School of High Commercials Studies

EHEC

This dissertation submitted in fulfillment of the requirements for the degree of master in commercial sciences

Option: Distribution and SCM

TOPIC:

Measuring performance of warehouse operations

Study case: SARL Aramex

Submitted by:

Mss. Hadjira ABBES

Supervised by:

Mrs. Nedjoua DEMMOUCHE

Lecturer at EHEC Algiers

3rd promotion

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ملخص

تعمل المستودعات كنقاط عقدة في سلسلة التوريد بهدف ربط التدفقات المادية بين المورد والعميل ونتيجة لبيئة السوق تنافسية للغاية. تضطر الشركات بشكل مستمر لتحسين عمليات التخزين الخاصة بهم. وتخصيص العديد من خدماتهم من اجل تلبية مطالب العملاء، الأمر الذي أدى إلى تغييرات في دور المخازن. في مثل هذه الظروف التحسن في تجهيز ومناولة المواد يمكن أن يحقق التوفير في التكاليف وفي نفس الوقت الزيادة في عدد العملاء. في هذه الحالة قياس الأداء حيوي للشركات لتحديد مدى نجاحهم في تنفيذ العمليات و تحقيق أهدافهم.

والغرض من هذه المذكرة إعطاء لمحة عامة وتقديم بإيجاز مفهوم التخزين، تحليل عملية التخزين، وإظهار مساهمة قياس الأداء في إدارة المستودعات. وعلاوة على ذلك، كيف يؤثر قياس أداء وظيفة التخزين ويسمح بتنظيم ومراقبة بيئتها من أجل الحصول على ميزة تنافسية، وهذا يؤدي إلى أن تكون قابلة للتكيف مع التغيرات وتكون قادرة على المنافسة.

التخزين، وقياس الأداء، ومؤشرات الأداء الرئيسية

Abstract

Warehouses function as node points in the supply chain linking the material flows between the supplier and the customer As a result of the highly competitive market environment. Companies are continuously forced to improve their warehousing operations. Many companies have also customized their value proposition to better meet customer demands, which has led to changes in the role of warehouses. In such conditions improvement of order processing and materials handling can bring significant cost savings and at the same time increase customer value. In this case measuring performance is vital for companies to determine how successful they have been in attaining their objectives.

The purpose of this thesis is to give an overview and to briefly present the concept of warehousing, analyzing the warehousing process, and demonstrate the contribution of performance measurement to warehouse management. Moreover, how performance measurement influences the warehousing function and allows it to organize and monitor its environment in order to have a competitive advantage, and this lead to be adaptable to changes and be able to compete.

Key words:

Warehousing, performance measurement, key performance indicators.

Dedication

I dedicate *this* thesis *to my beloved* ***mother*** *and to the loving memory of my* ***father.***

I would like to thank my sisters, my brothers and my family members for their constant encouragement, support and blessings throughout my life.

I am also grateful to all my friends: Khalida,Hayet, Khaoula, Aicha, Meghnia,Houda, Saada, Fouzia, Rim, Fatima, Karima, Yasmeen, Asma, Nassima, whose company and support made my life filled with joy and comfort.

If any names have been omitted here it is simply unintentional and I thank everyone for their support.

Acknowledgments

This thesis not only represents the end of a very important period of my student life but also the result of hard work, curiosity, challenges, difficulties, excitement, some frustrations and an invaluable learning process.

First of all, I would sincerely thank Allah for giving me the strength and the patience to accomplish this work.

From the stages of initial ideas until the final results it was a long hard path. Indeed this thesis could not have been accomplished without the help of a number of different people. That being said, initially I would like to express my sincere gratitude to my supervisor, Mrs. Nedjoua DEMMOUCHE, for all her patience and valuable guidance since the initial stages of this work.

I also take this opportunity to thank Ammar OBAIDAT, Nesrine DIB, Aimad Eddine BOUDISSA, and all Hammadi warehouse staff members for their time and good will in sharing their knowledge and expertise with me. Their inputs about warehousing and performance measurement were extremely valuable and enlightening for the accomplishment of this thesis.

I am also grateful to all the teachers as well as to the whole staff at the School for the three years of studies and challenges.

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Abbreviations

3PL: Third Party Logistics

SCM: Supply Chain Management

DC: Distribution Centers

FIFO: First-In-First-Out

FEFO: First-Expired-First-Out

ASN: Advanced Shipping Notice

EDI: Electronic Data Interchange

AS/RS: Automated Storage and Retrieval System

WMS: Warehouse Management System

TMS: Transportation Management System

LMS: Labor Management System

RFID: Radio Frequency Identification

IT: Information Technology

SKU: Stock Keeping Unit

JIT: Just In Time

KPI: Key Performance Indicator

MHE: Material Handling Equipment

Contents

GENERAL INTRODUCTION

General introduction

During the past decades, globalization, outsourcing, and information technology have radically changed the world environment for business resulting enhanced competition, emerging opportunities as well as threats and/or risks. Managing business organizations effectively has become more important, complicated and challenging. Business, nowadays, has to adapt multivariate technologies or strategies in order to compete and survive successfully.

The competition has changed from simply being based on price to be founded on range of other complementary factors such as: quality, product, service innovation, and flexibility of response to customer needs.

Today logistics is a crucial dimension of management and business competitiveness. It is recognized as a vital function within the business and economic environment. The role of logistics has developed such that it now plays a major part in the success of many different operations and organizations.

The competition in the logistics service providers market has increased the recent years in Algeria because of the emergence of multinational companies; also customers have become more demanding and less loyal to specific suppliers. This has created a situation where 3PL providers must offer customized services; while at the same time strive to reduce costs in order to gain competitive advantages. Therefore, the suppliers must be able to provide a broad set of solutions that suit the customer's particular environment.

These services can for instance include complete distribution and warehouse solutions, inventory management, customer service center and additional value adding services.

Warehousing is one of the key functions of logistics; it is likely to be involved in various stages of the sourcing, production and distribution of goods, from the handling of raw materials and work-in-progress through to finished products.

In the current economy it has been said that the customer is no longer king but dictator. With the proliferation of websites reviewing products and services it has become even more important to match or even exceed customer expectations in terms of quality and the service provided. It is also known that it is far cheaper to keep an existing customer than find a new customer. Therefore satisfying your current customer base is paramount.

From a warehouse perspective this means that you have to ensure accuracy, quality, timeliness, and cost effectiveness within the processes you control. By doing this, you are contributing to a high-performance operation and as a result, contributing to customer

satisfaction and retention. Therefore, performance measurement is very important to verify if the company is meeting its customers' requirements and also achieving its own objectives.

The present research focuses on the importance of measuring performance for warehouse operations and its contribution to the warehouse management, the choice of this subject was mainly because of its originality and our curiosity to understand the warehousing process.

We have also chosen the sector of logistics service provider which is a 3PL company, because warehousing is one of their main activities, which allows us to gain more experience.

Thus we are offering our subject we have titled:

"Measuring performance of warehouse operations"

This study aims to address a general problematic:

"How measuring performance can contribute to the warehouse management?"

From this problematic we can derive three secondary questions:

1. What are the key success factors in managing warehouses in 3PL Company?
2. What are the important activities to be measured within the warehouse?
3. How using KPIs can lead to a continuous improvement within the warehouse?

The answer of the posed problematic can be approximated by checking the principle hypothesis: "Performance measurement facilitates the decision making, and ameliorates the warehouse management"

Also the following assumptions:

1. Time management and the inventory accuracy are key success factors in managing 3PL warehouses.
2. Measuring performance for inbound activities is vital to assess the warehouse performance.
3. Using KPIs is a dynamic tool which allows the warehouse manager to identify problems, and evaluate the accomplishment of objectives.

The methodology used in this research is based on a descriptive and analytical study of the warehousing function, to illustrate theoretical concepts and qualitative scope study on a selected sample consists of four (2) executives, two (2) warehouse supervisors within the company Aramex in Algiers.

To make sure enough knowledge was gained about warehouse management and performance measurements, literature studies were performed before designing the empirical research.

To carry out this work we have consulted several books and academic works, reviews, web sites and interviews.

We have found it useful to divide this memory into three (3) chapters:

Chapter one (1), titled “Literature review on warehousing ", this chapter begins with introducing logistics and its main concepts, then presenting warehousing process, in order to understand and be more familiar with the topic, it continues with warehouse management and the important decisions to take.

Chapter two (2), titled “Warehouse performance measurement”, this chapter covers the performance notion, and its importance in the warehousing, it ends with presenting KPIs for each warehouse operation.

Chapter three (3), titled “Measuring performance of warehouse operations”, this last chapter is finding and discussions, it includes the practical methodology that is applied for this research purpose; and it followed by the recommendations and suggestions.

Finally, we will conclude our study with a general conclusion, limitations and further areas for research.

Chapter one

Chapter1: Literature review on warehousing

The elements of logistics and supply chain have, of course, always been fundamental to the manufacturing, storage and movement of goods and products. It is only recently, however, that they have come to be recognized as vital functions within the business and economic environment. The role of logistics has developed such that it now plays a major part in the success of many different operations and organizations.

This chapter will present an overview of previous studies related to the research question. The first section of the chapter provides a brief introduction to some basic aspects of logistics. The second section will present and discuss a review of the literature related to warehousing function. The third section will introduce a review of the literature regarding warehouse management and the strategic decisions that should be made within warehouse.

Section1: Basic concepts of logistics

1.1. Origin

Many people believe that logistics is a word, but from a semantics point of view its origin was from ancient Greek and meant the "science of computation." In fact, it is originally from combat environments and not from business or academia. It seems the ancient Greeks referred the word logistikos to military officers who were expert in calculating the military needs for expeditions in war[1].

1.2. Definition of logistics

Many different definitions of logistics can be found. The most well known are the following:

Hesket, Glaskowsky and Ivie, 1973 define it as "the management of all activities which facilitate movement and the co-ordination of supply and demand in the creation of time and place utility"[2].

[1] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): **logistics operations and management**, Elsevier science, USA, 2011, p.03.

[2] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): Op.cit, p.03.

"Logistics is defined as those activities that relate to receiving the right product or service in the right quantity, in the right quality, in the right place, at the right time, delivering to the right customer, and doing this at the right cost (The seven R's)" (Shapiro, Heskett,1985)[1].

According to the council of supply chain management professionals (CSCMP, 2004) logistics management is defined as following:

"Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer's requirements. Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution – strategic, operational, and tactical. Logistics management is an integrating function which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions, including marketing, sales, manufacturing, finance, and information technology".[2]

"Logistics is defined as the planning, organization, and control of all activities in the material flow, from raw material until final consumption and reverse flows of the manufactured product, with the aim of satisfying the customer's and other interest party's needs and wishes i.e., to provide a good customer service, low cost, low tied-up capital and small environmental consequences" (Jonsson, Mattsson, 2005)[3].

1.3. <u>Evolution of logistics over time:</u> Subsequently an overview on the evolution of logistics[4]:

Logistics has an ancient history. Starting with the wars of the Greek and Roman empires in which the military officials called logistiks were responsible for supplying and

[1] RAJULDEVI (M), VEERAMACHANEMI (R) and KARE (S): **warehousing theory and practice**, Master thesis, University Boras, Sweden, 2008, p10.
[2] Ibid.
[3] Ibid.
[4] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): Op.cit, p.05.

distributing needed resources and services. Providing them had an important and essential role in the outcomes of these wars. These logistiks also worked to damage the stores of their enemies while defending their own. This gradually guided the development of current logistics systems.

Logistics systems developed extensively during World War II (1939 - 1945). Throughout this war, the United States and its allies' armies were more efficient than Germany's. German army stores were damaged extensively, but Germany could not impose the same destruction on its enemies' stores. The US army could supply whatever was needed by its forces at the right time, at the right place, and in the most economical way. From that time, several new and advanced military logistic techniques started to take off. Gradually, logistics started to evolve as an art and science. Today, experts in logistics perform their duties based on their skills, experiences, and knowledge. In modern industries, the task of logistics managers is to provide appropriate and efficient logistics systems. They guarantee that the right goods will be delivered to the right customers, at the right time, at the right place, and in the most economical way. Although logistics is a dilemma for many companies, logistical science can bring some relief to them.

In today's business environment, logistics is a competitive strategy for the companies that can help them meet the expectations of their customers. Logistics helps members of supply chains integrate in an efficient way.

Logistics does not consist of one single component but involves a group of various activities and disciplines such as purchasing, planning, coordinating, warehousing, distributing, and customer service.

1.4. Objectives of logistics

Logistics has the following objectives[1]:

- **Reduction of inventory**: Inventory is one of the key factors, which can affect the profit of an enterprise to a great extent. In the traditional system, firms had to carry lot of inventory for satisfying the customer and to ensure excellent customer service. But, when funds are blocked in inventory, they cannot be used for other productive purposes. These costs will

[1] http://www.ciilogistics.com, in 22/05/2016 at 11:15

drain the enterprise‘s profit. Logistics helps in maintaining inventory at the lowest level, and thus achieving the customer goal. This is done through small, but frequent supplies.

- **Economy of freight**: Freight is a major source of cost in logistics. This can be reduced by following measures like selecting the proper mode of transport, consolidation of freight, route planning, long distance shipments etc.
- **Reliability and consistency in delivery performance**: Material required by the customer must be delivered on time, not ahead of the schedule or behind the schedule. Proper planning of the transportation modes, with availability of inventory will ensure this.
- **Minimum damage to products**: Sometimes products may be damaged due to improper packing, frequent handling of consignment, and other reasons. This damage adds to the logistics cost. The use of proper logistical packaging, mechanized material handling equipment…etc. will reduce this damage.
- **Quicker and faster response**: A firm must have the capability to extend service to the customer in the shortest time frame. By utilizing the latest technologies in processing information and communication will improve the decision making, and thus enable the enterprise to be flexible enough so that the firm can fulfill customer requirements, in the shortest possible time frame.

1.5. Typology of logistics

Logistics has been recognized as a major function in its own right. The main reason that this recognition has only been relatively recent is the nature of logistics itself. It is a function made up of many sub-functions and many subsystems, each of which has been, and may still be, treated as a distinct management operation. Both the academic and the business world now accept that there is a need to adopt a more holistic view of these different operations in order to take into account how they interrelate and interact with one another[1], subsequent the functional distinctions of logistics systems according to the phases of the flow of goods, this ranges from the supply of goods to the disposal or recycling of waste[2]:

1.5.1. Procurement logistics: is concerned with the organization and the physical processes involved in the transport and supply of the input factors for the corporate process. This applies both to industrial companies and trading companies.

[1] RUSHTON (A), CROUCHER (p) and BAKER (P): **the handbook of logistics and distribution management**, 5th Edition, Kogan page, UK, 2014, p.03.

[2] GLEISSNER, (H) and FEMERLING (J.C): **logistics**, Springer, Switzerland, 2013, p.12.

The procurement process aims to ensure the economic supply of the materials or commodities which are to be processed. In practice, the purchase with its market oriented and contracting tasks is either subsumed under the term procurement.

Manufacturing companies often refer to this phase in the flow of goods as materials management. However, materials management may also include production and distribution.

1.5.2. Production logistics is mainly associated with manufacturing companies. It deals with all tasks pertinent to the planning and controlling of those internal processes that relate to the materials flow, storage, and internal transport. Additionally, production logistics plays an important part in planning and integrating both the preceding procurement logistical processes and the subsequent distribution logistical processes. Production logistics is less characterized by major physical flows of goods over long distances rather than by intelligent planning of the processes and the provision of goods within a smaller context.

1.5.3. Distribution logistics is primarily concerned with the coordination of all processes that serve to deliver the goods to the recipient or to the point of sale for consumption by the end user. Distribution logistics describes the interaction of transport and storage processes within logistics systems for the distribution of a company's goods.

1.5.4. Reverse logistics is the process of moving goods from their place of use, back to their place of manufacture for re-processing, re-filling, repairs or recycling/waste disposal. It is a planned process of movement of goods in reverse direction in an effective and cost efficient manner, through an organization network. It is an integrated system in an organization's supply chain management[1].

1.6. Logistics flows

Logistics execution is defined as managing and coordinating the movement of materials, information and funds across the supply chain. The flow is considered to be bi-directional.

[1] http://fr.slideshare.net/sanket_123/reverse-logistics-presentation (consulted on 17/05/2016 at 10:06)

1.6.1. Financial flows

The tasks of optimizing supply chains tend to be limited to tangible cost elements such as transport and warehousing. The costs to finance products moving through the supply chains tend to be forgotten. These costs include not only inventory financing costs but also those costs associated with taking credit risks upon sale, supporting trade credit and taking out insurance. Logistics-driven finance costs also include process-related costs incurred through suboptimal designed processes for invoicing, monitoring receivables and payments. Furthermore, the cash flows and revenue stream generated by successful order fulfillment have to be looked at closely. The generation of reliable and predictable cash flow out of order fulfillment is a condition of the ability of any commercial organization to survive that is not to become in debt. This is not an isolated task of treasury department. On the contrary, it is the scope of SCM to integrate three flows: material, information and financial[1].

1.6.2. Physical and Information flows

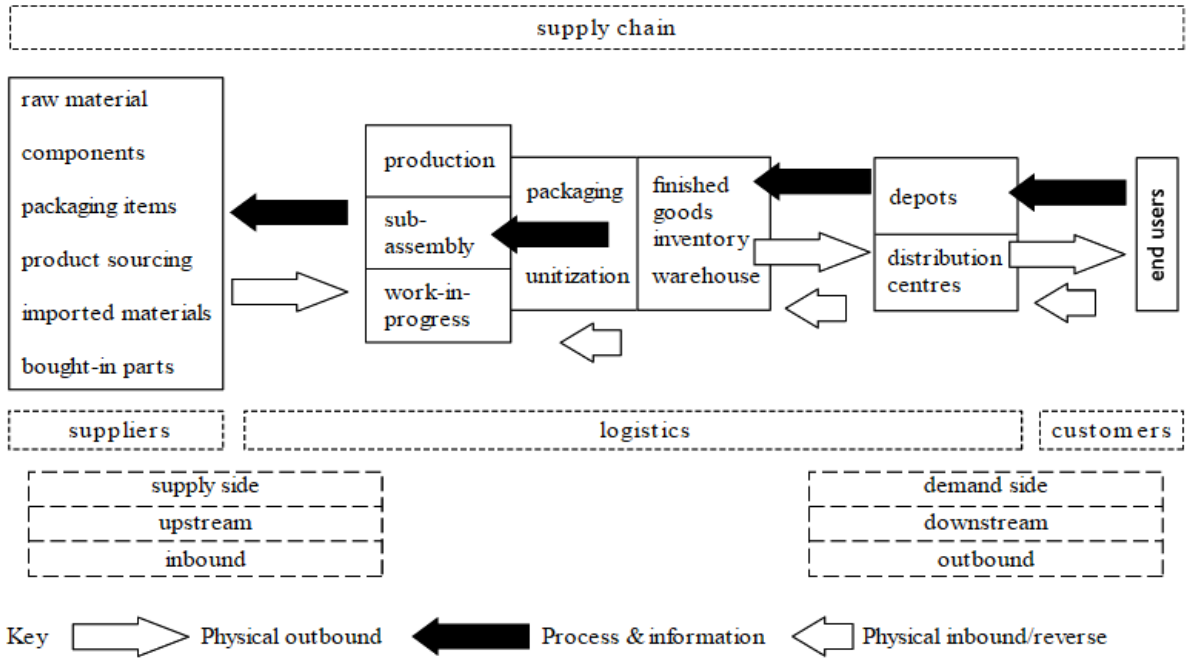
The logistics concept was introduced as a response to the increasing necessity of an integrated system, which plans and coordinates the materials flow from the source of supply to the point of consumption instead of managing theses flows as series of independent tasks.

The entire process of logistics, which deals with the moving of materials into, through, and out of a firm, can be divided into three parts[2]:

- Inbound logistics, which represents the movement and storage of materials received from suppliers;
- Materials management, which covers the storage and flows of materials within a firm;
- Outbound logistics or physical distribution, which describes the movement and storage of products from the final production point to the customer. These terms as well as some of the other associated logistics terminologies are indicated in Figure I-1

[1] WATERS, (Donald): **global logistics and distribution planning**, 4th edition, Kogan page, England, 2003, p.277.
[2] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): Op.cit, pp.12.13.

Figure I-1: Physical and information flows in the supply chain.



Source: WATERS, (Donald): global logistics and distribution planning, 4th edition, Kogan page, England, 2003, p.277.

As Figure I-1 illustrates, logistics is concerned with two types of flow:

Physical flow (Also known as material or inventory flows) and information flow. It is common to consider physical flow as the forward flow throughout the logistics network, the main direction of which is from the point of origin to the point of consumption. Also, the information flow is considered to be backward, so its main direction is from downstream to upstream elements. However, in practical terms, the directions of physical and information flows are not one way. Materials and information flow from both upstream and downstream. In regard to physical flow, the backward flow of product is referred to as reverse logistics.

It is the flow of returned goods and used products as well as salvage, scrap disposal, and returnable packaging back through the system.

Information flows occupy the integration of all the processes through the supply chain in order to share valuable information, which includes forecasts, inventory, transportation, and potential collaboration.

Physical flows involve the entire process and activities of logistics systems; however, to explore the concept of physical flows systematically, the major components of logistics systems can be categorized into five functional areas, based on Ailawadi and Singh:

- Network design
- Information
- Transportation
- Inventory
- Warehousing, material handling, and packaging

Considering these functional areas, physical flow is more involved with the transportation and warehousing, material handling, and packaging.

Section2: Introduction to warehousing

Warehouses are crucial components of most modern supply chains. They are likely to be involved in various stages of the sourcing, production and distribution of goods, from the handling of raw materials and work-in-progress through to finished products. As the dispatch point serving the next customer in the chain, they are critical to the provision of high customer service level[1].

Warehouses have always been paid a great deal of attention from managers due to the large potential impact it can have in creating customer value. Like most areas the key objectives for managing warehouses have changed over time to create additional competitiveness. Warehousing is however a correlation between logistics cost and good customer service; the higher customer service a company aims for, the greater logistics costs one can expect, which is one of the greatest trade-offs companies face in warehouse management (Van Den Berg, 2012)[2].

This following section will provide a brief review of literature of the warehousing within the distribution process (outbound logistics).

2.1. Definition of warehouse

A warehouse or a distribution center is a commercial building used for the storage of goods. The principal element of warehousing is order processing which generally refers to the work flow associated with delivering products ordered by a customer to a shipping carrier. The primary aim for warehouses and distribution centers is to facilitate the movement of goods from suppliers to customers while meeting the customers' demand in a timely and cost-effective manner[3].

[1] RUSHTON (A), CROUCHER (p) and BAKER (P): Op.cit, p.255.

[2] AXELSSON, (P) and FRANKEL (J): **performance measurement system for warehouse activities based on the SCOR model**, Master thesis, Lund University, Sweden, 2014, p34.

[3] BLOMQVIST, (Tommy): **a warehouse design framework for order processing and materials handling improvement**, Master thesis, Aalto University, 2010, p11.

2.2. Types of warehouses

The nature of warehouses within supply chains may vary tremendously, and there are many different types of classifications that can be adopted. Here are some of the more important distinctions:

2.2.1. By ownership:

For acquiring warehouse space, the following three options are available[1]:

2.2.1.1. Private warehouse

Private ownership of storage facility refers to having the entire facility under the financial and administrative control of the firm, ie, the firm owning the product operates the warehouses. The facilities may either be owned by the firm or taken on lease, for a period of three or five years, these facilities may include a production oriented captive warehouse or a distribution warehouse located in the field for customer service. Private warehouses are attractive proposition under certain circumstances, such as:

- Product specific material handling are not available with other options;
- Volumes handled are high, ensuring full capacity utilization and benefits of scale economics;
- A high degree of control over the operations is required.

The benefits of private warehouses are flexibility, full management control, and lower operating cost. Private warehouse operating cost less, as they do not have a profit markup. Material handling and storage facility can be changed as per product mix, which is not possible in the case of public or contract facilities. Hence, there is complete flexibility. Private warehouse facilities can be planned close to markets to service the customer efficiently and effectively. This enhances customer confidence in the supplier.

2.2.1.2. Public warehouse

Public warehouses are similar to private carriers in transportation service. Firms having warehousing space, storage facility, and material handling equipment for their own

[1] SOPLE, (Vinod): **logistics management**, Dorling Kindersley, India, 2007, p44 to 46.

use, provide these services to others as well, these are extensively used in logistical systems. Public warehouses are designed for handling the most general package products or commodities, which do not require specialized storage or handling arrangement.

Bonded warehouses under ‘customer’ control are mostly often public warehouses licensed to store goods intended for exports or imports till the time they are cleared by the customs authority for further movement.

The private warehouse provides financial flexibility. Newly formed firms, desirous of expanding their distribution network need not invest in developing a private warehouse. They have the option of hiring space in public warehouse and channeling their funds into other productive activities. This will substantially improve their performance and thereby increase return on investment. Public warehouses allow location flexibility, due to geographical changes in consumption centers; firms can close storage facilities in one market and open them at other places without any financial losses. The greatest disadvantage of private warehouse is the absence of control over operations. As product specific facility is not available, product damages during storage and handling may not be on the higher side. The speed of order fulfillment is slow, resulting in a lower level of customer service.

Economics scale can be achieved with public warehouses because of the volumes generated through a large number of facility users. Transportation charge can be considerably brought down.

2.2.1.3. Contract warehouse

These are the product specific warehouse facilities acquired for a specific period against fixed charges. Contract warehouses can provide the benefits of both private and public warehouses. This facility provides economics of scale, flexibility, and customized facilities. Recourses like labor, material handling equipment, storage arrangement, and communication equipment can be shared with depositors form the same industry to economize on operating costs. As the facilities are product specific, product damages are few. The large volume will apportion fixed costs with co-users.

2.2.2. By customers:

Following a categorization of warehouses by the customers they serve[1]:

2.2.2.1. A retail distribution center

Typically supplies product to retail stores, such as Wal-Mart or Target. The immediate customer of the distribution center is a retail store, which is likely to be a regular or even captive customer, receiving shipments on regularly scheduled days. A typical order might comprise hundreds or thousands of items; and because the distribution center might serve hundreds of stores, the flow of product is huge. The suite of products changes with customer tastes and marketing plans; but because the orders are typically known a day or more in advance, it is possible to plan ahead. Some product may be pushed from the distribution center to the stores, especially in support of marketing campaigns.

2.2.2.2. A Service part distribution center

Theses DCs store hundreds or even thousands of different parts, many which normally also are expensive and slow moving. Subsequently, such DCs are among the hardest to control and manage.

2.2.2.3. A catalog fulfillment or e-commerce distribution center

Typically receives small orders from individuals by phone, fax, or the Internet. Orders are typically small, for only 1–3 items, but there may be many such orders, and they are to be filled and shipped immediately after receipt. Because customer orders require instant response, such distributors typically try to shape demand by offering special prices for ordering at certain times or in certain quantities or for accepting more variable delivery dates.

2.2.2.4. A 3PL warehouse is one to which a company might outsource its warehousing operations. The 3PL provider might service multiple customers from one facility, thereby gaining economies of scale or complementary seasons that the customers would be unable to achieve on their own.

A 3PL provider is a company that offers service to its customers for part, or all, of their supply chain management functions (Kolderup-Finstad, 2012). In today's global markets

[1] BARTHOLDI, (J) and HACKMAN (S): **warehouse and distribution science,** the supply chain and logistics institute, Atlanta, 2014, pages 08 to 10.

many manufacturing companies increasingly focus on their core competences and outsource other activities. The reasons behind the decision can be to reduce cost or increase customer service and revenues, by for instance reducing lead-times and increase flexibility and responsiveness. By outsourcing less strategic activities, where for instance the level of competitiveness relative to the suppliers are low, the company can get access to competence or resources not present internally today. (van Weele, 2010)[1].

A 3 PL provider offers public and contract warehousing services and helps companies grow their business by enhancing their distribution process, providing a more flexible and agile supply chain capable of responding quickly and efficiently to their customer's changing requirements, and lowering a company's total cost of distribution[2].

2.2.2.5. A perishables warehouse may handle food, fresh flowers, vaccines, or other product requiring refrigeration to protect its very short shelf life. They are typically one link in an extended cold chain, along which perishable product is rushed to the consumer. Such DCs are distinctive in that product dwells within for very short times, frequently only hours. Also, there is a great emphasis on using space effectively because, with refrigeration, it is so expensive. They face many challenges in inventory management, including requirements to ship product according to FIFO or FEFO. Also, there typically many restrictions on how product is handled.

2.3. The Role of Distribution Centers and Warehouses in Logistics

The prime objective of most warehouses is to facilitate the movement of goods through the supply chain to the end consumer, as follows a general reasons for installing DCs and warehouses[3]:

- **Storage of goods:** The basic function of warehouses is to store goods for the time they will be needed. As part of production process: In many cases, a production process needs

[1] FRANKIN (S) and JOHANNESSON (K): **Analyzing warehouse operations in a 3PL company**, master thesis, Chalmers University of technology, Sweden, 2013, p.11.

[2] http://www.awilogistics.com/ (consulted on 17/05/2016 at 10:30)

[3] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L):Op.cit, pp 182.183.

a period of time (without any operation) to complete a product. Thus, warehouses can keep such products as a part of their production process.

- **Returned goods center:** In reverse logistics, the handling of returned goods becomes important, so warehouses can act as a place to accumulate and make decisions about returned goods;
- **Consolidation:** When customers order a number of products from different places and want them to be delivered together, a warehouse can receive the requested products from their separate origins and deliver them altogether to the customer.
- **Break-bulk:** Break-bulk warehouses divide large receiving shipments in bulk from manufacturers into small less than truckload (LTL) shipments and send them to the customers.
- **Postponement:** Warehouse can also be used as a place to postpone the production process. In these cases, a warehouse is capable of doing light manufacturing activities such as labeling, marking, and packaging. In-process goods are kept in these warehouses until a demand with special characteristics such as mark or package occurs; the requested activities will be done in the warehouse and finished goods will be ready to satisfy the demand.
- **Cross docking:** In some cases, a warehouses act as a cross-docking point. Inventory does not stay in more than 12 hours. However, these warehouses receive inventory, transfer it to vehicles, and deliver to retailers. This system leads to reduction of inventory costs and lead times by decreasing storage time.
- **Transshipment:** Transshipment is the process of transferring goods from one vehicle to another as necessary.
- **Product-fulfillment center:** Fulfillment centers are distribution centers or warehouses that connect directly with final consumers. The following are some of the differences between product-fulfillment centers and other warehouses:
  - Higher levels of customer service are available because of direct connects with final customers.
  - More orders of smaller size are possible; these are almost always received electronically.
  - Fulfillment centers typically must receive customer payments, often by major credit card; some also create customer invoices and handle banking for their clients.
  - Returns from customers are more than that in the other warehouses.

- Computerized information systems and task automation are increasingly critical, and the transportation function (especially residential delivery) is more complex.

2.4. Warehouse functions

Warehousing plays a critical role in logistics systems, providing the desired customer-service levels in combination with other logistics activities. A wide variety of operations and tasks are performed in warehousing; these can be categorized under three basic functions[1]:

1. Movement (material handling)

2. Storage (inventory holding)

3. Information transfer

Traditionally, the storage function was considered as the primary role of warehouses because they were perceived as places for long-term storage of products. However, today's organizations try to improve their inventory turns and move orders more quickly through supply chain networks; therefore, nowadays, long- term storage role of warehouses has diminished, and their movement function has received more attention.

2.4.1. Movement

The movement or material-handling function is represented by four primary activities:

2.4.1.1. Receiving and put away: The receiving function allows warehouse operators to receive product against a purchase order, and against an Advanced Shipping Notice (ASN) that has been received via Electronic Data Interchange (EDI). Receiving process could include goods physically received at the warehouse and stored or directly delivered at customer site or cross-docked. This activity includes unloading goods from the transportation equipment as well as verifying their count and specifications against order records, inspecting them for damage, and updating warehouse inventory records. Receiving also includes sorting and classification of products and prepackaging bulk shipments into smaller ones before moving them to their warehouse storage location. Finally, the

[1] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): Op.cit, pp.31.32.

physical movements of products to storage areas, locations for specialized services (such as consolidation areas), and outbound shipment places are referred to as pass-away activities.

2.4.1.2. Pick and pack: This is a fundamental movement activity in warehousing and involves identifying and retrieving products from storage areas according to customer orders.

This activity can be broadly divided into two parts. First one deal with case picking and the second one deal with small item picking. Further case picking can be classified into three categories. The first one is known as Pick-face palletizing where warehouse operator palletizes at the pick-face as he/she traverses the picking tour. The second one is downstream palletizing where cases are picked onto conveyors and sorted at the staging area. The third one is direct loading where the cases were conveyed directly into the truck. Further, the small item picking can be classified into three categories. The first one is known as picker-to-stock, where the picker moves around to pick the cases. The second one is stock-to-picker. In this case stock was sent to the stationed picker through AS/RS machine. The third one is known as automated item picking. In this process items are automatically dispensed into shipping cartons or tote pans. Order-picking activities are time consuming and labor intensive[1].

2.4.1.3. Cross docking: In this process, receiving products from one source are occasionally consolidated with products from other sources with the same destination and immediately sent to customers, without moving to long-term storage. A pure cross-docking operation only organizes the transfer of materials from inbound receiving dock to the outbound dock, eliminating non value-adding activities such as put away, storage, and order filling. In practice, however, there might be some delay, and the items may remain in the facility between 1 and 3 days.

2.4.1.4. Shipping: This activity involves physically moving and loading assembled orders onto transportation carriers, checking the content and sequence of orders, and updating inventory records. It may also include sorting and packaging the products for specific customers or bracing and packing the items to prevent them from damage.

[1] https://vijaysangamworld.wordpress.com consulted on 09/04/2016 at 11:19

2.4.2. Storage: The storage function of warehouses is simply about the inventory accumulation over a period of time. The storage of inventory may take place in different locations and for different lengths of time in warehouses, depending on the storage purpose. In general, four primary storage functions have significant impacts on the storage facilities' design and structure: holding, consolidation, break-bulk, and mixing. Warehouses may be designed to satisfy one or more of these functions, and their layout and structure will vary based on their emphasis on performing these storage functions.

The storage of inventory in warehouses can be categorized into two main groups, according to the length of storage time: temporary or short-term storage and semi-permanent or long-term storage. In temporary storage, only products required for basic inventory replenishment are stored. The amount of temporary inventory required to be stored in warehouses is determined based on the extent of variability in lead time and demand. Also, the design of logistics systems may affect the inventory extent. The emphasis of temporary storage is on the movement function of warehousing, and pure cross docking tends to use only this kind of storage. However, semi-permanent or long-term storage includes the storage of products in excess of that necessary for basic replenishment. Semi-permanent storage is justified in some common situations, including:

1. Seasonal or erratic demand

2. Conditioning of products (e.g., fruits and meats)

3. Special deals (e.g., quantity discounts)

4. Speculation or forward buying

2.4.3. Information Transfer

Precise and timely information is a must for managers to administer the warehousing operation; therefore, they attach great importance to the information-transfer function. This function takes place concurrently with the other warehousing functions movement and storage and provides the warehouse manager with information on the inventory and throughput levels, locations where products stored, as well as inbound and outbound shipments. These types of information along with the data on space utilization, customer and personnel information, and other pertinent information are essential for ensuring a successful warehousing operation. Recognizing the crucial importance of these types of information,

companies are continually improving the speed and accuracy of their information-transfer function by using computerized and modern processes such as bar coding their products, and using the Internet or electronic data interchange (EDI) systems for transferring their information.

2.5. Warehouse Costs

Warehousing typically accounts for about 20 to 30 per cent of logistics costs, while the carrying costs for the inventory within them account for a further 20 to 25 per cent. Together, these represent a very significant sum for many companies. The detailed breakdown of warehouse costs varies by the nature of the operation, but typical figures from past studies of 'conventional' warehouse operations (e.g. adjustable pallet racking served by reach trucks with case picking at ground level) are as follows[1]:

•Staff: 45 to 50 per cent, with half of this often represented by order picking and packing staff;

•Building: 25 per cent, including rent or depreciation on the building;

•Building services: 15 per cent, including heat, light, power, building maintenance, insurance and rates;

•Equipment: 10 to 15 per cent, including rental or depreciation, equipment maintenance and running costs;

•Information technology: 5 to 10 per cent, including systems and data terminals.

As mentioned before warehouse total cost mainly includes labor, space, equipments, and Information technology, therefore, warehouse manager's main mission is to optimize these inputs and create value. In the next section we'll mention the main areas in warehouse management and the strategic decisions that should be taken to ensure an effective utilization of warehouse resources.

[1] RUSHTON (A), CROUCHER (p) and BAKER (P): Op.cit, p.254.

Section3: Warehouse management

There are tremendous challenges within warehouse that the warehouse manager will confront; the most common ones are: inventory location and accuracy, space utilization (warehouse layout), picking optimization, and the degree of automation.

This section will provide an understanding of these areas and a short explanation of the tools of running them; we will also mention the strategic decisions within warehouse.

3.1. Inventory Management

Inventories are raw materials, work in process, and finished goods that companies keep for different reasons such as saving time, to meet economic objectives, and as a buffer against uncertainties. The basic element of customer service for all logistics is inventory availability, and generally the most expensive logistics cost is inventory. Effective inventory management decreases carrying cost and increases customer satisfaction at the same time[1].

3.1.1. Types of Inventory

The following are among the many types of inventory that can be warehoused:

- Cycle stock is inventory, i.e., highly predictable in its turnover and need to be replenished.
- Safety stock is inventory, i.e., concerned with short-range variations in either demand or replenishment. It protects against the uncertainty of demand and lead time.
- Transit inventory or pipeline inventory is composed of products that are in transit between producer and purchaser locations and are not ready to use or be sold. This stock is equal to the expected demand over the lead time (the time between issuing an order and receiving it).
- Speculative stock is inventory kept in case of material shortages, price increases, or unexpected changes in demand rather than to satisfy current demand.
- Seasonal stock is one form of speculative stock that is held for anticipated demand for a specific time period.
- Dead stock is inventory for which there is no longer demand. These inventories impose tax costs on a firm, so they should be moved out as appropriate.

[1] ZANJIRANI FARAHANI (R), REZAPOUR (S) and KARDAR (L): Op.cit, p.188.

3.2. Warehouse handling equipment

To be able to decide on how to equip our warehouses with the most efficient mechanical handling equipment we need to undertake the following[1]:

- define the functions to be performed;
- review all stock items and define their handling requirements;
- understand the travel distance and speed relationship;
- understand the limits of the building and the structures within it;
- evaluate staff capabilities; and
- evaluate vendors, equipment alternatives and relative costs.

3.3. Labor management in warehousing

An Ideal labor management measures the individual performances against standard times applied with the help of a labor management system that forms an interface between the labor management system and the time and attendance systems. The outcome results commonly in time, used by the warehouses to improve productivity. An effective labor management should support workload planning, process improvement, and in some cases, incentive schemes. A basic challenge for all warehouse managers is allocating right number of people in the right place and at the right time to produce quality work. Warehouses with more number of employees result in high labor cost, low productivity and less profits. Alternatively with less staff there is a problem of employee burnout, quality problems and higher costs. It is a proven fact that labor management could cut down the costs to a considerable level arising due to labor, warehouses with a labor management can save more on increasing resources.

The growing demand for value-added services, labeling and promotional display, packaging, reverse logistics, recycled packaging and product for rework and customer returns, had a direct impact on the warehouse costs, and thereby increasing the cost per employee.

Few case studies suggest an increase in productivity with labor management. Most of the warehouses have experienced a significant performance improvement, and also stated that

[1] GWYNNE, (Richards): **warehouse management**, 2nd edition, Kogan page, UK, 2014, p 239.

performance would fall back considerable without a labor management application (Dymond, 2007)[1].

3.4. Strategic warehouse decisions

3.4.1. Ownership

As mentioned in the precedent section, an insightful explanation of warehouses' types by ownership, a brief comparison between the three types in the following table:

Table I-1**:** comparison between warehouse types.

	Private	Public	Contract
Investment	High	None	Very little
Flexibility in	Material handling storage and throughput planning	Location	Location
Cost per unit stored	Inversely related to volumes	Low	Inversely related to volumes
Level of control	High	Low	Medium
Adequacy of goods stored	High	Low	High
Risk	Due to change in market demand or consumption centers	Minimal	Minimal

Source: SOPLE, (Vinod): logistics management, Dorling Kindersley, India, 2007, p.49.

Obviously the choice between the above operations will depend on the demand pattern of the product, volumes handled, geographical location, seasonality of the product, standardization of product packaging, financial strength of the firm, service level expectations of the customer, and competition. Thus, selecting one of these types depends on what the firm considers as vital factor for success.

[1] RAJULDEVI (M), VEERAMACHANEMI (R) and KARE (S): Op.cit, p. 45.

3.4.2. Number of warehouses

There is an ongoing debate as to whether companies are going to increase or reduce the number of warehouse operated within the supply chain. There is no doubt that the move to multichannel retailing is having an effect on the number and size of locations operated.

The increasing cost of fuel, a move towards near-shoring and a requirement to be nearer the customer could see the number of local warehouses and distribution centers increasing with cross-dock operations being favored by more companies. As with most areas of the supply chain there is a trade-off here. We can see from Table I-2 that most costs are higher if multiple warehouses are chosen; however, all of these costs can be off-set by a significant reduction in local transportation costs and improved service. In terms of inventory we need to be able to calculate by how much we will increase or reduce our safety stockholding when we change the number of warehouses operated[1].

Table I-2: Comparison between many and fewer warehouses.

Criteria	Many warehouses	Fewer warehouses
Inventory costs	Higher	Lower
Customer reaction time	Quicker	Slower
Facility costs	Higher	Lower
Inbound transport cost	Higher	Lower
Outbound transport cost	Lower	Higher
Systems costs	Higher	Lower

Source: GWYNNE, (Richards): warehouse management, 2nd edition, Kogan page, UK, 2014, p 20,

[1] GWYNNE, (Richards): **warehouse management**, 2nd edition, Kogan page, UK, 2014, p 20, 21.

3.4.3. Warehouse Design

When the location of warehouse is specified, the next decision is to determine the size of the building that is needed; also storage policies are required as subsequent[1]:

3.4.3.1. Size of the warehouse

Determination of warehouse size is affected by the following factors:

- Customer-service levels
- Size of market(s) served
- Number of products marketed
- Size of the product(s)
- Material-handling system used
- Throughput rate (i.e., inventory turnover)
- Production lead time
- Economics of scale
- Stock layout Aisle requirements
- Office area in warehouse
- Types of racks and shelves used
- Level and pattern of demand
- Storage policy

3.4.3.2. Storage Policies

Three policies are followed to assign products to storage areas: randomized, dedicated, and class based. Under a **randomized** storage policy, there are no restrictions on where items can be stored in the storage area, so any item can be placed anywhere. Under the **dedicated** storage policy, items can only be stored in their own special areas. Under **class-based** storage policy, items are divided into some classes, and each class is assigned to one storage area. Indeed, in the class-based storage policy, when there is only one class for all items, we have a randomized storage policy; when there is one class for each item, we have class-based storage policy. The best selection among different storage policies depends on the costs of order picking and warehouse space. Dedicated or random policy is selected when the order-picking costs or space costs are important. However, if both of costs (order picking and

[1] GWYNNE, (Richards): Op.cit, P.27.

warehouse space costs) simultaneously are important, the best solution is class-based storage policy.

3.4.4. Warehouse location

After a need for storage space has been demonstrated, the warehouse location should be determined. Facility location has a long-term impact on supply chains, so it is a strategic decision in supply-chain design. According to Chopra and Meindl, there are many factors that help decision makers to choose a place for warehouse; the following factors are some of them[1]:

- Land configuration and developing costs
- Building construction costs
- Community and local government attitude toward the warehouse
- Availability and access to transportation services
- Potential for expansion
- Hazards of the site (fire, theft, flood, etc.)
- Local labor quantity, labor rates, and climate
- Traffic congestion around the site Advertising value of the site
- Taxes relative to the site and operation of the warehouse.

  Facility location decision is typically made at two levels:

1. With respect to the location of all existing warehouses, where should be located a new one to balance transportation costs, inventory costs, order processing costs, etc.

2. After determination of general geographic region, it should be determined whether the warehouse is to be located on this side of town or that, or in this industrial part or that.

3.4.5. Warehouse layout design

When considering the planning, layout and operation of the warehouse system the following fundamental principles, which embody the philosophy of good practice, should be adhered to[2]:

[1] GWYNNE, (Richards): Op.cit, P.32.

[2] SOPLE, (Vinod) : **logistics management**, Dorling Kindersley, India, 2007, p49,50.

- Make the best use of available space
- Use a ‘unitized’ load system suitable for storage
- Minimize goods movement by proper storage area allocations
- Provide safe, secure, and clean working conditions

The location of stock in warehouse directly affects the total material handling expenses of all goods moving through the warehouse. A balance has to be maintained between the material handling cost and utilization of warehouse space. The storage and handling equipment should be chosen to improve the cubic capacity utilization. Effective space utilization includes making good use of building volume and not merely floor area.

The following steps need to be followed while designing warehouse layout for a given space:

- Define the location for receiving and shipping functions
- Allocate separate area for slow, medium, and fast moving items
- Define the location of fixed obstacles such as building columns, staircases, elevator shafts, toilets etc
- Define minimum path, for the movement of equipment and persons, for faster storage and retrieval
- Locate stationary material handling equipment (crane, conveyer) at their assigned places
- Locate storage equipment at its assigned places
- Repeat the process for generating an alternative layout

3.4.6. Packaging and unit loads

Most goods that pass through a warehouse are packaged. This may be, for example, to contain the product, protect or preserve it, improve its appearance, provide information, or facilitate storage and handling. Frequently, this packaging is at a number of different levels, such as directly enclosing the product (i.e. primary packaging), containing a number of primary packages (i.e. secondary packaging), or some form of outer packaging (normally to facilitate transport and handling).

The nature of packaging is very important for warehousing operations, particularly as customers may require the goods at any of these levels. Thus, some customer orders may

be for individual items (e.g. in their primary packaging), for cases of goods (eg containing a number of items) or at some greater quantity (e.g. a full pallet load of goods). The warehouse operation must be designed so that any of the order quantities that are offered to customers can be picked and dispatched cost-effectively.

Most supply chains are structured around the unit load concept, whereby goods are transported, stored and handled in standard modules. This may occur at different levels, for example with goods being placed in cartons, which are placed on pallets, which in turn may be loaded in ISO containers for export shipping. The use of such unit loads enables transport, storage and handling systems to be designed around modules of common dimensions[1].

3.4.7. Warehouse automation

One of the most important developments in warehousing today is the application of automation and computerized software and information-gathering devices to plan, control, monitor, and perform materials handling functions. The growth of automation in the warehouse is the result of the following drivers[2]:

- Growing requirements for the application of lean thinking and practices to warehousing.
- The application and adoption of sustainable business practices in the warehouse focusing on reducing energy and environment costs.
- Requirements for increased horizontal integration between the warehouse and the information systems used by other enterprise business functions.
- Integration between warehouse management systems (WMS) and transportation management systems (TMS).
- Increased need to design multi-channel warehouses capable of fast-flow throughput and cost-reducing measures in the fulfillment of online order and web-based information.

Effective scheduling, training, and management of warehouse labor through integration with labor management systems (LMS). Effectively responding to these six challenges involves the increased utilization of technologies designed to enhance warehouse automation, deepening the planning and control of warehouse functions, and providing for

[1] RUSHTON (A), CROUCHER (p) and BAKER (P): **the handbook of logistics and distribution management**, 5th Edition, Kogan page, UK, 2014, p263, 264.

[2] ROSS, (David): **warehouse management**, Springer, New York, 2015, p.674.

integration with order management and transportation software applications. These imperatives are enhanced in today's warehouse for the following reasons:

- Declining costs of warehouse automation,
- Increasing costs of labor and associated overheads,
- Demand for much closer supply chain integration and collaboration,
- Value-added philosophies stressing continuous elimination of operational wastes and redundancies, and
- Requirements for shorter purchasing and customer service cycle times.

While there are many possible directions that can be pursued in warehouse automation, two critical paths stand out. The first is the use of warehouse automation tools to reduce error, increase productivity, and speed supply chain flow-through. The second path is the implementation of software suites for integrated warehouse management, labor and task planning, automation of stock put-away and order picking, and use of bar coding, robotics, and radio frequency identification (RFID).

3.4.7.1. Warehouse Management System

Warehouse management is the critical part of any business and in order to manage efficiently, we need IT systems and tools. Managing a modern day warehouse with ever increasing SKUs is becoming challenging. Added to that, globalization influenced how we warehouse products in a multi-site warehousing. Complex supply chains, JIT, Cross Docking, In-transit merging and multi-site warehousing made inventory management and control a challenging task without an efficient WMS. In order to deliver targeted warehouse objectives and transform warehouses into profit centre it is essential to understand warehouse objectives and make use of people strengths, processes and technology to achieve the same[1].

What are warehouse Objectives?

- Maximize Storage (space or cube) utilization;
- Maximize warehouse equipment utilization;
- Maximize human resources utilization;

[1] https://vijaysangamworld.wordpress.com Op.cit.

- Reduce SKU handling;
- Minimize Operating expenses;
- Assure protection of Assets

In order to achieve, above identified objectives, we need technology help and importantly information technology which is Warehouse Management System (WMS).

What is WMS?

"*A warehouse management system provides the information necessary to manage and control the flow of products in a warehouse, from receiving to shipping."* In simple warehouse manages product flows and WMS manages information flows of the products handled and moved within a warehouse. In many organizations we see WMS working as an independent node managing product flows. However, it is crucial that WMS is integrated or capable of interacting with other information systems in order execute actions seamlessly.

3.5. Performance measurement

The final step in the warehouse management process is establishing detailed performance measurements. Warehouse performance metrics have three objectives. First, they enable management to formulate a clear, quantitative statement of the performance standards to be achieved by the warehouse. These standards are then used as a benchmark guiding daily activity execution and continuous improvement. Second, they enable managers to chart how effectively warehouse activities are being performed to standard. Because the rest of the organization depends on the warehouse to execute receiving, storing, picking, and shipping functions that match published standards, performance measures demonstrate the degree to which the warehouse is responding to enterprise operational needs. Third, they assist managers and associates in pinpointing problems that inhibit productivity so that constructive steps are taken to eliminate the problem from reoccurring. Finally, performance measurements provide companies with a means to plan and control the significant variances experienced in warehouse operations. The randomness of customer demand, customer service commitments, rush shipments, postponement activities, equipment capacities, and a host of other factors disrupt normal throughput and require detailed planning and control if the warehouse is to maintain high productivities[1].

[1] ROSS, (David): **warehouse management**, Springer, New York, 2015, p.637.

Warehousing and warehouse management are part of a logistics management system, which is itself a component in supply chain management. Although viewed as simply a place to store finished goods, inbound functions that prepare items for storage and outbound functions that consolidate, pack and ship orders provide important economic and service benefits to both the business and its customers.

This chapter covered the major notions of logistics, and also identified the warehousing as one of the most challenging activities which have always been paid a great deal of attention from managers due to the large potential impact it can have in creating customer value. And also explains the difficulties they are facing to optimize warehouse's operations.

The next chapter will be about performance process and the importance of measuring warehouse's performance.

Chapter two

Chapter2: warehouse performance measurement

"Y*ou can't manage what you can't measure*". It is an old management adage which remains equally true today. Therefore, measurement is fundamental to management effectiveness. Performance measurement is at the heart of management for controlling, reporting as well as learning and improvement.

This chapter covers the literature concerning performance measurement within warehouses. The most relevant performance metrics, as well as performance methodologies are reviewed.

Section1: Introduction to performance

To get a brief understanding about any business term a definition is often a good start.

1.1. Definition

According to Lebas (1995) performance is being *not so much about past achievements, as generally accepted, but about the future, about the capability of the unit evaluated.* Otley (2001) considers it in business context and includes two useful dimensions to the meaning: *effectiveness* of delivering desired outputs and *efficiency* of using as few inputs as possible to obtain the outputs[1].

Performance is defined *as an ability to provide results with set dimensions relation to set targets*. This definition has open parameters for dimensions and set targets. Primary target for enterprises is a profitable operation and yield (Niven 2006). On the process view, performance measurement is giving information how well process is producing planned goods or services (Andersen 1999)[2].

"*The accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed. In a contract, performance is deemed to be the fulfillment of an obligation, in a manner that releases the performer from all liabilities under the contract*"[3].

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[1] MAKILA, (Marko): **measuring and managing process performance in a contemporary multinational organization**, Master thesis, Aalto University, Finland, 2014, p.06.

[2] KEKKONEN, (Erkki): **designing of balanced performance measurement system to purchasing process**, Master thesis, LAPPEENRANTA University of technology, Finland, 2014, p.13.

[3] http://www.businessdictionary.com consulted in 23/08/2016 at 11:48

Also performance management has been defined as a "*process by which the company manages its performance in line with its corporate and functional strategies and objectives*" (Bititci, et al., 1997).

More practically performance management can be seen as *the process of creating and executing business plans effective and efficient. This process often starts with the creation of budgets and operational plans that are tied to strategic goals, these initiatives can then be allocated resources by managers based on financial assessments*. The next step is to execute these plans and focus on identifying, measuring and developing performance. To develop and inform corporate strategies throughout the organization is therefore an important part of performance management; however the most relevant part to this research is performance measurement[1].

Amaratunga and Baldry (2002) define performance management as "*the use of performance measurement information to effect positive change in organizational culture, systems and processes, by helping to set agreed upon performance goals"*[2], allocating and prioritizing resources, informing managers to either confirm or change current policy or performance directions to meet these goals, and sharing results of performance in pursuing these goals.

1.2. Related concepts to performance

Effectiveness relates the output (or result) with the objective of an activity to indicate "whether the system is doing the right thing". Similarly, **efficiency** is the ratio of the output with the resources consumed in order to measure "whether the system is doing things right". Finally, **effectivity** as defined by Senechal (2004) is the balance of objective, resources and the output produced with regard to the finality of the organization[3].

[1] AXELSSON, (P) and FRANKEL (J): Op.cit, p.29.
[2] LIAQAT, (Ali shah): **Value-risk based performance evaluation of industrial systems,** Doctoral thesis, L'École Nationale Supérieure d'Arts et Métiers, Paris, 2012, p.71.

[3] Ibid.p.65.

1.3. Performance management process

The relationship among these steps is that each step serves as a building block for the next step. In other words, to monitor performance effectively performance must be primary planned. We observe also that the whole system is surrounded by the organization's culture. This model assumes a supportive organization culture. Next a short look at each step in the process and how they are interrelated[1]:

1.3.1. Planning

Planning performance is all about establishing expectations. The primary question to be answered is: What is expected? Clear expectations provide direction. At the outset, the manager and the employees have to determine what performance is to be directed and how much direction is required. Ideally, through the use of performance management the employees will eventually become self-directed, assume responsibility for their results, and truly manage their own performance.

During this first step, the manager and the employee must also make a commitment to regularly communicate with each other. In essence, they develop a performance contract that describes how they will work together to achieve the defined goals.

1.3.2. Monitoring

Monitoring performance is about ensuring expectations are being met. The primary question to be answered is: Are we on track? Step 2 begins with reaching agreement on how to monitor and measure performance by using various charts and graphs that provide a visual representation of results. Once the method has been determined, the next step is to gather actual performance data that feeds into the charts and graphs. In addition, observing performance is one of the keys to monitoring performance. Throughout the process of monitoring performance, the partnership between manager and employee is critical. They must be in agreement about what results are to be monitored and how to interpret the findings. This is imperative since determining whether or not results are on track determines where we go next—to Step 3 or to Step 5.

[1] M. CADWELL, (Charles): **performance management**, Amacom, USA, 2002, pp.14.15.

1.3.3. Analyzing

Analyzing performance is about determining the cause of poor performance. In Step 2, if the answer to the question, "Are we on track?" is "No," that leads us to Step 3 analyze performance. At this point the manager and the employee must look at the situation and find out what performance gaps exist. Simply stated, a performance gaps exists when there is a difference between desired and actual behavior or results. Once performance gaps are identified, it is important to determine their cause(s) in order to figure out what can be done to improve performance.

Typically such things as a lack of knowledge, a lack of feedback, some task interference, or an imbalance in consequences cause performance gaps. Correctly identifying the cause then leads to determining the best course of action to get performance back on track, this step is critical because if the wrong cause is identified it can lead to taking the wrong action to solve the problem. Once the cause of the gap is identified, the next step is to determine what's the PIP (Potential for Improved Performance) to determine if the problem, or gap, is worth the investment of time, energy, and possibly money, that will be required to close the gap.

1.3.4. Improving

Improving performance is about implementing strategies to reduce or eliminate performance gaps. In partnership, the manager and the employee must agree on what action to take to get performance back on track. Choosing the right strategy can affect how long it takes to improve performance. Some of the strategies that can be used are making organization and environment changes; providing training and development; coaching and mentoring; or developing performance action plans. Selecting the best strategy depends on how accurately the cause of the performance gap was identified in Step 3.

1.3.5. Maintaining

The last step in performance management is about keeping good performance on track. We get to this point either after Step 2: monitoring performance and determining that all is well; or we get here after Step 4: implementing strategies to improve performance. One of the tools that can be used to help maintain performance is to develop feedback systems and then to provide employees with either positive or corrective feedback as appropriate. Formal

performance appraisals are an- other tool for maintaining performance. The role of compensation in maintaining performance also must be considered along with the appropriate use of nonmonetary rewards and incentives. Maintaining performance ultimately leads back to the first step, thus restarting the whole performance management process.

1.4. Logistics performance

Logistics performance is a multiple concept that must be understood and globally transverse to the extent that the flow does not stop at company boundaries. Whatever the objectives of the companies and business relationships they have, the purpose of the supply chain is to meet customer demand at the lowest cost with the least environmental impact.
This is the common goal of all players in the supply chain to which all performance indicators must be turned.

In this sense, we define logistics performance *as the result of four key factors are reliability, efficiency, responsiveness and respect for the environment* on which all Supply Chain Manager must act to fulfill its mission.

In the corporate world, the notion of performance is somewhat different. The company is not trying to beat records but to achieve a balanced set of objectives. Guided by the principles of sustainable development, they have the distinction of being multidimensional and global. Indeed, they must meet all stakeholders (shareholders, customers, processes, personnel, and environment) without favoring one player over another[1].

To improve the overall performance of the supply chain, we must understand the need to develop indicators in all segments. This approach has the merit of each company to conduct its own review sources of growth and productivity and to seek synergies with its partners.

1.5. The SCOR model

The supply chain operations reference model (SCOR) is a management tool used to address, improve, and communicate supply chain management decisions within a company and with suppliers and customers of a company. The model describes the business processes required to satisfy a customer's demands. It also helps to explain the processes along the entire supply chain and provides a basis for how to improve those processes.

The model integrates business concepts of process re-engineering, benchmarking, and measurement into its framework. This framework focuses on five areas of the supply chain: plan, source, make, deliver, and return. These areas repeat again and again along the supply

[1] https://www.supplychain-meter.com consulted on 12/05/2016 at 07:15

chain. The supply chain council says this process spans from "the supplier's supplier to the customer's customer"[1].

Plan

Demand and supply planning and management are included in this first step. Elements include balancing resources with requirements and determining communication along the entire chain. The plan also includes determining business rules to improve and measure supply chain efficiency. These business rules span inventory, transportation, assets, and regulatory compliance, among others. The plan also aligns the supply chain plan with the financial plan of the company.

Source

This step describes sourcing infrastructure and material acquisition. It describes how to manage inventory, the supplier network, supplier agreements, and supplier performance. It discusses how to handle supplier payments and when to receive, verify, and transfer product.

Make

Manufacturing and production are the emphasis of this step. Is the manufacturing process make-to-order, make-to-stock, or engineer-to-order? The make step includes, production activities, packaging, staging product, and releasing. It also includes managing the production network, equipment and facilities, and transportation.

Deliver

Delivery includes order management, warehousing, and transportation. It also includes receiving orders from customers and invoicing them once product has been received. This step involves management of finished inventories, assets, transportation, product life cycles, and importing and exporting requirements.

Return

Companies must be prepared to handle the return of containers, packaging, or defective product. The return involves the management of business rules, return inventory, assets, transportation, and regulatory requirements.

[1] https://scm.ncsu.edu consulted on 20/04/2016 at 14:30

Section2: Performance measurement

The following section will provide an understanding of performance measurement and its importance.

2.1. Definition

Traditionally, performance measurement is defined as "*the process of quantifying the effectiveness and efficiency of actions (Neely et al., 2002) in other words, measurement is the process of determining how successful organizations or individuals have been in attaining their objectives (Evangelidis,1992) employing performance indicators/measures"*.

In modern business management, performance measurement assumes a far more significant role than quantification of efficiency and effectiveness. It provides important feedback information in the form of performance measure to enable managers to monitor and improve performance, reveal progress, diagnose problems, enhance motivation and communication (Waggoner *et al*., 1999). However, it can play a significant role only if performed in a systematic and balanced way[1].

According to Bourne et al. (2003), performance measurement refers to a multidimensional set of financial and non-financial measures, internal and external measures of performance and measures quantifying what have been achieved as well as measures that help to predict the future. It should not be done in isolation and should be developed from strategy. Performance measurement is also being used to assess how actions are impacting on stakeholders of the organization and on the environment in which it operates. In fact, managing an organization nowadays has become so complex that managers are required to view performance in several areas almost in a synchronized way. A problem that many enterprises will certainly come across sooner or later is with regards to measurement.

According to Marr (2006), this happens when the organization does not link their indicators to the strategy of the organization. It also occurs when they try to quantify the unquantifiable or try to measure what is easy without focusing on relevant and meaningful indicators. These mistakes will reduce the chances of enhancing strategic-decision making[2].

[1] LIAQAT, (Ali shah): Op.cit, p.70.
[2] ROSSI, (Ana Carolina): **proposal of a performance measurement system for e-commerce SMEs in Denmark**, master thesis, Aarhus University, Denmark, 2012, p43.

2.2. Why measure performance?

Organizations measure performance for many different reasons. Some of the reasons may be to[1]:

- Identify success;
- Identify if they are meeting customer requirements;
- Help them to understand their processes: to confirm what they know or reveal what they do not know;
- Identify where problems, bottlenecks or waste exist and where improvements are necessary;
- Ensure decisions are based on fact, not on supposition, emotion, faith or intuition;
- Show if improvements planned, actually happened.

2.3. The importance of measuring performance

Performance measurement has had a tremendous impact in management over the last decades according to this research there are three main reasons why performance measurement is essential[2]:

1. Today's businesses are very complex, which also makes them hard to manage. Performance measurement's purpose is to simplify the reality so that rational decisions can be made. That the reality is transformed to simplified numerical concepts that can be communicated and acted upon is the key to successful management (Lebas, 1995).

2. Performance measures play an important role in success by giving the opportunity to evaluate performance and benchmark the results against similar organizations (Camp, 1989) (Stewart, 1995).

3. Performance measurement plays the role of feedback in one's organization, it facilitates the assessment whether plans were accurate or not and it shows how well the execution was carried out. These processes are of critical importance to effective and efficient performance management (Bititci et al., 1997) (Bongsug, 2009).

4. Control: Measurements help to reduce variation.

5. Continuous Improvement: Measurements can be used to identify defect sources, process trends, and defect prevention, and to determine process efficiency and effectiveness, as well as opportunities for improvement.

.[1] STEFENSON, (Tomas): **performance measurement at DHL solutions**, master thesis, Lulea University of technology, Sweden, 2004, p14.

[2] AXELSSON, (P) and FRANKEL (J): Op.cit, p.29.

The key in all of these statements is that implementing performance measurement in an organization will not improve performance by itself. It will however facilitate decision-making and the control over processes. The business information that is attained through performance measurement is the real value of performance measurement.

2.4. Challenges in measuring performance

Even though performance measurement is a stated factor for successful management many companies are not engaged in it, and there are issues that speaks against it[1]:

- Measuring is often put in negative terms because people think of surveillance and pressure to perform.
- To develop a measurement system or a set of KPIs can be very challenging and time craving.
- Even if a measurement system is in place it has to be continuously updated to stay relevant and it's easy that the system keeps expanding and the meaning of having a few powerful KPIs are lost.

2.5. Performance indicators

Performance indicators (PIs) are descriptors of performance and vital tools for organizations for the identification of the degree that an objective has been achieved.

According to AFGI (French association of production management), "*a performance indicator is a quantified data which describes the effectiveness or efficiency of the whole or part of the system (real or simulated) with reference to a norm, plan or objective in the context of company strategy*".

Berrah (2002) elaborates the definition proposed by AFGI and decomposed it into three distinct facets:

- Objective Determination: Linking an objective to a performance indicator,
- Performance Evaluation: Compare the measure with a predefined objective,
- Performance Appreciation or Analysis: Analyze performance in the context in which the process is carried out.

Berrah proposes the following definition of a performance indicator:

[1] AXELSSON, (P) and FRANKEL (J): Op.cit, p.31.

"Performance expression, less or more valid, described in the way with regard to the global objective, appreciated with reference to the context in which the activity, process or considered system is carried out"[1].

Neely et al. (1995) "*A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of action*"[2].

2.5.1. Hard and soft measures:

The traditional logistics performance measures include hard and soft metrics. The first one treats quantitative measures such as order cycle time, fill rates and costs; the second deals with qualitative measures like manager's perceptions of customer satisfaction and loyalty (Chow et al., 1994; Fugate et al., 2010). The "hard" metrics are computable with some simple mathematical expressions relatively easy to measure, being quantifiable and less ambiguous, while the soft metrics require more sophisticated tools of measurement[3].

Soft measures are difficult, but not impossible, to define and measure. For example, a survey via a questionnaire can be used to assess several aspects of user satisfaction, for example on a scale of 1 to 10. The survey can be repeated at appropriate intervals to examine changes in perceived service.

Surveys can be used to improve service quality by asking customers to score service quality for the provider against a company thought to be excellent in its market.

2.6. Performance Measurement Systems and (tools)

2.6.1. Balanced scorecard

Kaplan and Norton made a significant contribution in overcoming some of the limitations of traditional performance measurement systems by linking them to strategy. They developed a balanced scorecard, which was first presented in 1992. It is a comprehensive performance summary that complements financial measures with operational measure, which are the drivers of future financial performance. The word "balanced" calls attention to the fact that the system must combine financial and non-financial measures. The set of measures can be grouped into four main perspectives, the figure II-1, represents them as followed:

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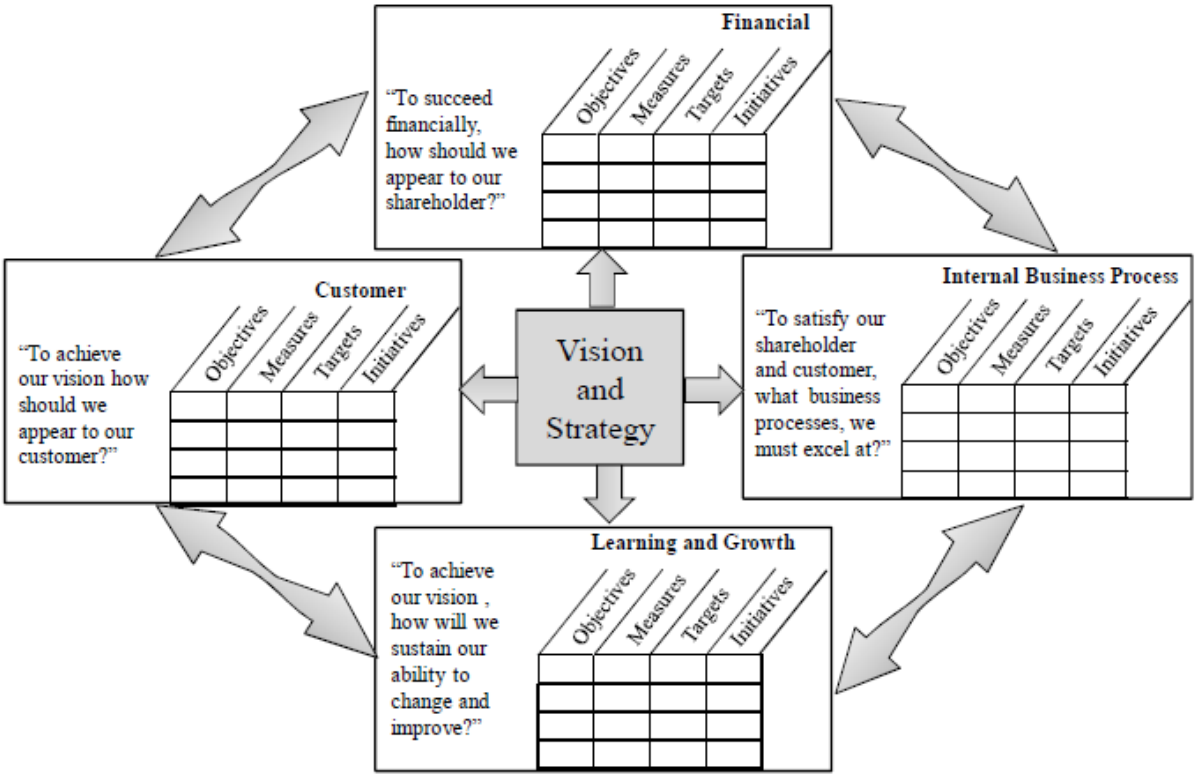
[1] LIAQAT, (Ali shah): Op.cit, p.68.
[2] ROSSI, (Ana Carolina): Op.cit, p.42.
[3] HEDLER, (Francielly): **global warehouse management: a methodology to determine an integrated performance measurement**, doctoral thesis, University of Grenoble Alpes, Paris, 2006, p.23.

Figure II-1: The balanced scorecards (Tableau de bord)



Source: STEFENSON, (Tomas): performance measurement at DHL solutions, master thesis, Lulea University of technology, Sweden, 2004.

Salter et al (1997) defines the four perspectives as[1]:

- **The financial perspective:** is concerned with identifying the key financial drivers in creating value for the shareholders. Measures on financial performance are outcomes and hence, they tell us what has happened in the past.
- **The internal perspective:** is primarily concerned with the efficiency of the entire business system. It will be most useful when it views the firm as a system of business process, all of which must be coordinated for the purpose of creating customer value.
- **The customer perspective:** includes measure of corporate or brand awareness, customer focused measures may be leading indicators of what the financial measures will later reveal.
- **The innovation and learning perspective:** is concerned with how effectively the business can adapt to changing conditions with the development of new products and services or the improvement of internal processes.

[1] STEFENSON, (Tomas): Op.cit, p.18.

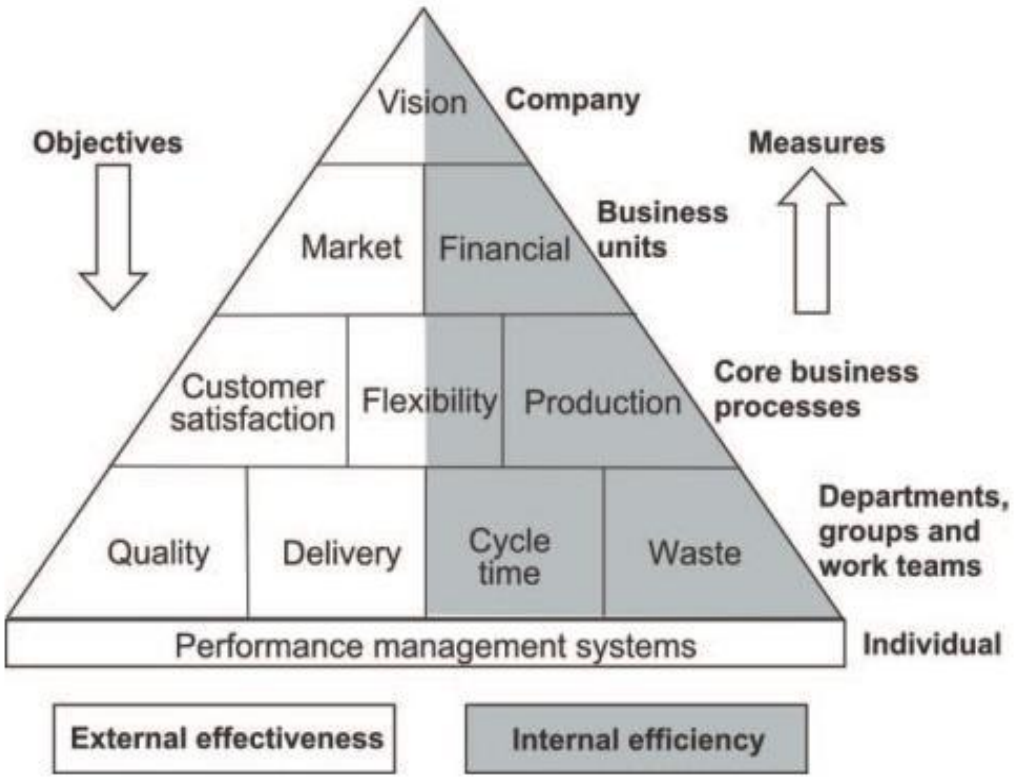
2.6.2. Performance pyramid

Performance Pyramid is a performance measurement system created by Lynch and Cross (1992). It results from dissatisfaction with traditional performance measures such as utilization, efficiency, productivity and other variances used for financial purpose[1].

The performance pyramid has four target levels including internal and external performance efficiency. All the four levels have their own performance metrics for these views.

The performance pyramid, shown in figure II-2, represents linked building blocks in the performance information network. A four-level pyramid of objectives and measures ensures an effective link between strategy and operations by translating strategic objectives from the top down (based on customer priorities) and measures from the bottom up.

Figure II-2: Performance pyramid system



Source: LIAQAT, (Ali shah): Value-risk based performance evaluation of industrial systems, Doctoral thesis, L'École Nationale Supérieure d'Arts et Métiers, Paris, 2012.

[1] KEKKONEN, (Erkki): Op.cit, p.19.

- At the top level of the pyramid, a vision for the business is setup which forms the basis for corporate strategy. The senior management then assigns a corporate portfolio role to each business unit (cash flow, growth, innovation, etc.) and allocates resources to support them.
- At the second level, objectives for each business unit are defined in market and financial terms. Strategies to reach these goals are worked out.
- At the third level, more tangible operating objectives and priorities are defined in terms of customer satisfaction, flexibility and productivity.
- At the fourth level, or foundation level, customer satisfaction, flexibility and productivity are represented by criteria such as quality, delivery, process time and cost. These criteria or operational measures are the keys to achieving higher level results and ensuring successful implementation of the company strategy.

2.6.3. Performance prism

The Performance Prism was developed by Neely *et al* (2002). Prism advocates that a PMS should be organized around five distinct but linked perspectives of performance[1]:

1. Stakeholder satisfaction: Who are the stakeholders and what do they want and need?

2. Strategies: What are strategies we require to ensure the wants and needs of our stakeholders?

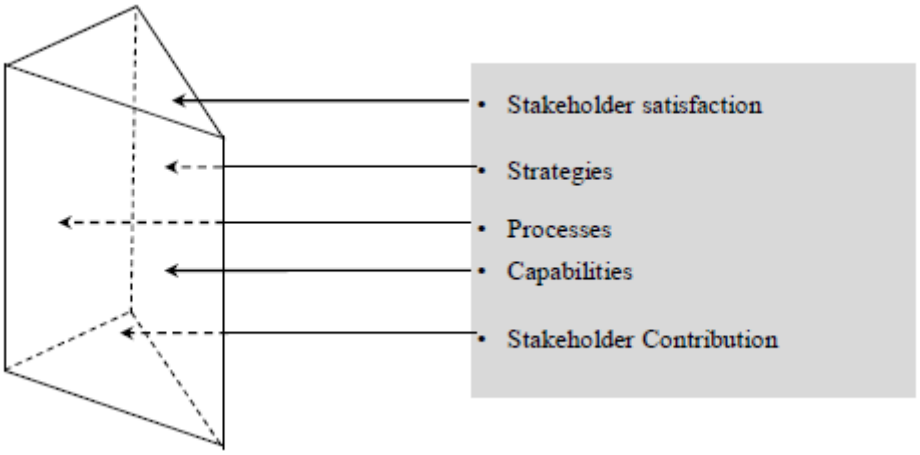
3. Processes: What are the processes we have to put in place in order to allow our strategies to be delivered?

4. Capabilities: What are the capabilities we require to operate our processes?

5. Stakeholder contribution: What do we want and need from stakeholders to maintain and develop these capabilities?

[1] LIAQAT, (Ali shah): Op.cit, p.95.

The figure II-3: The Prism performance measurement framework.



Source: LIAQAT, (Ali shah): Value-risk based performance evaluation of industrial systems, Doctoral thesis, L'École Nationale Supérieure d'Arts et Métiers, Paris, 2012.

The authors of the Performance Prism stress that all performance measures should not be derived from strategies because strategy is not the aim to be reached but a tool to help managers achieve the objectives. They argue that it is the wants and needs of the stakeholders that first must be considered. Therefore, organizations should first identify stakeholders, their needs and expectations and then strive to satisfy them.

For this purpose, strategies are then devised and processes are designed and implemented in the light of already formulated strategies. Capabilities are evaluated while designing and implementing processes and, in the end, stakeholder contribution is taken into consideration.

Section3: Warehouse key performance indicators

A warehouse, like any other enterprise, should constantly measure its performance, compare with others, and plan to improve.

3.1. Warehouse performance measurement

One of the primary goals of logistics management is to establish appropriate indicators that measure and ensure that logistical activities are fulfilled as they were initially planned. However, when it comes to the control of a warehouse, metrics make it possible for the workforce to better evaluate and govern their area of responsibility (Melnyk et.al, 2004) and thereby solve problems before it's too late (Ilies, Turde, & Crisan, 2009). Warehouse performance measurements are made to ensure: Good customer service that a philosophy of continuous improvement exists among the staff and that issues are discovered before they harm the operations (Gwynne Richards)[1].

It is hard to judge the effectiveness of a warehouse based on daily observation because events are fast-paced and distributed over a large area. But it is possible to infer details of warehouse activities from a history of customer orders together with a map of the warehouse. This can then be used to compare with other warehouses to identify and fix inefficiencies.

What should we measure to judge the performance of a warehouse or distribution center? It is not enough to measure only output because that says nothing about the expense required to generate that output. Instead, we typically measure performance by a ratio units of output achieved units of input required. These ratios generally are intended to summarize one of the following[2]:

- Operating costs, such as warehouse costs as a percentage of sales.
- Operating productivity, such as pick-lines, orders, cartons, pallets handled per person-hour
- Response time, measured, for example, as order-cycle time (minutes per order)
- Order accuracy, measured, for example, as fraction of shipments with returns

Many warehouses are managed from a list of such measurements, which are referred to as key performance indicators (KPI).

[1] AXELSSON, (P) and FRANKEL (J): Op.cit, p.25.
[2] GWYNNE, (Richards): Op.cit, p.252.

Ideally, a measure of productivity will be unbiased, customer-focused, and consistent with corporate goals. None of the KPI's mentioned above fits these criteria perfectly. For example, "total units shipped" is probably inconsistent with corporate goals because it excludes concern for whether the correct items were shipped; furthermore, it is biased because it depends on total units ordered by the customer and so is not under direct control of the warehouse. Similarly, "pick-lines per labor hour", a popular performance indicator, is biased because it depends on the units being picked: One would expect a higher score if picking cartons instead of pieces. And it is not focused on the customer. "Order-cycle time" seems more defensible; but "warehousing costs as a percentage of sales" is biased because it depends on sales and so could be skewed by marketing. In addition, it is not customer-focused.

3.2. Benchmarking

According to Natarjan (2005), benchmarking is: "*the practice of being humble enough to admit that someone else is better at something and being wise enough to try to learn how to match and even surpass them at it"*[1]. It is a systematic approach to warehouse improvement where best practice is sought and implemented to improve a process.

Benchmarking is a way of comparing your own performance with that of your peers, to find out how efficient and effective your warehouse is compared to others. By identifying high-performance or best-in-class operations, you can learn what it is they do that allows them to achieve competitive advantage. It also provides you with targets based on other operations currently achieving these levels of performance.

According to Sweeney: Benchmarking is not about copying other companies' approaches; rather it is about learning and adapting appropriate practices so that they can be usefully adopted in an effort to improve efficiency and/or effectiveness (adapt before adopting!)... Companies do not need to be the world's best at everything[2].

All companies have finite resources and benchmarking can help to identify where these resources should be targeted.

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[1] GWYNNE, (R) and GRINSTED (S): **the logistics and supply chain toolkit**, 1st edition, Kogan page, UK, 2013, p.259.

[2] ROSS, (David): Op.cit, p.45.

A word of caution, benchmarking may point to best current practice but not to best possible practice. 'As good as' is not 'better than'. It is not a substitute for creativity and innovation.

Benchmarking can be used to:

- Understand your own business performance.
- Identify areas for improvement.
- Discover what the competitors are doing better to reach a competitive advantage.
- Manage and accelerate change within the business.
- Set performance targets that can be proven to be achievable.

3.3. What should we be measuring?

According to Ackerman (2003), we should be measuring four areas within the warehouse[1]:

Reliability includes on-time delivery, fill rates and accuracy. Order cycle time is probably the best measure of **flexibility** as it covers all aspects of the customer order process: how we handle the order initially, whether we have the stock available, how quickly we can process the order through the warehouse and, finally, how quickly we can deliver to the customer.

Cost measurements include cost as a percentage of sales and productivity against labor hours. **Asset utilization** will include efficient use of warehouse space, MHE, staff and storage equipment. Warehouse utilization is normally measured in the amount of floor space utilized.

However, it is more realistic to measure the cubic utilization of the building. Other companies will look at the number of pallet locations utilized against the total number of locations available.

Frazelle (2002) suggests that as occupancy rates exceed 86 per cent utilization, productivity and safety decline exponentially with each percentage point increase in occupancy. He goes on to say that warehouses managed in real time might be able to operate at 90 per cent occupancy, although this is wholly dependent on the accuracy of the system and the experience of the warehouse team.

[1] GWYNNE, (Richards): Op.cit, p.265.

Third-party logistics companies will look to increase space utilization to the maximum as this is a revenue stream for them. However, productivity reduces significantly when space is at a premium. The coordination of pallets out and pallets in (in that order) is paramount, otherwise major bottlenecks appear.

In order to ensure that you provide your customers with the service they require, you need to understand your customers' requirements both as a whole and individually and, secondly, the limitations you have within your company and operation.

Frazelle (2002), consider that the selection of logistics measures is dependent on the nature the business, because logistics performance is multi-dimensional. Typical business measures are based on financial (cost), productivity, quality, and cycle time performance[1].

We deduce that the productivity to the areas that must be measured within warehouse.

Productivity

Productivity is part of the overall performance umbrella[2]: productivity output such as goods and services produced in relation to inputs that include labor, finance, material and other resources.

Warehouse managers have a number of inputs and resources under their control including labor and MHE. The key to running an efficient warehouse is to make best use of these inputs. The essence of productivity measurement is the recording and analysis of the time it takes to perform each handling movement within the warehouse.

This seems a daunting task. However, if you are to continually improve the operation you need to be able to measure it accurately. Not only do you need to measure each activity but also measure it at different times of the day and undertaken by different people.

For a third-party operator they need to know how long it takes them to undertake the different tasks associated with the warehouse in order to quote and charge their customers accordingly.

Finally, you need to decide whether the measures are individual or taken on a group basis, there are many areas within the warehouse where performance is the key to the company's well-being.

[1] BLOMQVIST, (Tommy): Op.cit, p.13.
[2] GWYNNE, (Richards): Op.cit, p. 295.

3.4. How to choose the right performance measures?

Each company will have different priorities, a different customer base and a different method of operation. In order to choose the most appropriate measure you need to undertake the following[1]:

- Understand your business and its strategy.
- Decide on the objectives.
- Understand which KPIs are likely to assist in meeting the objectives.
- Align the KPIs to others within the company.
- Ensure that everyone works towards achieving the targets – nominate KPI owners.
- If targets aren't achieved, analyze the reasons why and introduce processes to enable achievement.
- If the target isn't realistic, replace it.

The first task in any performance measurement system is to understand the vision of the company and how your department can assist in achieving the company's goals. Too often department heads will produce key performance measures which they are comfortable with and which are easily achievable but are not aligned to the company's vision and are rarely of interest to senior managers. Departments end up with too many measures which detract from the day-to- day running of the operation.

The measures you choose need to be SMART. That is, they need to be:

- **Specific:** Objectives should specify what they want to achieve. Are they clear and unambiguous?
- **Measurable:** Can we put a value on the KPI? E.g. How much, how long, how many?
- **Achievable:** Are the targets you set achievable and attainable?
- **Relevant:** Are the measures relevant to the overall goal and strategy of the company?
- **Timely:** Are the timescales realistic and how often do you measure?

We need to ensure that the data collected is accurate.

[1] ROSS, (David): Op.cit, p.412.

Moseley and Vitasek (2004) suggest that when introducing key performance indicators we should:

- Use terminology that your staff understand and is meaningful to them;
- Understand what your staff need to do to improve service or reduce costs as identified by the KPIs;
- Try to use common industry KPIs so that you can benchmark your own operation against your peers;
- Review the data regularly and look for specific trends;
- Not overreact to a particular data point;
- Only introduce measures you know you can implement and measure;
- Only introduce cost-effective metrics, i.e. ensure that it doesn't cost you more to manage than the likely savings you make;
- Only introduce measures you know you can change;
- Do not measure what you won't or can't change;
- Be seen to be using the data; there is nothing more frustrating than collecting data which isn't used.

The best measures therefore are those that are aligned to and governed by customer expectations. However, they also need to be aligned to your company's resources.

According to Rushton, Croucher and Baker (2010), there is a need to balance the level of customer service with the cost of providing that service. They go on to say that the cost of providing a given service is markedly higher the nearer it reaches the 'perfect service', that is, 100 per cent.

They also explain that the cost of an increase in service from 95 per cent to 100 per cent will be far greater than an increase from 70 to 80 per cent. This may be anathema to certain companies and cultures where service is overriding and paramount; however, you have to be realistic and accept that 100 per cent on time in full every time is desirable but not always achievable.

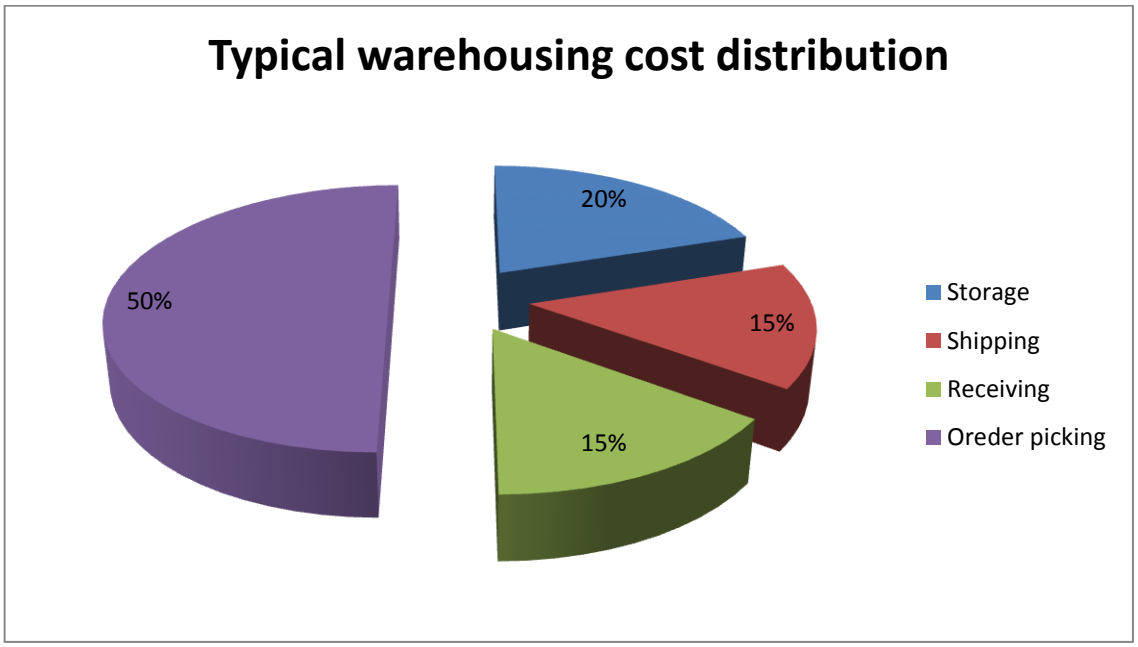
3.5. How to determine KPIs?

Key objectives in designing warehouse operations include increasing productivity, reducing cycle time, and increasing accuracy (Gunasekaran et al., 2004). Often times these objectives may conflict with one another because a method that focuses on productivity may not provide a short enough cycle time or a method that focuses on accuracy may sacrifice productivity. Researchers and managers typically attempt to find a set of measures which collectively capture most, if not all, of the performance dimensions thought to be important, over both short and long-term horizons. It is also advisable to review the warehouse performance measures periodically because this way it is possible to estimate the development of warehousing operations by comparing results between different time periods with each other[1].

Operating cost break-up in a typical warehouse:

As you can see from the below given pie chart that the order picking is the most expensive operation and it is directly linked to customer satisfaction. Any wrong pick would lead to an unhappy customer. In order to drive improvements it is very important to identify the cost distribution and identify improvement areas. Generally the improvement activities are identified based on cost or productivity linked activities. The order pick activity is both highly labor intensive and 50% of warehouse costs were spent on this activity[2].

Figure II-4: Typical warehousing cost distribution.



Source: https://vijaysangamworld.wordpress.com survey of warehousing professionals

[1] BLOMQVIST, (Tommy): Op.cit, p.43.
[2] https://vijaysangamworld.wordpress.com consulted on 09/04/2016 at 11:19

3.6. Key performance indicators for warehouse operations

People, Cost, Space and Systems drive the performance inside the warehouse. Hence, generally warehouse KPIs are based on the above mentioned drivers and focused on activity in order micromanage the performance. The following activities are common in any warehouse[1]:

3.6.1. Receiving: The receiving activity is fundamental to warehousing function. Unless the merchandise is properly received, it will be very difficult to handle all other subsequent functions. The relevant KPIs for receiving function should include the following:

1. Cost – Cost of Receiving per receiving line;
2. Productivity – Volume received per man-hour;
3. Utilization – Receiving Dock door utilization %;
4. Quality – Accurate receipts %;
5. Cycle Time – Time taken to process a receipt.

3.6.2. Put-away: Once receiving activity is completed, the accepted merchandize has to be stored in a location that is convenient to retrieve for further action. This process is called put-away.

The KPIs for this activity should include the following:

1. Cost – Cost per put-away line;
2. Productivity – Put-away per man-hour;
3. Utilization – Utilization % of labor and equipment;
4. Quality – Perfect put-away %;
5. Cycle Time – Time taken for each put-away.

3.6.3. Storage: Broadly we have two types of storage systems and they are manual storage and the second one is automated storage and retrieval system (AS/RS). Again within manual storage, we have six different types of storage and they are:

1. Block stacking – "Units loads stacked on top of each other and stored on the floor on the storage lanes."
2. Stacking frames – "are either frames attached to standard wooden pallets or self-contained units made up of decks and posts. Stacking frames are portable and enable users to stack material several loads high."

[1] https://vijaysangamworld.wordpress.com consulted on 09/04/2016 at 11:19

3. Single-deep selective pallet rack – "is a simple construction of metal uprights and cross-members providing immediate (pick-face) access to each load stored (that is, no honey combing)."
4. Double-deep rack – "are mostly selective racks that are two pallets position deep."
5. Drive-in rack – "extend the reduction of aisle space begun with double-deep rack by providing storage lanes from five to ten load deep and three to five loads high."
6. Drive-thru rack – "is merely drive-in rack that is accessible from both sides of the rack."

The KPIs for this activity would include:

1. Cost – Storage cost per item;
2. Productivity – Inventory per sq. foot;
3. Utilization – % Location and cube occupied;
4. Quality – % Location without inventory discrepancies;
5. Cycle Time – Inventory days on hand.

3.6.4. Pick and Pack: this activity includes accumulating, regrouping, and packaging the products into customers' desired assortments. Moreover, generating packing slips or delivery lists may also take place at this point. Order-picking activities are time consuming and labor intensive. The relevant KPIs for this activity would include:

1. Cost – Cost of picking per order line;
2. Productivity – Order lines picked per hour;
3. Utilization – Picking labor and equipment utilization %;
4. Quality – Perfect picking lines %;
5. Cycle Time – Order Pick cycle time per order.

3.6.5. Shipping: Shipping is the last step in warehouse activity in handling shipping goods to the customer or handling stock transfers. This process is the origin to moving product from point A to point B.

The KPIs for this activity could include:

1. Cost – Cost of shipping per order;
2. Productivity – Order process for shipping per man hour;
3. Utilization – Utilization of shipping docks in %;

4. Quality – Perfect shipping %;
5. Cycle Time – Shipping time (from the time order picked to physically movement of the truck) per order.

Subsequent Table II-1 represents a summary of these measures with respect to each of the various warehousing functions. It is possible to use hard measures to track internal quality measures such as the timeliness of an order or shipping accuracy, but capturing customer satisfaction is typically the underlying reason for supplementing hard measures with soft, perceptual ones (Mentzer et al., 2001)[1].

Table II-1: Warehouse key performance indicators

	Financial	Productivity	Utilization	Quality	Cycle Time
Receiving	Receiving cost per line	Receipts per man-hour	% Dock door utilization	%Receipts processed accurately	Receipt processing time per receipts
Putaway	Putaway cost per line	Putaways per man-hour	% Utilization of putaway labor and equipment	% Perfect putaways	Putaways cycle time (per putaway)
Storage	Storage space cost per item	Inventory per square foot	% Locations and cube occupied	% Locations without inventory discrepancies	Inventory days on hand
Order picking	Picking cost per order line	Order lines picked per man-hour	% Utilization of picking labor and equipment	% Perfect picking lines	Order picking cycle time (per order)
Shipping	Shipping cost per customer order	Orders prepared for shipment per man-hour	% Utilization of shipping docks	% Perfect shipments	Warehouse order cycle time
TOTAL	Total cost per order, line, and item	Total lines shipped per total man-hour	% Utilization of total throughput and storage capacity	% Perfect warehouse orders	Total warehouse cycle time = DTS + WOCT

Source: BLOMQVIST, (Tommy): a warehouse design framework for order processing and materials handling improvement, Master thesis, Aalto University, Finland, 2010.

[1] BLOMQVIST, (Tommy): Op.cit, p.44.

3.6.6. Transversal Indicators which are defined for a process rather than a unique activity. The inbound logistics concern both the materials transportation and storage, while outbound logistics involve the outbound warehousing tasks, transportation and distribution. Based on this idea, the inbound process covers both Receiving and Storage activities and is named as "Inbound Processes". While Picking, Shipping and Delivery activities are regrouped under "Outbound Processes". Inventory is considered as internal process in this case linking inbound to outbound processes. The indicators are then placed according to the extent of their boundaries. For example, the transversal indicator "Dock to stock time" is classified as an inbound indicator encompassing receiving and storing activities. "Order lead time" is an outbound indicator, covering picking, shipping and delivery activities. Moreover, there are the global transversal indicators that cannot be assigned to specific activities. That is the case, for example, of "Cost as a % of sales", defined as global to all warehouse activities since its measure represents a sum of warehouse activity efforts[1].

"Continuous improvement is better than delayed perfection." Mark Twain

Well-established research by Reichheld and Teal (2001) found that, for many companies, an increase of 5 per cent in customer retention can increase profits by 25 to 95 per cent. The same study found that it costs six to seven times more to gain a new customer than to keep an existing one. From a warehouse perspective this means that you have to ensure accuracy, quality, timeliness, and cost effectiveness within the processes you control. By doing this, you are contributing to a high-performance operation and as a result, contributing to customer satisfaction and retention.

As discussed previously, the warehouse operation is crucial in ensuring that the customer gets the right product at the right time and in the right condition. This chapter discussed why we need to measure, what we need to measure and how we can use this information to improve our overall service to our customers.

[1] HEDLER, (Francielly): Op.cit, p.33.

Chapter three

Chapter3: Measuring performance of warehouse operations

This chapter begins with a brief presentation of the case company "Aramex", its historical evolution, and services, followed by a brief explanation of the warehousing process within the company. Finally, we will describe how the study was carried out; it includes the course of work from, the selection of research approach, empirical data gathering methods and analysis.

Section1: presentation of the company "Aramex"

This section consists of a detailed presentation of the company under investigation, starting by an explanation of how the company has been funded and its history and the main services they provide to their customers.

1.1. Presentation of the company

Aramex is a leading global provider of comprehensive logistics and transportation solutions. The company was founded by Jordanian Fadi Ghandour and Bill Kingson in 1982 as an express operator, the company rapidly evolved into a global brand recognized for its customized services and innovative multi-product offering. In January 1997, Aramex became the first Arab-based international company to trade its shares on the NASDAQ stock exchange. After five years of successful trading, Aramex returned to private ownership in February 2002 and continued to expand and excel as a privately owned company, establishing global alliances and gaining stronger brand recognition. In June 2005 Aramex went public on the Dubai Financial Market (DFM) as Arab International Logistics (Aramex) with its shares traded under ARMX. Today, Aramex has a strong alliance network providing worldwide presence[1].

The range of services offered by Aramex includes international and domestic express delivery, freight forwarding, logistics and warehousing, records and information Management solutions, e-business solutions, and online shopping services.

[1] http://www.aramex.com/ consulted on 15/05/2016 at 22 :30

Corporate facts[2]:

- 354 offices in 60 countries
- Worldwide coverage through the Global Distribution Alliance
- Over 14,500 employees from 84 nationalities
- Logistics facilities, strategically located and technologically connected
- Serving over 60,000 customer worldwide
- A federal structure that empowers local stations, and strengthens global standards.

1.2. The historical evolution of Aramex

- **1982:** Aramex was funded by Fadi Ghandour and his business partner Bill Kingson.

The company began operations in Amman, Jordan. Arab American Express aimed to become the first courier company in the Middle East. At the time there were no international courier companies based in the region because of logistical and bureaucratic challenges caused by civil wars and complex political relationships. The company's first international delivery was a document for the Housing Bank for Trade and Finance based in Jordan to New York City. Within two years, the company's name was shortened to Aramex.

- **1984**: the company's operations were less than $1 million in revenue. Aramex offered Airborne Express 50% ownership of the company for $100,000, that year. Airborne Express declined the offer because it did not have the resources to invest in a small market such as the Middle East. The partnership made Aramex responsible for Airborne's business in the region.

- **1985**: Aramex moved its headquarters to Dubai, United Arab Emirates.

- **1987**: Aramex gained Federal Express as a client.

In the first year of partnership, 30% of Aramex's revenue came from packages originating from the Federal Express network. Airborne Express acquired 9% of Aramex for $2 million.

- **1997:** Aramex was listed on the NASDAQ stock exchange.

  The company became the first Arab-based company to trade its shares on an American stock exchange. Aramex's valuation was $24 million and the IPO raised $7 million. The company accrued $66 million in revenue and $31 million in gross profit that year.

[2] Internal documents of the company.

- **2001:** The Company expanded its operations to 120 locations in 33 countries, primarily emerging markets in the Middle East and Southeast Asia.

The company's strategy was to enter high-growth markets characterized by high populations and liberalizing economies. During summer 2001, Abraaj Capital, the first private equity firm in the Middle East, proposed Aramex a leveraged buyout offer that would take the company off of the NASDAQ stock exchange. The deal was accepted and Abraaj Capital acquired the majority of Aramex for $65 million in February 2002. The deal allowed Kingson and Airborne to exit, while Ghandour retained 25% of the company and management control. Abraaj acquired 75% of Aramex and made 6% of its shares available to company employees in the form of stock.

- **Between 2002 and 2003**: Aramex's net income raised from $4 million to $10 million.

- **2003:** DHL acquired Airborne Express, Aramex's main United States partner.

This resulted in Airborne Express exiting the Airborne Alliance. In the same year, Aramex took over the alliance and co-founded the Global Distribution Alliance (GDA), a global alliance of 40 express companies with combined revenues of $7.5 billion. Aramex is chairing the alliance which uses a shipment management system developed by the company.

- **2005:** Aramex went public on the Dubai Financial Market.

The IPO raised $270 million. The company's revenue increased 23% over 2004 and net income increased 56% that year.

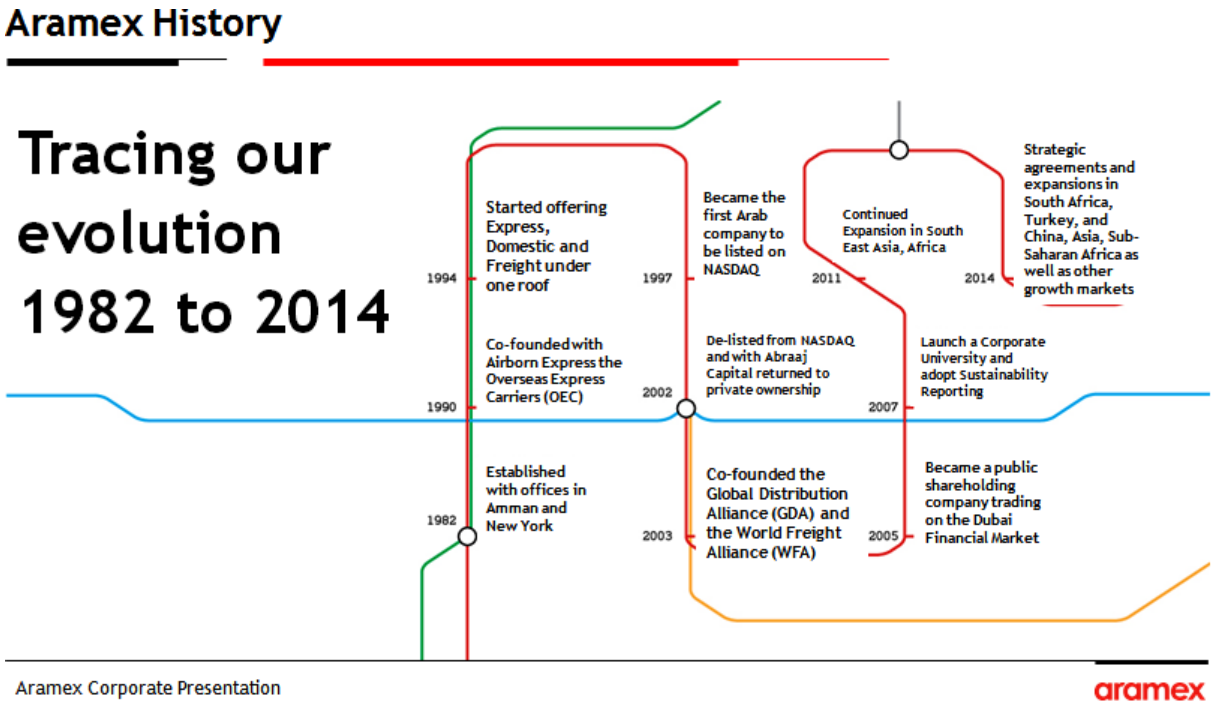
- **2007:** Launch a Corporate University and adopt Sustainability Reporting**.**

- **2011:** Continued Expansion in South East Asia, Africa**.**

- **2014:** Strategic agreements and expansions in South Africa, Turkey, and China, Asia, Sub-Saharan Africa as well as other growth markets.

Following a schema of Aramex’s development and its historical evolution:

Figure III-1: The historical evolution of Aramex.



Source: Internal documentation of the company (Aramex)

1.3. Expansion

In February 2011, Aramex acquired One World Courier and In-Time Couriers, two Kenyan courier firms. Aramex acquired Berco Express, a South African logistics firm in December 2011. PayPal partnered with Aramex in 2012.The partnership gave PayPal credibility in the Middle East, while opening up new markets abroad for Aramex. Aramex developed REDe, a solution aimed at enabling companies to begin selling their products online, in early 2012. Shop Go, an e-commerce solution, released Aramex Suite in August 2013. The module enabled e-commerce stores to automatically access several of Aramex's services. Aramex launched Aramex Bio, a medical courier service in March 2014.The service was launched in the Middle East and North Africa. In June 2014, Aramex acquired Mail Call Couriers, an Australian courier service.

1.4. Aramex services

1.4.1. Express: International local delivery, documents and parcels.

Aramex offers:

- Latest technology tools
- Time definite pickup and delivery
- Reverse logistics
- Cash-on-Delivery
- Temperature-sensitive goods delivery

1.4.2. Freight: Air Freight, ocean Freight, land Transport and multimodal Freight.

Aramex offers

- Flexible and tailored services
- Door-to-Door / Door-to-Port
- Consolidation
- Customs clearance
- Exhibition handling and special projects

1.4.3. E-commerce:

REDe: Aramex will deliver online orders from your website to your customers locally and globally, offering full supply chain solutions from storage of your products to order fulfillment coupled with the latest technologies.

Shop and Ship

- Unique account number in US, the UK, China, Turkey, UAE, India, South Africa, Hong Kong, Germany, Italy, Spain, France, Singapore and Canada
- Customers can shop on the Internet and provide their domestic US, UK, China, UAE, Turkey and India delivery address
- Aramex ships packages to their door step

1.4.4. Logistics:

- State-of-the-art logistics facilities;
- Strategically located center and technologically connected;
- Complete supply chain management and logistics solutions.

Aramex offers:

- Order fulfillment
- Warehousing
- Customs and brokerage
- Distribution

- Inventory management
- Value-added services

Mission: to be recognized as one of the top five global logistics and express transportation service providers.

Purpose

- To enable and facilitate regional and global trade and commerce responsibly;
- To satisfy its customers, obtain the maximum, and emerge new markets;
- Provide new services, and more add value activities

1.5. Aramex's standards

1.5.1. Innovation and Technology

Innovation is deeply ingrained in our corporate culture, and has long been a driving force in the growth of Aramex services. It originally stems from listening to customers and developing new products and services that address market needs. At Aramex, creativity is celebrated and rewarded. Small and big ideas come from all levels of the company to achieve the highest levels of customer satisfaction.

1.5.2. Quality

Improving processes, eliminating bottlenecks and increasing efficiency of daily operations is an ongoing cycle in Aramex. We place high value on maintaining and enhancing quality in every facet of the organization. Therefore we have designed and implemented a quality management system to ensure a consistent level of high standards at all times, and we evaluate these standards regularly and work on technological and process innovations to improve upon them. The Aramex DQMS (Documented Quality Management System), called InfoHub, complies with the requirements of the international standard of ISO 9001:2008 and includes a set of effective systems that measure customer satisfaction in order to ensure continuous service enhancement.

1.5.3. People

At Aramex, we believe that quality people produce consistently excellent service, and continuously innovate to meet customer needs, which is a cornerstone of our business. Therefore we strive to attract and maintain the best talents, while continuously nurturing and offering them opportunities to achieve and innovate.

1.5.4. Corporate Activism

For Aramex, sustainability is a strategy. Corporate activism then becomes embedded in our business model, and a reflection of how Aramex chooses to exist and operate.

As the first company in the region to report on its sustainable practices, Aramex continues to be accountable for its commitments to all stakeholders. Aramex is keen on continuously practicing its citizenship by being an active partner in development and serving its communities and the environment. Aramex supports entrepreneurial initiatives, education and youth empowerment, sports and community organizing developing models (www.ruwwad.net)as a way to highlight the importance of human capital, citizenship and activism.

1.5.5. Commitment to Security – TAPA

As one of the industry's key security regulatory agencies, the Transported Asset Protection Association (TAPA) has put in place rigorous guidelines and assessment criteria to ensure that every company meets a specified level of security throughout the supply chain. Aramex has already received TAPA certifications for facilities in Bahrain, Riyadh, Dammam, Beirut, Amman, Amsterdam, and Jebel Ali Free Zone in Dubai, and is moving towards certifying the rest of its facilities in the network. The company has also received certification for Authorized Economic Operators (AEO) in the Netherlands and Ireland and is working towards acquiring certification for all European countries it operates from.

1.5.6. Aramex Information Security Policy

Aramex has adopted an information security policy which addresses security issues related to the ownership, integrity and accessibility of information, and in particular, risks associated with the use of computers and networks for storing, transferring and processing information. Aramex has a strong commitment to protecting its critical information assets against unauthorized access and use, theft, modification, destruction and unauthorized disclosure, and regards the protection of information assets as a common responsibility of all staff.

This policy also supports Aramex objectives to comply with the International information security standards.

Section2: Description of warehousing process in Aramex

Aramex's main activity in Algeria is logistics, and specifically warehousing, in this section we will provide a brief description of ALR Hammadi warehouse which was our case of study, followed by an explanation of warehousing process.

2.1 Hammadi warehouse

The warehouse is located in Hammadi (Algiers), and dedicated for alimentary products with a small area for pharmaceutical products, there are four customers with different capacities:

Nestlé: 5000 pallets, DABA Nespresso: 500 to 600 pallets, HBI International in the small warehouse and GSK (GlaxoSmithKline).

The warehouse contains:

- Four docks;
- Four zones (V-X-Y-Z);
- Eight aisles from A to H;
- PLV (Marketing) area;
- Damage area (Cage);
- Zone near expire;
- Operations room.

Employees:

- Operation manager;
- Supervisor;
- Team leader;
- Quality controller;
- Floor leader;
- Four team members (Data entry);
- Four employees work with forklifts and two with the transplants.

2.2. OPTILOG portal

When we discuss aramex's warehousing process it is crucial to mention Optilog which is a system developed by aramex, and linked to the company strategy.

Aramex logistics and IT teams have joined forces to develop software for the streamlining of aramex's logistics operations. The result was the cutting-edge warehousing management system dubbed OptiLog. Already deployed in all aramex logistics centers, OptiLog has emerged as a powerful and efficient tool in the aramex warehouses.

The web-based system covers the main warehousing functions from receiving, to put away to allocation & picking and shipping in addition to trans-shipping operations. The system is operated in more than 25 sites in aramex logistics network to run and manage the daily warehouse operations and control the inventory of aramex 3PL customers. Furthermore, OptiLog WMS is utilized by some of aramex customers to run their own warehouses and inventory operations.

The OptiLog portal is the gate for Customer Web Access; it is directly linked to the main database and provides real time information. The portal has a search tool and a bunch of reports that cover all parts of the process cycle. Reports could be obtained in a number of different file formats including PDF, XML, Excel, Word, text, etc.

New functionalities are continuously added to the portal. Our customers (or their customers/suppliers) are now able to place shipping orders and pre-alerts into the system through the portal.

Moreover, customized reports can be added to the customer's page to fulfill the customer's specific need[3].

2.3. The warehousing process

A brief description for both inbound and outbound process:

2.3.1. Inbound process

As we previously discussed the inbound process has two main activities which are receiving and put away.

First of all receiving begins with a pre-alert of the arrival of goods, which has been received via Electronic Data Interchange (EDI), the customer sends a packing list[4] with all the necessary details such as the number of trucks will be received and quantities, which allows

[3] Internal documentation of the company
[4] Appendix n° 01.

the warehouse to schedule receipt and unloading to coordinate efficiently with other activities within the warehouse.

Once the container has arrived, they unload products from the transportation equipment as well as verify their count and specifications against order records, inspect them for damage, and update warehouse inventory records, with the presence of an expert sent by the customer to control the process and report the damages. The damaged products will be registered as "hold" and stored in the cage.

Before the put away operation they determine an appropriate storage location, they also classify the products and prepackage bulk shipments into smaller one before moving them to their warehouse storage location, after storing the pallets they give them a code depending on the aisle and the zone they are located in. This information will subsequently be used to construct efficient pick-lists[5] to guide the order-pickers in retrieving the product for customers.

After that a data entry member, record the receiving into the WMS. Finally, he sends a receiving confirmation[6] to the customer with a detailed report about the products.

2.3.2. Outbound process

In a similar manner to the inbound process, the warehouse receives a pre-alert via Electronic Data Interchange (EDI). Aramex as we mentioned uses Optilog portal and its main customer Nestlé uses SAP, as soon as the order is sent the warehouse perform checks such as verifying that inventory is available to ship, and make sure that the customer is not breaking the FIFO by ordering the wrong SKUs, the system is highly accurate and these mistakes are rarely happening but a confirmation is always required, especially when we are dealing with alimentary products like Hammadi warehouse. Then the warehouse produces a pick lists to guide the order-picking, after the picking operation is over each piece of a customer order is being handled to check that the customer order is complete and accurate. Order accuracy is a key measure of service to the customer which the warehouse needs to focus on especially in a 3PL company, inaccurate orders not only annoy customers by disrupting their operations, they also generate returns; and returns are expensive to handle (up to ten times the cost of shipping the product out).

[5] Appendix n°02
[6] Appendix n°03

Next, they pack the products to be shipped and distributed; Shipping generally handles larger units than picking, because packing has consolidated the items into fewer containers (cases, pallets). They update inventory records in the system.

All the details are being registered such as the arrival time of trucks and the time they leave the warehouse, the evaluation of the truck[7], such information are useful in calculating KPIs, also for the company for not assuming the responsibility of any damaged products.

Finally, they produce any necessary shipping documentation. These activities are typically accomplished by WMS (Optilog).

[7] Appendix n°04

Section3: The contribution of performance measurement in warehouse management

In this section we will provide a presentation of the methodology of the survey, results of the interview, proposals and suggestions and finally a general conclusion to summarize our study.

3.1. Methodology of the survey

Concerning our problem, we considered it appropriate that the warehousing is a main driver of the company's competitiveness particularly in 3PL sector, where certain level of customer service is required.

In our case, we will treat the contribution of performance measurement on warehouse management. So we will take the adequate research technique with our problem, and the best choice of the research tools.

3.1.1. Research tools:

Our search tool in this case is the interviews, this tool have more technical suitable for qualitative analysis, because they allow to deepen our subject and work on a cognitive dimension, based on interrogations with actors and interviewers using their knowledge, their beliefs, their experiences, their feelings , motivations on the warehousing process.

Finally, the treatment of this research process is made by the transcript of records, the selection and analysis of the interviews, the overlap between the various interviews, to abstract all the results of each proposed questions and to make the results of inquiry, to achieve our goal.

3.1.2. Our interview guide:

After considering all the tools of our research, we have to define our interview guide from our initial problematic. So what is the population need to know? And how we define the questions that run throughout our interview?

Our goal is to select the employees who have the best experience in warehousing, especially in measuring the warehouse performance. With the best choice for the questions we must ask.

These questions must be in the form of our problematic and secondary questions of our research. To achieve answers align with the proposed assumptions.

3.2. The conditions of progress of our interview

3.2.1. The interview sample size:

It is a case of qualitative research, where in our case the selected sample consists of four employees within aramex's warehouse. They have good experience and they have the best skills on the workflow of all warehousing and logistics activities.

3.2.2. Date, place and time of the interview:

- **The date?**

We did our interview on May 5th, 2016 in Hammadi warehouse, Algiers.

- **The place of the interview:**

Because of the special nature of the warehouse, there is only the operations room where we could conduct the interview.

- **The time of the interview:**

The beginning of the interview was devoted to explain the purpose of our research, and then the first minutes were important to help create a climate of confidence to facilitate the flow of the interview. So we can devise the duration of the interview on the steps bellow:

- **Preamble:** This step was done firstly to present ourselves and our research, secondly to properly present the company and the position of works of each, so we spent between three (3) and five (5) minutes to start the discussion.
- **Development:** Twenty (20) minutes have been devoted to this second step "ask questions" so we entered into the subject.
- **Conclusion:** The last five (5) minutes were devoted to this stage, which allowed the interviewees to express their selves, give as instructions and advices to work on, and the final word of the interview.

So we spent an average of thirty (30) minutes for each interview.

3.2.3. With whom I did my interview?

We developed our interview with a group of managers and team leaders of the warehouse whom are:

- Two logistics operation team members (Data entry).
- The warehouse manager.
- The Operation manager.

In addition, we asked other warehouse employees few question such as quality controller, and the floor leader.

3.3. Results of the survey

Question n°1: Could you present your company briefly?

Aramex is a leading global corporation in the areas of Express and logistics; we are primarily focusing on third-party logistics, which means that we offer to manage the whole supply chain after production for our clients. This includes services such as: warehousing, inventory management.

Our main objectives are to satisfy our clients and expand in new countries.

Question n°2: What is your position in the company?

As we previously mentioned the four interviewers were in different position:
The operations manager; the warehouse manager and two members in logistic operation team (Data entry).
We also asked other employees a few questions such as: quality controller and the floor leader.

Question n°3: What are your missions and responsibilities in the warehouse?
For the data entry team, they are responsible about:

- The follow up;
- Daily cycle count (Inventory);
- Order operation;
- Inbound and outbound operations;
- Follow the KPI.

Operations manager:

- Running a direct distribution center;

- Ensure that incoming materials from suppliers are in good order and properly stored; and that outgoing parts and materials for customers leave in the right quantities and in good condition;
- Negotiate with transportation companies over rates or service levels;
- Prepare documents; or review invoices and customs documents;
- Resolve issues with suppliers, customers, transportation companies or employees;
- Review distribution center workloads with other departments, coordinating with the schedulers and planners.

The warehouse manager:

- Processing orders;
- Operating mechanical and IT systems;
- Liaising with customers and other departments;
- Training, supervising and appraising staff;
- Maintaining statistical and financial records;
- Planning;
- Ensuring that quality objectives and delivery deadlines are met;
- Ensuring compliance with health and safety legislation.

Question n°4: What are the important warehouse success factors?

Our main success factors as a 3PL provider are:

- Short delivery time, is a very important factor for an excellent customer service, our clients rely on us to provide them with their products in the precise time without any delay, the only case where we don't commit with the time is when we receive an additional order, which is an order we weren't prepared for therefore, the client cannot blame us for any delay.
- Inventory accuracy is also an important factor; Inventory is a major company asset that helps us with tasks such as planning and staying within budget. Thus we consider keeping accurate inventory records as a major management tool that has multiple benefits, the more accurate the stock the more likely we are to fulfill orders correctly and increase efficiency.

- Safety of the inventory, other companies outsource some of the activities they can't handle to gain more time and to focus on their crucial functions like production hence, they must outsource those activities for a company that can manage them in professional way, and safety is a major condition. In Aramex we commit to safety standards and we attempt to increase our security level.
- Asset management is also an important factor, as a warehouse manager I try to ensure an efficient use of warehouse space, MHE, staff and storage equipment, because they help in time reducing and also the cost.

Question n°5: What challenges do you confront in managing the warehouse?

Among the challenges we face:

- Increase customer service requirements;
- Demands to enhance warehouse operating efficiency and space utilization;
- Demands for increased product customization;
- A significantly larger number of SKUs;
- Increase demands for responsiveness.

Question n°6: How relevant is performance measurement in your company?

Performance measurement is very relevant in Aramex's warehouses, it plays the role of feedback in the company, facilitates the assessment whether plans were accurate or not and it shows how well the execution was carried out.

Question n°7: Does your company focus on qualitative or quantitative measures in term of performance?

We focus on quantitative measures, because they cover all aspects of the customer order process: how we handle the order initially, whether we have the stock available, how quickly we can process the order through the warehouse and, finally, how quickly we can deliver to the customer.

As we mentioned before time management is the key factor in warehouse success, and customer satisfaction.

Question n°8: Does your company have strategy linked to performance measurement and KPIs?

Yes, we have a strategy linked to KPIs which are also aligned and governed by customer expectations. However, they are aligned to the company's resources.

Question n°9: What is the important dimension to measure in warehouse?

All the interviewers had the same answer: Reliability which includes on-time delivery, fill rates and accuracy.

Question n°10: Do you focus on measuring inbound or outbound process, and which operation exactly?

For inbound process we have two KPIs, one of them concerning the system, and the other about unloading[8] it's calculated by the number of pallets unloaded in less than four hours.

Outbound process is more important for our company, because we are aiming for customer satisfaction by reduction in the order cycle time which leads to a reduction in the supply chain response time, we calculate the outbound efficiency[9] which is defined by the number of customers orders prepared for dispatch to the customer within one working day out of total number of customer orders, we also calculate the loading efficiency which is determinate as number of customers orders prepared for dispatch to the customer in less than 01:30h.

There are no specific operations; we measure the process as a whole, because measuring operations like picking and packing is useless for us, since we don't have KPIs for those operations.

Question n°11: Do you find that the company is using enough indicators in the warehouses?

All the employees considered that the company is using enough indicators concerning the warehousing. There two indicators which are Order Cycle Time and Dock to Stock regarding the time management and the third one is Inventory Record Accuracy.

Setting new KPIs is not a big deal for us, because it takes more time to collect data and has no real add value.

There are new KPIs that the company has programmed for this year[10], but we haven't start working with them yet.

[8] Appendix n° 05
[9] Appendix n°06
[10] Appendix n°07

Question n°12: Does performance measurement facilitate decision making?

Yes of course, when we measure performance especially with quantitative measures they give us a clear image about the situation of the warehouse, and where change needs to be made we can also predict issues we might face in the future.

There are many areas where performance measurement can facilitate decision making among them:

- First area is cycle time, when the time increases and we surpass the targets (KPIs) we will face problems with our clients, this has a diverse possible sources it could be because of the lack of WHM, the length of the travel distance in the picking operation, or the lack of employees. In this case if we have the right KPIs they will be very useful to diagnose the reason of the problem and take the right decision to reduce the lead time and be more productive.
- Secondly quality, there are a several decisions to take in order to improve the quality like increasing responsiveness, accuracy, and safety of products.
  Qualitative KPIs are useful in this case to identify customers' needs, also quantitative KPIs to know how far we are, if the stuff is prepared and trained also if we have the required resources.
- Finally cost which is a critical component in warehouse success, reducing cost and making economics of scale is essential that's why we need to automate some operations, decrease the number of employees those decisions can also be made after calculating such KPIs.

Question n°13: Can you consider that using KPIs as a way to manage the warehouse?

Yes, as we previously mentioned KPIs facilitate decision making, and managing warehouse is all about taking the right ones.

In my opinion we shouldn't measure to much areas because it's an exhausting process, we can focus on few KPIs which help us analyze our crucial operations and motivate the staff.

Question n°14: What are the reporting practices and time horizons does your company uses?

Daily and sometimes weekly meetings, focused on addressing any tactical issues to improve performance.

3.4. Analysis and summary of results

The analysis of the results was carried out by collecting data and summarizing what was taken from interviews with executives of Aramex. This analysis helps us to conclude that the warehousing is a critical activity of the company; it strengthens the efficiency and influence on the dynamism of this latter, and due to this importance performance measurement is vital for this function.

Warehouse management has been defined as the combination of planning, decision-making and controlling inbound, storage and outbound flows, while in our case study we have essentially focused on control and decision making aspects of warehousing.

The company key objectives within warehousing related to maximizing the utilization of resources within the warehouse while satisfying customer requirements. Therefore, managers aim to maximize profits while providing good customer service.

For those objectives to be met, they must measure the warehouse performance because they cannot improve if they did not measure.

To simplify, warehouse performance measurements are made to ensure: Good customer service that a strategy of continuous improvement exists among the staff and that issues are discovered before they harm the operations, performance measurement in general is important for the company, and it’s also critical on several levels, such as to improve decision-making.

Outbound metrics seem to be more valuable .Furthermore; most metrics used by Aramex are connected to the outbound flow of the warehouse, it might be due to the fact that they are linked to customer satisfaction.

Storage metrics are also important such as KPIs that measure “inventory accuracy”. The emphasis put on storage metrics may show that if the storage is handled in a proper way, the challenges in the warehouse could easier be dealt with. But in general inbound metrics seem to be less utilized.

A central concept related to warehouse efficiency is the overall cycle time of order processing. Reducing cycle time increases the responsiveness and flexibility of a warehouse but requires identifying bottlenecks in the warehousing process and finding ways to streamline materials handling and order picking activities.

The performance measurement process involves a large number of performance data to deal with multiple dimensions of performance. The difficulty lies not in collecting the performance relevant data but in their transformation into useful performance measures and performance indicators for the purpose of informed decision making, which means to set performance measures/indicators that truly reflect the objectives of the company and customer expectations.

We observed that the executive team is aware of the performance measurement importance, and uses a strategy but this strategy may either not be known outside of their team.

3.5. Recommendations and Suggestions

Based on our theoretical researches and the observation of warehouse operation, we have elaborated a set of suggestions, in order to improve warehouse efficiency and optimize its operations, the recommendations are as follow:

- Set goals and measure performance against benchmarks that matter to the customers. This might include on-time delivery, number of returns, and price compared to the competition. The goals should be based not on the company's past performance, but on what the best companies in the industry are achieving, because those are your competitors.
- Place new KPIs related to crucial operations such as the picking since, it's a time consuming and labor intensive activity.
- Use automatic data collection, the benefits of automatic data collection via bar code and radio frequency identification are well-established, including increased productivity and accuracy and lower labor costs.
- Don't rely on manual data entry processes. Instead, use mobile computers with bar code scanners or RFID readers at the receiving dock to immediately identify products on arrival. This helps get product off the dock quickly and eliminates nearly all the errors associated with manual receiving: including identification, counting, and data entry errors. With scanning and RFID technology, you'll avoid the mistakes that influence inventory accuracy and eat up time and resources to fix. And that means your warehouse staff can focus on processing customer orders more quickly.
- Communicate effectively and often, communicating to workers your organizational goals and the processes to achieve them is one key to effective warehousing operations.

Also explaining to them the importance of measuring performance, and the way KPIs help in achieving our goals.

- Improve cycle time utilization through lean applications. “Lean applications can help improve cycle time utilization, reduce costs, increase productivity, and increase customer satisfaction. To get to lean, begin with conducting a time study and analysis of the current order fulfillment process. Identify non-value added steps and note the amount of time spent on each of them. Then, assess overall workflow in an attempt to reveal inefficient product pick paths, wasted motion, excessive delays, aisle and work area congestion, and equipment availability.
- Measure what matters for continuous improvement in your processes. If an outcome is not important to customers and shareholders, don't waste time measuring it.
- Align warehouse employees’ motivation with management objectives, and reward them for good performance by sharing the fruit.

As a result, we deduce that Warehousing is a crucial function in managing the supply chain. The warehouse is evolving into a customer satisfaction center that performs numerous customized and value added services to products before shipment. Therefore, measuring performance for this activity is critical to ensure customer satisfaction.

General conclusion

General conclusion

The final part of this research will cover the conclusion and limitations of the study. It is divided in three parts. The first part is conclusions, second part covers the limitations of the study, and final part includes further areas for research.

The purpose of our internship within Aramex Company was to study and evaluate the contribution of performance measurement to warehouse management.

First, we tried to give a global view of warehousing and performance measurement and its importance to guaranty continuous improvement and take the right decisions within the warehouse.

Therefore, we deduce that performance measurement essentially contributes in:

- Problems identification,
- Reducing cycle time which increases the responsiveness,
- Convincing potential clients,
- Labor management and evaluation,
- Enhance the service quality

It also assist in eliminating the waste of time, extra costs, and low service quality ...etc, during the warehousing process which enables the value added activities to run smoothly,

From this study, we can conclude that performance measurement is not difficult to apply in this company's warehouses; it is just obvious that the change must be inside the spirit and mind of the workers within Aramex in order be aware of the importance of measuring performance, they also need to admit that an additional KPIs must be set.

Research framework was derived to answer the research questions. Qualitative data was collected from semi-structured interviews and observations which help to detail analysis where the discussion was carried out, this research led us to answer and verify our hypothesizes.

According to the results we can confirm first that time management and inventory accuracy are imperative to ensure warehouse success for the simple reason that executives rely on them to improve service quality and satisfy their customers, managers added asset management and safety of products as an additional importance factors.

Then, we infirm the second hypotheses concerning the inbound activities and their importance in assessing the warehouse performance; since the most KPIs that Aramex is using or willing to use are related to outbound activities such as loading efficiency and order cycle time, and

because the sensitivity of outbound activities as the picking and shipping to the customer service.

At last, we confirm that using the right KPIs is a dynamic tool to manage the warehouse.

Based on results from our study we conclude that measuring performance facilitates the warehouse evaluation, the problems identification, and helps to accomplish the company's objectives.

These are some of the limitations that were identified during the research:

- The unavailability of executives because of their work plan which affect our time of interview and limit it in some cases.
- Another limitation was that due to confidentiality reasons we were unable to access some information which affect our analysis and interpretations.

Through our study of this subject we found several areas and subjects that can be treated as a future academic work such as:

- The degree of automation and its impact on warehouse performance.
- Performance measurement system for warehouse based on SCOR model.
- Green supply chain and its influence on warehouse sustainability.

Finally, this experience as training in Aramex was a rewarding and worthwhile experience for beginners to active and professional life. This allows acquiring both the organizational skills and team spirit.

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List of Appendixes

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Appendix n°10

The interview:

Name and Surname of the interviewee: ……

Date of the interview: The…...../……./2016.

Time of interview: ……h: ……

Question n°1: Could you present your company briefly?

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Question n°2: What is your position in the company?

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Question n°3: What are your missions and responsibilities in the warehouse?

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Question n°4: What are the important warehouse success factors?

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Question n°5: What challenges do you confront in managing the warehouse?

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Question n°6: How relevant is performance measurement in your company?

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Appendix n°10

Question n°7: Does your company focus on qualitative or quantitative measures in term of performance?

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Question n°8: Does your company have strategy linked to performance measurement and KPIs?

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Question n°9: What is the important dimension to measure in warehouse?

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Question n°10: Do you focus on measuring inbound or outbound process, and which operation exactly?

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Question n°11: Do you find that the company is using enough indicators in the warehouses?

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Question n°12: Does performance measurement facilitate decision making?

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Appendix n°10

Question n°13: Can you consider that using KPIs as a way to manage the warehouse?

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Question n°14: What are the reporting practices and time horizons does your company uses?

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