial to be acknowledged for the evaluation of the organisational performance of the operational activities.

The TMS dashboard does not allow the transporter performance evaluation of efficiency considering the Logistics Service Providers (LSPs). Therefore, some improvements could complement the management to make effective decision-making in order to increase the service level to the clients.

REFERENCES

Amaro, A. C. S., & Barbosa-Póvoa, A. P. F. D. (2008a). Planning and scheduling of industrial supply chains with reverse flows: A real pharmaceutical case study. *Computers and Chemical Engineering*, *32*(11), 2606–2625. https://doi.org/https://doi.org/10.1016/j.compchemeng.2008.03.006

Amaro, A. C. S., & Barbosa-Póvoa, A. P. F. D. (2008b). Supply Chain Management with Optimal Scheduling. *Industrial & Engineering Chemistry Research*, *47*(1), 116–132. https://doi.org/10.1021/ie070262a

Amaro, A. C. S., & Barbosa-Póvoa, A. P. F. D. (2009). The effect of uncertainty on the optimal closed-loop supply chain planning under different partnerships structure. *Computers and Chemical Engineering*, *33*(12), 2144–2158. https://doi.org/10.1016/j.compchemeng.2009.06.003

Asadi, N. (2012). Performance Indicators in Internal Logistic systems. *International Conference on Innovation and Information Management*, *36*(2012), 48–52.

Azevedo, P. S., Romão, M., & Rebelo, E. (2012). Advantages, Limitations and Solutions in the Use of ERP Systems (Enterprise Resource Planning) – A Case Study in the Hospitality Industry. *Procedia Technology*, *5*, 264–272. https://doi.org/https://doi.org/10.1016/j.protcy.2012.09.029

Ballard, R. L. (1996). Methods of inventory monitoring and measurement. *Logistics Information Management*, *9*(3), 11–18. https://doi.org/10.1108/09576059610116653

Bertrand, J. W. M. (2003). Supply Chain Design: Flexibility Considerations. *Handbooks in Operations Research and Management Science*. https://doi.org/10.1016/S0927-0507(03)11004-3

Bowersox, D. J., Closs, D. J., & Cooper, B. M. (2011). *Supply Chain Logistics Management* (5th ed.). McGraw-Hill Education (India) Pvt Limited, 2011.

Bunte, S., & Kliewer, N. (2009). An overview on vehicle scheduling models. *Public Transport*, *1*(4), 299–317. https://doi.org/10.1007/s12469-010-0018-5

Capgemini. (2011). Transportation Management Report 2011. Retrieved May 22, 2017, from https://www.capgemini.com/nl-nl/wp-content/uploads/sites/7/2017/07/Transportation_Management_Report_2011_1.pdf

Caputo, A. C., Pelagagge, P. M., Scacchia, F., Caputo, A. C., & Scacchia, F. (2003). Integrating transport systems in supply chain management software tools Integrating transport systems in supply chain management software tools. *Industrial Management & Data Systems*, *103*(7), 503–515. https://doi.org/10.1108/02635570310489205

Chae, B. (Kevin). (2009). Developing key performance indicators for supply chain: an industry perspective. *Supply Chain Management: An International Journal*, *14*(6), 422–428. https://doi.org/10.1108/13598540910995192

Chopra, S., & Meindl, P. (2015). *Supply Chain Management: Strategy, Planning, and Operation* (6th ed.). Pearson Education, 2015.

Christensen, C. R., & Andrews, K. R. (1982). *Business policy : text and cases* (3rd ed.). R.D. Irwin. Retrieved from http://www.worldcat.org/title/business-policy-text-and-cases/oclc/257071206

Connaughton, P. M. (2008). The Forrester Wave ™: Transportation Management Solutions , Q1 2008. Retrieved May 23, 2017, from http://logistiek.nl.s3-eu-central-1.amazonaws.com/app/uploads/2015/04/attachment-002_logistiek-download-LOGNWS106093D01.pdf

Crainic, T. G. (2000). Service network design in freight transportation. *European Journal of Operational Research*, *122*(2), 272–288. https://doi.org/10.1016/S0377-2217(99)00233-7

Crainic, T. G. (2003). *Long-Haul Freight Transportation*. *Transportation Science* (Vol. 32). Springer. https://doi.org/10.1007/0-306-48058-1

Crainic, T. G., & Laporte, G. (1997). Planning models for freight transportation. *European Journal of Operational Research*, *97*(3), 409–438. https://doi.org/10.1016/S0377-2217(96)00298-6

De Muynck, B. (2015). Magic Quadrant for Transportation Management Systems. Retrieved May 22, 2017, from https://go.oracle.com/LP=14561

Domschke, W., & Scholl, A. (2005). *Basics of the Business Administration: An introduction from a decision-oriented perspective* (6th ed.). Springer Italy.

Dwight, R. (1999). Searching for real maintenance performance measures. *Journal of Quality in Maintenance Engineering*, *5*(3), 258–275.

Eurostat. (2017). European Union GDP 2017. Retrieved January 1, 2017, from http://ec.europa.eu/eurostat/documents/2995521/8057546/2-08062017-AP-EN.pdf/8321df8a-ba1b-433e-9cdc-bfd81e3f4a45

Faber, N., Koster, R., & Velde, S. (2002). Linking warehouse complexity to warehouse planning and control structure: an exploratory study of the use of warehouse management systems. *International Journal of Physical Distribution & Logistics*, *32*(5), 381–395. https://doi.org/10.1108/MBE-09-2016-0047

Fleischmann, B. (2010). *Supply Chain Management and Advanced Planning*. (H. Stadtler, C. Kilger, & H. Meyr, Eds.). Springer.

Folan, P., & Browne, J. (2005). A review of performance measurement: Towards performance management. *Computers in Industry*, *56*(7), 663–680. https://doi.org/10.1016/j.compind.2005.03.001

Franceschini, F., Galetto, M., & Maisano, D. (2007). *Management by Measurement: Designing Key Indicators and Performance Measurement Systems* (1st Ed.). Springer Science & Business Media, 2007.

Frazelle, E. H. (2001). *World-class warehousing and material handling* (2nd ed.). McGraw Hill Professional. https://doi.org/10.1036/9780071842839

Frazelle, E. H. (2002). *Supply Chain Strategy: The Logistics of Supply Chain Management*. McGraw Hill Professional. https://doi.org/10.1036/0071418172

Green, F. B. (2001). Managing the unmanageable: integrating the supply chain with new developments in software. *Supply Chain Management: An International Journal*, *6*(5), 208–211. https://doi.org/10.1108/13598540110407741

Hall, R. (2012). *Handbook of Transportation Science*. Springer Science & Business Media, 2012. https://doi.org/10.1007/b101877

Hall, R. E., & Lieberman, M. (2012). *Economics: Principles and Applications* (5th ed.). Cengage Learning. https://doi.org/10.1016/S1574-0110(02)80013-3

Handfield, R. B., & Nichols, E. L. (2002). *Transforming Supply Chains into Integrated Value Systems*. *FT Press*. https://doi.org/10.1016/S0026-0576(00)83977-X

Helo, P., & Szekely, B. (2005). Logistics information systems: An analysis of software solutions for supply chain co-ordination. *Industrial Management & Data Systems*,

105(1), 5–18. https://doi.org/https:// doi.org/10.1108/02635570510575153

Hou, Y. M., Jia, Z. H., Tian, X., & Wei, F. F. (2013). Research on Vehicle Routing Problem with Soft Time Windows. *Journal of Systems Engineering*, *30*(2), 240–250. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-LYGY201302010.htm

House, R., & Jackson, G. (1995). Trends in computer applications in transportation and distribution management. *International Journal of Physical Distribution & Logistics Management*, *25*(4), 22–34.

INE. (2011). Instituto Nacional de Estatistica, Censos 2011. Retrieved November 30, 2016, from http://censos.ine.pt/xportal/xmain?xpid=CENSOS&xpgid=ine_censos_publicacao_det&contexto=pu&PUBLICACOESpub_boui=73212469&PUBLICACOESmodo=2&selTab=tab1&pcensos=61969554

Johnson, G., Scholes, K., & Whittington, R. (2008). *Exploring corporate strategy*. *Pearson Education* (8th ed.). Prentice Hall.

Jordan, S., & Messner, M. (2012). Enabling control and the problem of incomplete performance indicators. *Accounting, Organizations and Society*, *37*(8), 544–564. https://doi.org/10.1016/j.aos.2012.08.002

Kreipl, S., & Pinedo, M. (2004). Planning and Scheduling in Supply Chains : An Overview of Issues in Practice, *13*(1), 77–92. https://doi.org/10.1111/j.1937-5956.2004.tb00146.x

Lacefield, S. (2005). Overwhelmed by your WMS choices? *Logistics Management*, *44*(5), 61–63. Retrieved from https://trid.trb.org/view.aspx?id=764799

Lahmar, M. (2008). *Facility Logistics: Approaches and Solutions to Next Generation Challenges*. CRC Press.

Larsen, A., Madsen, O. B. G., & Solomon, M. M. (2008). *The Vehicle Routing Problem: Latest Advances and New Challenges*. (B. L. Golden, S. Raghavan, & E. a Wasil, Eds.), *Information Systems Journal* (Vol. 43). Springer. https://doi.org/10.1007/978-0-387-77778-8

Lau, H. C. ., & Lee, W. . (2000). On a responsive supply chain information system. *International Journal of Physical Distribution & Logistics Management*, *30*(7/8),

598–610.

Lauterbach, B., & Metzger, D. (2015). *Transportation Management with SAP TM* (2nd ed.). Rheinwerk Publishing Incorporated (SAP Press).

Luis Simoes, W. (2017). Luís Simões. Retrieved July 8, 2017, from http://www.luis-simoes.pt/

Luo, J., & Wu, Y. (2015). Modelling of dual-cycle strategy for container storage and vehicle scheduling problems at automated container terminals. *Transportation Research Part E: Logistics and Transportation Review*, *79*, 49–64. https://doi.org/10.1016/j.tre.2015.03.006

Lydenberg, S., Rogers, J., & Wood, D. (2010). From Transparency to Performance. Retrieved from https://www.sasb.org/wp-content/uploads/2012/03/IRI_Transparency-to-Performance.pdf

Manzini, R., Gamberi, M., Gebennini, E., & Regattieri, A. (2008). An integrated approach to the design and management of a supply chain system. *International Journal of Advanced Manufacturing Technology*, *37*(5–6), 625–640. https://doi.org/10.1007/s00170-007-0997-9

McLaughlin, J., Motwani, J., Madan, M. S., & Gunasekaran, A. (2003). Using information technology to improve downstream supply chain operations: a case study. *Business Process Management*, *9*(1), 69–80. https://doi.org/10.1108/MBE-09-2016-0047

Meier, H., Lagemann, H., Morlock, F., & Rathmann, C. (2013). Key performance indicators for assessing the planning and delivery of industrial services. *Procedia CIRP*, *11*, 99–104. https://doi.org/10.1016/j.procir.2013.07.056

Min, H., & Zhou, G. (2002). Supply chain modeling: past, present and future. *Computers & Industrial Engineering*, *43*(1–2), 231–249. https://doi.org/10.1016/S0360-8352(02)00066-9

Nahmias, S., & Olsen, T. L. (2015). *Production and Operations Analysis* (7th ed.). Waveland Press, 2015. Retrieved from https://books.google.com/books?id=SIsoBgAAQBAJ&pgis=1

Neely, A., Gregory, M., & Platts, K. (1995). A Literature Review and Research Agenda. *International Journal of Operation Management & Production Management*, *15*(4),

80–116.

Neto, M. S., & Pires, S. R. I. (2012). Performance Measurement in Supply Chains: A Study in the Automotive Industry. In J. P. Carmo & J. E. Ribeiro (Eds.), *New Advances in Vehicular Technology and Automotive Engineering* (pp. 379–398). Rijeka: InTech. https://doi.org/10.5772/48620

Parmenter, D. (2015). *Key Performance Indicators (KPI): Developing, Implementing, and Using Winning KPIs*. *John Wiley & Sons, 2015* (3rd ed.). https://doi.org/978-0470545157

Pettersen, J. (2009). Defining lean production: Some conceptual and practical issues. *TQM Journal*, *21*(2), 127–142. https://doi.org/10.1108/17542730910938137

Piasecki, D. (2007). Warehouse Management Systems - WMS. Retrieved May 28, 2017, from http://www.inventoryops.com/warehouse_management_systems.htm

Poirier, C. C. (2016). *Using Models to Improve the Supply Chain*. CRC Press.

Rahimi-Vahed, A., Gabriel Crainic, T., Gendreau, M., & Rei, W. (2015). Fleet-sizing for multi-depot and periodic vehicle routing problems using a modular heuristic algorithm. *Computers & Operations Research*, *53*, 9–23. https://doi.org/10.1016/j.cor.2014.07.004

Richards, G. (2017). *Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse*. *Distribution Planning and Control: Managing in the Era of Supply Chain Management* (3rd ed.). Kogan Page Publishers, 2017. https://doi.org/10.1007/978-1-4899-7578-2

Samsonowa, T. (2011). *Industrial Research Performance Management: Key Performance Indicators in the ICT Industry*. Springer Science & Business Media, 2011.

Sheffi, Y. (1990). Third party logistics: present and future prospects. *Journal of Business Logistics*, *11*(2), 27–39.

Simão, H. P., Day, J., George, A. P., Gifford, T., Nienow, J., & Powell, W. B. (2009). An Approximate Dynamic Programming Algorithm for Large-Scale Fleet Management: A Case Application. *Transportation Science*, *43*(2), 178–197. https://doi.org/10.1287/trsc.1080.0238

Spiegel, R. (2003). *Logistics management & distribution report. Logistics Management and Distribution*. Cahners Pub. Co. Retrieved from https://trid.trb.org/view.aspx?id=602957

Stadtler, H., Fleischmann, B., Grunow, M., Meyr, H., & Surie, C. (2014). *Advanced Planning in Supply Chains*. (H. Stadtler, C. Kilger, & H. Meyr, Eds.) (5th ed.). Springer.

Stank, T. P., & Goldsby, T. J. (2000). A framework for transportation decision making in an integrated supply chain. *Supply Chain Management: An International Journal*, *5*(2), 71–78. https://doi.org/10.1108/13598540010319984

Surwade, D. (2016). Management information systems and business decision making : review , analysis , and recommendations. *International Journal on Recent and Innovation Trends in Computing and Communication*, *4*(8), 201–203.

Taylor, D. A. (2010). *Supply Chains: A Manager's Guide* (1st ed.). Addison-Wesley Professional, 2010.

Thonemann, U., Behrenbeck, K., Diederichs, R., Grobpietsch, J., Kupper, J., & Leopoldseder, M. (2013). *Supply Chain Champions: What they do and how they become one?* Springer, 2013.

Topaloglu, H., & Powell, W. B. (2007). Incorporating the pricing decisions into the dynamic fleet management problem. *Transportation Science*, *41*(3), 281–301. https://doi.org/10.1287/trsc.1070.0196

Van der Vorst, J. G. A. J. (2000). *Effective Food Supply Chains-Generating, Modelling and Evaluating Supply Chain Scenarios*. https://doi.org/ISBN 90-5808-261-X

Verwijmeren, M. (2004). Software component architecture in supply chain management. *Computers in Industry*, *53*(2), 165–178. https://doi.org/10.1016/j.compind.2003.07.004

Waal, A. A. (2003). Behavioral factors important for the successful implementation and use of performance management systems. *Management Decision*, *41*(8), 688–697. https://doi.org/10.1108/00251740310496206

Weintraub, A., Epstein, R., Morales, R., Seron, J., & Traverso, P. (1996). A truck scheduling system improves efficiency in the forest industries. *Interfaces*, *26*(4), 1–12. https://doi.org/10.1287/inte.26.4.1

Wong, A., & Fung, P. (1999). Total quality management in the construction industry in Hong Kong : A supply chain management perspective. *Total Quality Management*, *10*(2), 199–208. https://doi.org/10.1080/0954412997956

Wong, & Wong, K. (2008). A review on benchmarking of supply chain performance measures. *Benchmarking: An International Journal*, *15*(1), 25–51. https://doi.org/10.1108/MBE-09-2016-0047

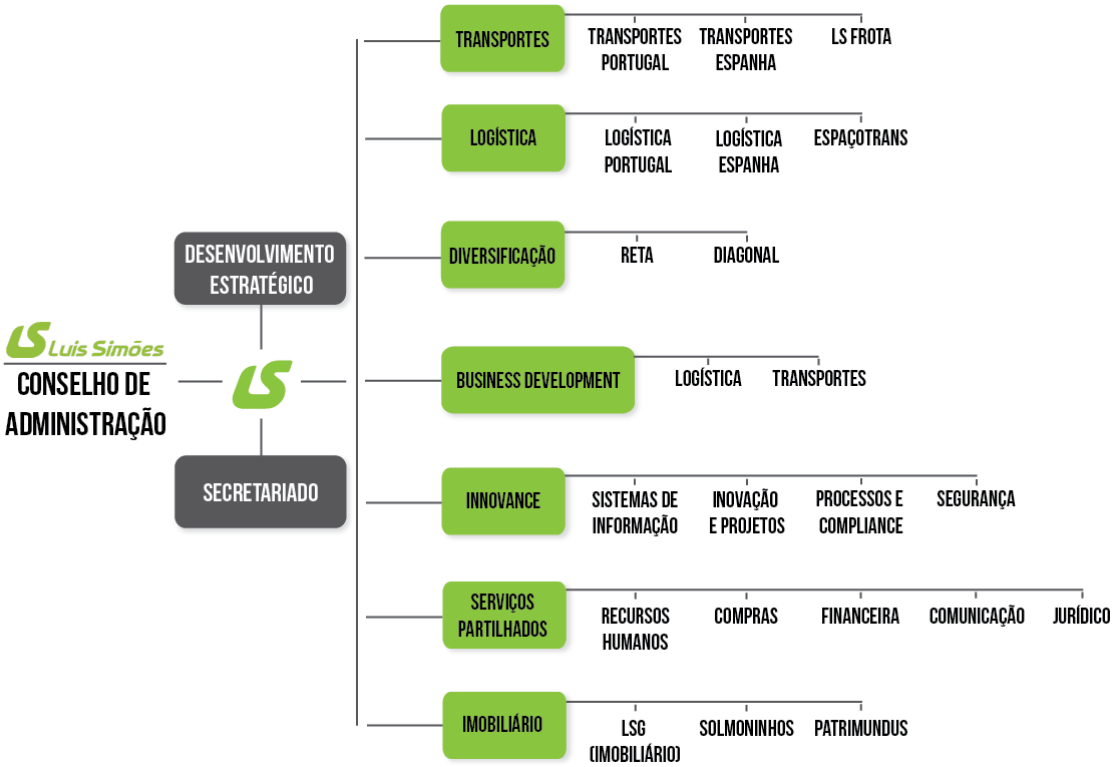
Wtransnet. (2007). Freight and Truck Exchange in Southern Europe | Wtransnet. Retrieved January 11, 2017, from http://www.wtransnet.com/en/

Xia, J., Li, K. X., Ma, H., & Xu, Z. (2015). Joint Planning of Fleet Deployment, Speed Optimization, and Cargo Allocation for Liner Shipping. *Transportation Science*, *49*(4), 922–938. https://doi.org/10.1287/trsc.2015.0625

Żak, J., Redmer, A., & Sawicki, P. (2011). *Multiple objective optimization of the fleet sizing problem for road freight transportation*. *Journal of Advanced Transportation* (Vol. 45). John Wiley & Sons, Ltd. https://doi.org/10.1002/atr.111

APPENDICES

APPENDIX 1 – ORGANISATION STRUCTURE OF LUÍS SIMÕES



APPENDIX 2 - INTERVIEW QUESTIONS TO THE LOGISTICS MANAGER

What?
What key performance indicators (KPIs) are currently measured?
Do you categorise the measurement?
What happens if the target is not achieved?
What are the measurements used for?
What is the information system used for measurements?
How?
How do you measure the internal logistics performance?
How are the measurements determined?
How are they calculated?
How are the measurements compiled and presented to the management?
How are the measurements evaluated and validated?
Why?
Why these measurements?
Who?
Who is responsible for these measurements?
Who develops and updates these measurements?

APPENDIX 3 - WHAT LS GROUP AT COIMBRA ARE MEASURING

Measurements	**Period**	**Unit of Measurement**
Increase in Sales	Monthly	% (Million Euros)
Profitability in Operations department	Monthly	% (Value)
Net Operating Revenue	Monthly	Value (%)
Average Period of Receipts	Monthly	Fixed Value
Client Loads	Monthly	Value
Gross Total Margin/ Margin of Distribution	Monthly	%
On-Time Service Level	Monthly	%
Percentage of Corrected Non-conformities	Monthly	%
Compliance with food security prerequisites	Monthly	%
Energy Consumption Factor	Monthly	Fixed Value
Kaizen Efficiency of Internal Operations	Daily	% and Fixed Value
Frequency of Accidents	Quarterly	Fixed Value
Responsible – Head of Logistics		

APPENDIX 4 – FEATURES & ADVANTAGES OF WTRANSNET PORTAL

The Wtransnet Portal has following features:

- It is an intranet service for companies that want to share information in real time with their branches.
- The Wtransnet transport intranet goes beyond a private freight exchange; also, it is an application where all the information is centralised and shared according to the requirements of the user.
- It is an innovative service that applies the concept of freight exchange to optimise the management of the company's transport department, recording all the information that enters the company's daily activities and shares it:

  1. within the same traffic department
  2. with the other branches of the group
  3. to act in the light of market supply and demand, in real time.

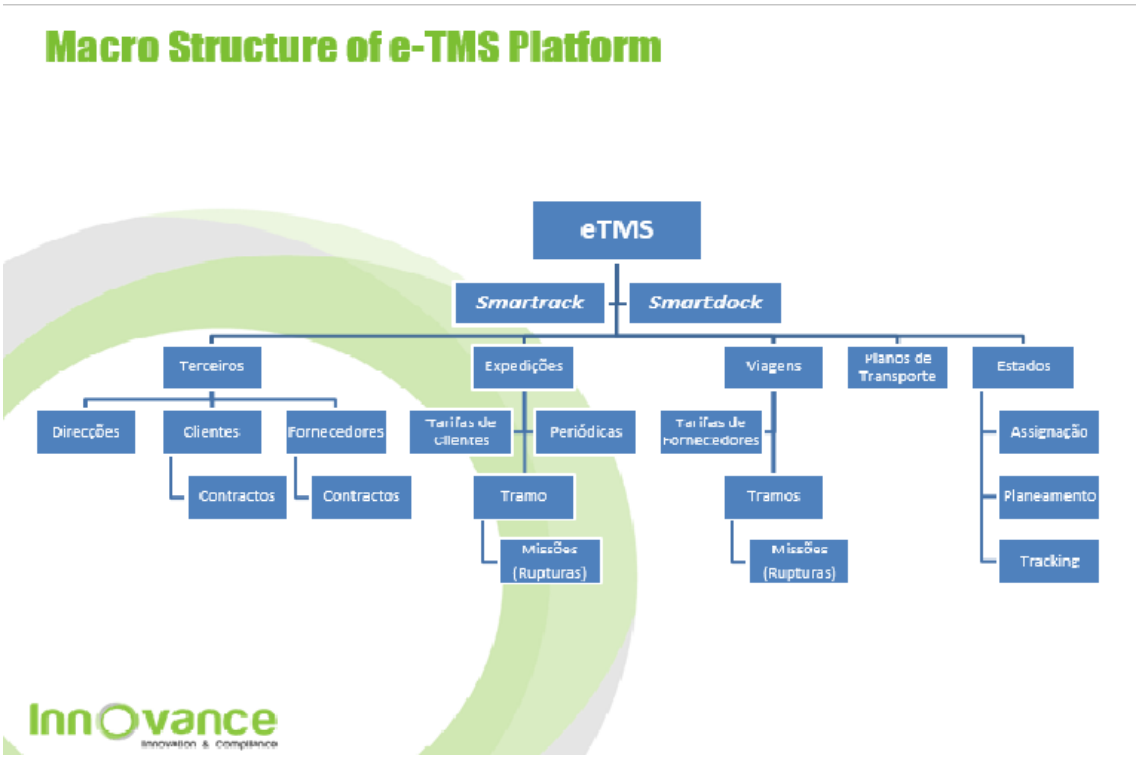
The advantages of Wtransnet portal are-

- A system of recording the needs of its clients, the offers of freight and truck availability of its employees and the availability of its vehicles.
- Handling all this information and looking for real-time correspondence to optimise the management of the transport activities in the traffic department of a branch.
- Alliance of the working methods of all branches.
- A communication in real time, taking into account the business opportunities of transport services of all the group's branches both at the national and international level.
- Enables faster communication in real time and corresponding response with the business opportunities available in the market.
- An increased competitiveness and responsiveness through faster processing of all the information registered in company's office, in all branches, and in the market.
- Improvement of the quality of the service to its clients and optimisation in the management of its fleet.

APPENDIX 5 – CLIENT PARAMETERISATION

Type	**Initial (€)**	**Final (€)**
Premium	3,000,000	1,000,000
A	1,000,000	2,999,999
B	500,000	999,999
C	250,000	499,999
D	100,000	249,999
E	50,000	99,999
F	0	49,999

APPENDIX 6 - MACRO STRUCTURE OF e-TMS PLATFORM



APPENDIX 7 – TMS OPTIMISER

The Luxemburg based TMS vendor "AndSoft" developed this TMS solution. Also, the TMS application consists of a Distribution Scheduling (DISC) package specifically designed to solve the problems of scheduling and to optimise large complex logistics operations:

1. **Multi-depot Logistics**

In this module of the software package, the software is designed to schedule the whole multi-depot logistics operations namely- primary distribution involving inter-depot cross-docking and pickup from suppliers. Secondary distribution involves transportation from distribution centres to the merchandising outlets, consumers or other divisions. Also, it is capable of solving the problems of reverse logistics of waste, equipment & product returns, backhauls, and backloading from third-party client sites to maximise fleet operation and the overall minimisation of costs.

Distribution Scheduling (DISC) offers optimisation tools for complex operational distribution planning problems. Those tools have following features: i.) Freight Optimisation; ii.) Vehicle Optimisation; iii.) Retail Distribution; iv.) Express Parcel Delivery Networks; v.) Home delivery Scheduling; vi.) Road Haulage Scheduling; vii.) Bulk Haulage Planning and viii.) Delivery Planning.

2. **Delivery Scheduling**

This module of the software optimises the allocation of tasks to the crew and trucks to maximise productivity and efficient resource utilisation. The distribution and vehicle route planning system take into account, the constraints such as time windows, vehicle type & capacities, driving hours and access restrictions, load consolidation, and temperature restrictions.

3. **Driver/Vehicle Scheduling**

Distribution Scheduling (DISC) offers crew planning tools for monitoring the real-time scheduling of crew for the vehicles to accommodate strategically optimising rosters and the shift structures for the crew. All the vehicle schedules consider constraints, for example, minimum driving hour instructions, contractual obligations, ideal starting times, crew skills, and training, etc.

Complexities such as changeovers, night-away, tramping, driver swaps, etc. are modelled. Integration of DISC with the roster creation tools enabled planning of driver rotations based on anticipated demand and required working patterns. The transport scheduling software plans vehicle operation and incorporates constituted guidelines for driving the vehicle crew to optimise the usage of own-fleet and other resources or 3PL (third-party logistics) crew and vehicles.

4. Integrated Distribution Logistics Optimisation

In this module, Distribution Scheduling (DISC) provides transportation and warehousing activities schedule that builds an integrated logistics solution. Through this module, the application assures all the aspects of operational distribution are planned, coordinated, and an approach that aids to maximise efficiency and flexibility in the business operations. The vehicles, crews, trailers, loaders, warehouse staff, docks, lanes, bays, etc. are included in the module if required.

Accurate Logistics Planning Model

In order to fulfil this, all transportation and warehouse variables and constraints are modelled including: i.) *Volumes & Orders:* Forecasting of order cycle by clients, delivery points, product types and capacities. ii.) *Transport constraints:* Trucking Size/type, accommodation size for products, temperature restraints, and compatibility of the products. iii.) *Delivery routing constraints:* Docking restrictions, prioritisation of deliveries, Sequencing constraints, and time windows for deliveries. iv.) *Vehicle Tracking:* Delivery tracking through Global Positioning System (GPS), and automated response for order updates, the position of trucks, and potential delays through in cab/smartphone. v.) *Manufacturing/Production:* the availability of stocks, repositioning, the shelf-life of products, production planning, and the supply chain. vi.) *Warehouse Constraints:* loading and unloading capacities, pickup capacities, docking capacities, holding vessel limitations, and the floor space to accommodate pallets. vii.) *Consolidation of Loads:* Cross-docking situations, trans border shipments, groupage deliveries, hub-and-spoke, trunk moves, and the line haul and viii.) *Resource Constraints:* Trucks, tractors, crew, tankers, cranes, loading & unloading locations.

Warehouse Load Planning

Distribution Scheduling (DISC) offers an integrated distribution schedule and the load plan which covers: i.) The loading, unloading, and distribution for each warehouse and the shipping location; ii.) The staff schedules of warehouse, assembly line or pickup, and the reports of loading; iii.) Shifting movements and the schedule for trailer docking which involves inbound and outbound logistics activities; iv.) The vehicle scheduling for the trailers and tractors with appropriate load contents and the structured plan and v.) The crew schedule for vehicles, the employee shift scheduling, and the overtime surcharges.

5. **Load Planning**

Distribution Scheduling (DISC) offers a load planning algorithm that enhances the process of optimal load building process. The application determines the pallet load and the subsequent vehicle assignment, with the due consideration of constraints like compatibility of products, packing constraints, weight balancing, dispatch sizes, loading sequences, loading schedules, drop-trailer operations, etc.

In this module, the load building rules are configured to ensure that the optimal load is the part of overall planning and delivery operations. So, that the resulting vehicle movements and warehousing schedules are feasible for the vehicle loading. Consequently, the load plans involve manifestation and job sheets, and the optimiser ensures the systematic integration of WMS and TMS for real-time monitoring of the operational activities.

6. **Strategic Logistics Optimisation**

Distribution Scheduling (DISC) also utilised by the distribution and logistics managers to monitor "what if" situations for the strategic planning levels. In this situation, the users can simulate the future operations or derive a contingency plan to mitigate the bottlenecks in the planned operational activities.

Furthermore, the DISC allows users to answer questions like: i.) What if the company centralise the transport & logistics planning? ii.) What if the logistic operator utilises the logistics service providers (LSPs)? iii.) What if the vehicle scheduling changes occur daily? iv.) What if the fleet of the vehicles is reduced by 30%? v.) What if the operating staff costs vary?