DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION
BUSINESS ADMINISTRATION PROGRAM
MASTER'S THESIS

LOT SIZING AND VARIABLE PERIODIC CONSUMPTION BASED STOCK ORDERING IN AN AUTOMOTIVE SUPPLIER COMPANY

Hüseyin Engin AYDIN

Supervisor

Assoc.Prof.Dr. Sabri ERDEM

İZMİR-2015

YÜKSEK LİSANS
TEZ/ PROJE ONAY SAYFASI

2009800227

Üniversite : Dokuz Eylül Üniversitesi

Enstitü : Sosyal Bilimler Enstitüsü

Adı ve Soyadı : Hüseyin Engin AYDIN

Tez Başlığı : Lot sizing and Veriable Periodic Consumption Based Stock Ordering in an Automotive Supplier Company

Savunma Tarihi : 10.06.2015

Danışmanı : Doç.Dr.Sabri ERDEM

JÜRİ ÜYELERİ

Ünvanı, Adı, Soyadı	Üniversitesi	İmza
Doç.Dr.Sabri ERDEM	DOKUZ EYLÜL ÜNİVERSİTESİ	.....
Doç.Dr.Güzin ÖZDAĞOĞLU	DOKUZ EYLÜL ÜNİVERSİTESİ	.....
Prof.Dr.Şevkinaz GÜMÜŞOĞLU	YAŞAR ÜNİVERSİTESİ	.....

Oybirliği (X)
Oy Çokluğu ( )

Hüseyin Engin AYDIN tarafından hazırlanmış ve sunulmuş "**Lot sizing and Veriable Periodic Consumption Based Stock Ordering in an Automotive Supplier Company**" başlıklı Tezi(X) / Projesi( ) kabul edilmiştir.

Prof.Dr. Utku UTKULU
Enstitü Müdürü

DECLARATION

I hereby declare that this master's thesis titled as " **Lot Sizing and Variable Periodic Consumption Based Stock Ordering in an Automotive Supplier Compan**y" has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resourses in the reference list. I verify all these with my honour.

20/ 05/ 2015

Hüseyin Engin AYDIN

ABSTRACT

Master's Thesis

Lot Sizing and Variable Periodic Consumption Based Stock Ordering in an Automotive Supplier Company

Hüseyin Engin AYDIN

Dokuz Eylül University
Graduate School of Social Sciences
Department of Business Administration
Business Administration Program

As a result of the effects of the globalization process, companies emphasize the importance of inventory holding and ordering process. In busines life, the aim of all companies are to make profits. In order to realize this purpose and continue their existences in market, companies should have some values and these values should be always ready to use. One of them is called inventory. Inventory management process starts from purchasing the raw materials and continues to sales of finished goods to customers.

In order to manage the inventory process efficiently, companies should choose the best methods to order and control them. This gets more difficult if the product variety is high. Especially if the customer demand variation is high, companies gets more difficulties to meet their needs. These kinds of factors cause customers' compliances.

Companies should keep enough stock to meet the demand in market. Inventory holding cost in high for all companies. In the mean time, stockout costs are also very high. In this scope, it gets vital to determine the optimum lot sizing policy and optimum minimum stock holding policy.

Another important factor is to determine how much inventory should be kept from each product. In order to determine this, an ABC analysis can be used. So that the unnecessary inventory can be avoided. This will also decrease ordering cost, holding costs and related costs.

In this study, the actual method will be discribed and different lot sizing methods will be searched to understand the optimum method. In the mean time, customer's actual minimum stock policy will be defined and new methods will be searched to find the best solution. Before to start searching, an ABC analysis will be performed to understand the value in total for each product and best lot sizing method will be searched for each group in ABC analysis. Finally an optimal lot sizing method will be determined and a new heuristic method will be applied and implemented as a minimum stock ordering policy.

Keywords: Inventory, Stock, Buffer, Lot Sizing, Automotive, Inventory Management, ABC analysis

ÖZET

Yüksek Lisans Tezi

Bir Otomotiv Tedarikçi Firmasında Sipariş Büyüklüğünün Belirlenmesi ve Değişebilir Periyodik Tüketim Esaslı Stok Siparişinin Verilmesi

Hüseyin Engin AYDIN

Dokuz Eylül Üniversitesi
Sosyal Bilimler Enstitüsü
İşletme Yönetimi Anabilim Dalı
İşletme Yönetimi Programı

Globalleşme süreci etkilerinin bir sonucu olarak, şirketler envanter tutma ve sipariş verme konularına özen göstermektedirler. İş yaşamında tüm şirketlerin amacı kar getirmektir. Bu amacı gerçekleştirmek ve piyasadaki varlıklarını devam ettirebilmek için şirketlerin değerlere sahip olmaları gerekir ve bu değerler de yeri geldiğinde kullanıma hazır olmalıdır. Bu değerlerden biri de envanterdir. Envanter yönetimi süreci, hammaddelerin satın alma sürecinden başlayıp, son mamulün müşteriye teslimatına kadar olan süreyi kapsar.

Envanter yönetimi sürecine hakim olmak için, şirketler envanter kontrolü için en uygun yöntemleri seçip uygulamalıdırlar. Ürün çeşitliliğinin fazla olduğu şirketlerde bu durum daha da zor hale gelebilir. Özellikle de talep değişkenliğinin yüksek olduğu şirketlerde, müşteri beklentilerini karşılamak daha da zorlaşacaktır. Bu gibi zorluklar da müşteri şikayetlerine yol açacaktır.

Şirketler pazardaki talebi karşılamak için yeterli miktarda envanter bulundurmalıdır. Envanter tutma maliyeti tüm şirketler için yüksektir. Aynı zamanda stoksuz kalma durumunun getireceği maliyetler de yüksek olacaktır. Bu anlamda, en uygun sipariş miktarını belirlemek ve tampon stok değerlerini hesaplamak hayati anlam taşıyacaktır.

Bu çalışmada öncelikle mevcut metot tanımlanacaktır ve farklı metotlar deneyerek en uygun sipariş belirleme yöntemi aranacaktır. Aynı zamanda müşterinin istediği tampon stok miktarı incelenecek ve yeni metotlar denenerek en iyi çözüm bulunmaya çalışılacaktır. Bu çalışmaya başlamadan önce de ABC analizi yapılarak her ürünün toplam değerde ne kadarlık bir payı olduğu araştırılacaktır.

Anahtar kelimeler: Stok, Envanter, Sipariş Belirleme, Tampon Stok, Envanter Yönetimi, ABC Analizi

LOT SIZING AND VARIABLE PERIODIC CONSUMPTION BASED STOCK ORDERING IN AN AUTOMOTIVE SUPPLIER COMPANY

LIST OF CONTENTS

THESIS APPROVAL PAGE ii
DECLARATION iii
ABSTRACT iv
ÖZET vi
LIST OF CONTENTS viii
LIST OF ABBREVIATIONS xii
LIST OF TABLES xiv
LIST OF FIGURES xv
LIST OF APPRENDICES xvi

INTRODUCTION 1

CHAPTER ONE
SUPPLY CHAIN MANAGEMENT

1.1. Literature Review 3
1.1.1. Supply Chain 3
1.1.1.1. Supply Chain Management as a Management Philosophy 6
1.1.1.2. Supply Chain Management as a Set of Activities to Implement a Management Philosophy 7
1.1.1.3. Supply Chain Management as a Set of Management Processes 8

1.1.2. Development of Supply Chain Management 9
1.1.3. Supply Chain Management Functions 10
1.1.4. Logistics 12
1.1.5. Logistics versus Supply Chain Management 15
1.1.6. Logistics Activities 16
1.1.6.1. Customer Service 16
1.1.6.2. Demand Forecasting/ Planning 17
1.1.6.3. Inventory Management 17
1.1.6.4. Logistics Communication 17
1.1.6.5. Materials Handling 17
1.1.6.6. Order Processing 18
1.1.6.7. Packaging 18
1.1.6.8. Parts and Service Support 18
1.1.6.9. Plants and Warehouse Site Selection 18
1.1.6.10. Procurement 18
1.1.6.11. Return Goods Handling 19
1.1.6.12. Reverse Logistics 19
1.1.6.13. Traffic and Transportation 19
1.1.6.14. Warehousing and Storage 20

CHAPTER TWO
INVENTORY MANAGEMENT

2.1. Industry Concept 21
2.1.1. Historical review of inventory Management 22
2.1.2. Definition of inventory 23
2.1.3. Reasons for Holding Inventories 24
2.1.4. Types of Inventory 26
2.1.5. Safety/Buffer inventory details 28

2.1.6. Inventory Costs 29
2.1.7. Inventory Control Models (Systems) 37
2.1.8. ABC Analysis 37
2.1.9. SDE Analysis 40
2.1.10. VED Analysis 40
2.1.11. Material Requirements Planning (MRP) 41

2.2. Ordering- Lot Sizing 43
2.2.1. Optimizing Techniques 44
2.2.1.1. Economic Order Quantity method 45
2.2.1.2. Period Order Quantity method 47
2.2.1.3. Wagner-Whitin method 47
2.2.2. Heuristic Rules 48
2.2.2.1. The Least Unit Cost and Least Total Cost methods 48
2.2.2.2. The Silver–Meal method 49
2.2.3. Intuitive/Experience 50
2.2.3.1. Lot for Lot Method 50
2.2.3.2. Fixed Order Quantity Method 50
2.2.3.3. Fixed Period Requirements Method 50

CHAPTER THREE
INVENTORY MANAGEMENT IN AN AUTOMOTIVE COMPANY

3.1. Industry Concept 52
3.1.1. Ordering day 54
3.1.2. Speeded truck 54
3.1.3. Special transport 55

3.1.4. Special order 55
3.1.5. Minimum stock 55
3.1.6. Average Daily Consumption 56
3.1.7. Premium and Premium Cost 56
3.1.8. Blockage Cost 56
3.1.9. Stoppage Cost 56
3.2. Assumptions 57
3.3. Limitations 58
3.4. Problem Definition 59
3.5. Flow Diagram 61
3.6 ABC Analysis 63
3.7. Current Lot Size and Reorder Point Situation 64
3.8. Current Minimum Stock Policy 65
3.9. Proposed Lot Size and Reorder Point Situation 65
3.10. Lot sizing Results 66
3.11. Findings From Lot Sizing Results 67
3.12. Min. Stock Calculation Results 68
3.13. Findings From Min Stock Calculation 68

CONCLUSION 70
REFERENCES 73
APPENDICES

LIST OF ABBREVIATIONS

SCM	Supply Chain Management
ADC	Average Daily Consumption
GSCF	Global Supply Chain Forum
SCOR	Supply-Chain Operations Reference Model
CPFR	Collaborative Planning, Forecasting & Replenishment
MRP	Material Requirements Planning
WIP	Work in process
JIT	Just in time
CLM	Council of Logistics Management
WACC	Weighted Average Cost of Capital
SDE	Scarce/ Difficult/ Easily
VED	Vital/Essential/Desirable
BOM	Bill of Materials
MPS	Material Production Scheduling
ATP	Available-to-promise
W-W	Wagner-Whitin
EOQ	Economic Order Quantity
POQ	Period Order Quantity
GMC	Groff's Marginal Cost
IC	Incremental Cost
IOQ	Incremental Order Quantity
IPPA	Incremental Part-Period Algorithm
LTC	Least Total Cost
LUC	Least Unit Cost
MPG	Maximum Part-Period Gain
MOM	McLaren's Order Moment
PPB	Part Period Balancing
S-M	Silver-Meal
UOQ	Uniform Order Quantity

FOQ	Fixed Order Quantity
FPR	Fixed Period Requirements
L4L	Lot for Lot
EOQ	Economic Order Quantity
WCM	World Class Manufacturing
ETA	Estimated Time Arrival
PN	Part number
DOH	Days on hand

LIST OF TABLES

Table 1: Definitions of supply chain management p.4
Table 2: Supply chain management functions p.11
Table 3: ABC analysis grouping p.38
Table 4: Classification of Lot-sizing Methods p.44
Table 5: PNs to analyze p.66
Table 6: Lot sizing results p.67

LIST OF FIGURES

Figure 1: Process flow p.59

Figure 2: Problem definition p.60

Figure 3: Flow Diagram p.62

LIST OF APPENDICES

APPENDIX 1: Demand for all part numbers -1 app. p.1
APPENDIX 2: Demand for all part numbers -2 app. p.7
APPENDIX 3: Demand for all part numbers -3 app. p.14
APPENDIX 4: Demand for all part numbers -4 app. p.21
APPENDIX 5: Demand for all part numbers -5 app. p.27
APPENDIX 6: Demand for all part numbers -6 app. p.34
APPENDIX 7: ABC analysis results app. p.40
APPENDIX 8: L4L Calculation-1 app. p.46
APPENDIX 9: L4L Calculation-2 app. p.47
APPENDIX 10: L4L Calculation-3 app. p.48
APPENDIX 11: EOQ-1 app. p.49
APPENDIX 12: EOQ-2 app. p.50
APPENDIX 13: EOQ-3 app. p.51
APPENDIX 14: Fixed Period-1 app. p.52
APPENDIX 15: Fixed Period-2 app. p.54
APPENDIX 16: Fixed Period-3 app. p.55
APPENDIX 17: Least Unit Cost-1 app. p.56
APPENDIX 18: Least Unit Cost-2 app. p.58
APPENDIX 19: Least Unit Cost-3 app. p.59
APPENDIX 20: Least Unit Cost-4 app. p.60
APPENDIX 21: Least Unit Cost-5 app. p.61
APPENDIX 22: Silver Meal-1 app. p.63
APPENDIX 23: Silver Meal-2 app. p.64
APPENDIX 24: Silver Meal-3 app. p.67
APPENDIX 25: Silver Meal-4 app. p.67
APPENDIX 26: Silver Meal-5 app. p.68
APPENDIX 27: Min Calculation app.p.70

INTRODUCTION

In today's challenging business world, the focus point of successful supply chain management is inventory and inventory controlling. One of the main problem is forecasting future stock levels for multiple stockholding locations in production-distribution networks, and minimizing the total value within given inventory budgets or within given allowable inventory holding costs but in the mean time reducing the logistics costs.

Competitive pressures in today's marketplace are forcing companies to offer quicker response to customer needs (Song, 2006: 46). As mentioned in the Kumar and Sharman's well-known essay "We love your product, but where is it?" on time delivery comes second after the product attributes, in deciding customer satisfaction. Meeting customer demand on time not only improves profit margins, but also develops a better public image.

In an increasing competitive market, it becomes important to meet customer demands on time. Enterprises assess the customer satisfaction as providing all products and services to meet their primarily needs and more than these needs. In this context, it is attempted to be perfect in the ongoing process starting from te design of products or services from pre-sales to aftersales process. In this process, it is a key factor that the customer finds the needed amount of product or service and at closest place when they want to receive. Because the product or service being purchased at the requested time available or if it is not sufficient, despite the pre-sales or aftersales performance is excellent, the product will not be sold or customer will not fully satisfied. Therefore product or service offered at present in sufficient quantities will directly effect the satisfaction of customer.

Ganeshan and Harrison define a supply chain as ''a network of facilities and distribution options that performs the functions of materials procurement, transformation of these materials into intermediate and finished products, and product distribution to customers''. For all supply chains, there is a disconnected flow of information and inventory and it leads to a lack of real time information and causes to build an excess

stock in order to buffer any supply due to demand variation. In the mean time, long order lead times cause difficulties to respond to real-time changes and necessitates to be proactive all the time. In order to solve these kinds of problems, enterprises should take some actions not only to meet customer needs but also to compete in challenging business life.

The primary reasons for logistics changes in growing companies are new requests from customers, ongoing improvement in internal processes, and re-evaluation of company logistics strategies (Lattmann, 2000: 40).

In order to meet the customer needs, the product or service should be provided to customer at the requested time, with requested quantity at the right place. To ensure this balance, all sales network should be stocked but it must be calculated that each part number has an inventory holding cost. These holding costs contradict with the target of cost reduction of the enterprises. The aim of this study is to optimize the stock levels, decrease the inventory holding costs and decrease the number of special transports which means additional cost for the enterprises but moreover to find a new method for the company about lot sizing and minimum stock ordering and see the results of the application if it is feasible or not. In this scope, actual methods should be clarified and new proposed methods should be evaluated.

In literature, there are various studies on lot sizing and minimum stock ordering policies. The study can be differentiated from other studies by being implemented in an automotive industry and also containing both lot sizing methods and minimum stock ordering policy and implementing a new heuristic methods that is only used for the related cupplier company. Therefore this thesis can be a leading study for automotive supplier companies who wants to change or create a new policy on lot sizing and also a new heuristic minimum stock holding policy.

In terms of method, observations from past experince and literature review methods will mostly be used in this study. In order to prepare he theoretical part, literature reviews and in implementation part, observation will be considered.

CHAPTER 1
SUPPLY CHAIN MANAGEMENT

1.1. Literature Review

In this chapter, some information from various authors about supply chain management will be collected and the logic will be discussed in details.

1.1.1. Supply Chain

The Suply Chain which has rarely started to be used since the last quarter of 20th century, has many different definitions in many different sources in the literature. Ganeshan and Harrison has defined SCM as a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Lee & Corey stated that SCM consists of the integration activities taking place among a network of facilities that procure raw material, transform them into intermediate goods and then final products, & deliver products to customers through a distribution system. Christopher defined the supply chain as the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer.

Many other definitions of supply chain management by different researchers are given in Table 1.

Table 1: Definitions of supply chain management

Researchers	Year	Definiton
Chopra & Meindl	2001	"A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request".
Mentzer et al.	2001	"The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."
Handfield & Nichols	1999	"A supply chain encompasses all activities associated with the flow and transformation of goods from the raw material stage, through to the end user, as well as the associated information flows".
Christopher	1998	"The supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer".

Lee & Corey	1995	"The integration activities taking place among a network of facilities that procure Raw material, transform them into intermediate goods and then final products, & deliver Products to customers through a distribution system"
Ganeshan and Harrison	1995	"A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials intermediate and finished products, and the distribution of these finished products customers."
Cooper & Ellram	1993	"SCM is an integrative philosophy to manage the total flow of distribution channel from the supplier to ultimate user"
Cavinato	1992	"The supply chain concept consists of actively managed channels of procurement and distribution. It is the group of firms that add value along product flow from original raw materials to final customer".
Towil, Naim, and Wikner	1992	"The supply chain is a system, the constituent parts of which include material suppliers, production facilities, distribution services, customers linked together via the feed forward flow of materials and the feedback flow information"
Scott & Westbrook	1991	"supply chain is used to refer to the chain linking each element of the process from, raw materials through to the end customer"

Novack & Simco	1991	"The supply chain management covers the flow of goods from supplier through manufacturer and distributor to the end-user"

From these definitions we can get these points (Ning, 2006: 68):

- Supply chains are autogenetic in nature, whereas managed supply chains are artificially organized with collective efforts of supply chain members;
- A supply chain should consist of multiple firms, at least three, in both upstream (i.e., supply) and downstream (i.e., distribution operation);
- Supply chain management is a system approach to viewing the channel as a whole, a single entity, rather than a set of fragmented parts;

Although definitions of Supply chain management differ across authors, they can be classified in three categories (Mentzer, 2001: 8): a management philosophy, implementation of a management philosophy, and as a set of management processes.

1.1.1.1. Supply Chain Management as a Management Philosophy

Supply chain management as a management philosophy takes a system approach to view the supply chain as a single entity. This means that the partnership concept is extended into a multi-firm effort to manage the flow of goods from suppliers to the ultimate customer. Each firm in the supply chain directly or indirectly affects the performance of the other supply chain members, as well as the overall performance of the supply chain (Cooper, 1997: 5).

Supply chain management as philosophy has the following characteristics:

- A systematic approach to viewing the supply chain as a whole and managing the total flow from the supplier to the ultimate customer.
- A strategic orientation toward cooperative efforts to synchronize and converge intra-firm

and inter-firm operational and strategic capabilities into a unified whole.

- A customer focus, to create unique and individualized sources of customer value, leading towards customer satisfaction.

1.1.1.2. Supply Chain Management as a Set of Activities to Implement a Management Philosophy

When a company adopts a certain philosophy, a set of management practices must be established to ensure behaviour consistent with the philosophy.

The key activities needed for successful implementation of the supply chain management philosophy are (Mentzer, 2001: 10):

- Integrated behaviour.
- Mutually sharing information.
- Mutually sharing risks and rewards.
- Cooperation.
- The same goal and the same focus on serving customers.
- Integration of processes.
- Partners to build and maintain long term relationships.

Therefore supply chain management philosophy requires extension of certain behaviour to external partners (suppliers, customers) and in this context the philosophy of supply chain management turns into a set of activities that carries out the philosophy. One of the important aspects of an integrated behaviour is also mutual sharing of information among members of the supply chain. This is particularly valuable for the planning and monitoring processes. Open sharing of information such as inventory levels, forecasts, sales promotion strategies, marketing strategies, reduces uncertainty and increases performance. Risk and reward sharing helps maintain a focus on the long-term benefits and cooperation among the supply chain members. Cooperation on all levels among all processes in the supply chain is needed to reduce inventories and pursue supply chain-wide cost effectiveness. Establishing the same goal and focus on serving

customers is a form of policy integration, which is possible if there are compatible cultures and management approaches among supply chain members. Implementation of Supply chain management requires integration of processes from sourcing to manufacturing, and to distribution across the supply chain (Cooper, 1997: 12). This can be achieved via cross-functional teams, involving supplier personnel, and third party service providers. Supply chain management requires partners to build up and maintain long-term relationships. Cooper believes that the time horizon of the relationships extends beyond the lifetime of a contract and the number of the partners should be small to facilitate increased cooperation.

1.1.1.3. Supply Chain Management as a Set of Management Processes

Supply chain management is increasingly being recognized as the integration of key business processes across the supply chain. Implementation is carried through by three primary elements: the supply chain network structure, the supply chain processes, and the management components. In terms of supply chain network structure, it is important to integrate decisions related to purchasing, manufacturing, stocks, warehousing, and distribution, as well as define goals and strategies how to achieve it. On the other hand, it is important to design a set of standard processes which will assure rational behaviour of the individuals or companies that are part of the supply chain. Last but not alt least, it is necessary to define control mechanisms to be able to audit performance of supply chain according to the plan, by coordinating activities and processes in order to build links between supply chain members and making the right decisions.

There are several organizations trying to set cross-industry standard processes such as Global Supply Chain Forum (GSCF), SCOR (Supply-Chain Operations Reference Model), CPFR (Collaborative Planning, Forecasting & Replenishment), and Rosseta Net, which can help members of a supply chain integrate efficiently.

The Global Supply Chain Forum defines supply chain management as "the

integration of key business process from end user through to original suppliers that provide products, services and information that add value for customers and stakeholders" (Lambert, 2005: 28).

The following eight key supply chain management processes are included in the framework (Cooper, 1997: 14):

- Customer Relationship Management.
- Customer Service Management.
- Demand Management.
- Order Fulfilment.
- Manufacturing Flow Management.
- Supplier Relationship Management.
- Product Development and Commercialisation.
- Returns Management.

1.1.2. Development of Supply Chain Management

The industrial production affected by Ford and Taylor has been done in a manner of mass production in serial conditions until the 1970s. This approach started not to satisfy the customer needs after the last quarter of 20th century. In order to meed the demand in the market, lean production started to be a must. Hight flexibility of product, short lead times, deliveries on time and product with high quality are the basics of lean manufacturing logic. Unlike today, sharing technology and expertise with customers or suppliers was considered too risky and therefore unacceptable, thus little emphasis was placed on cooperative and strategic buyer-supplier partnerships (Tan, 2002: 13).

During the 1960s, new approaches in marketing emerged as the areas of consumer behavior and the analysis of distribution systems became the focus of much business-related research. During the decade of the 1970s, a trend which began in the 1960s—the migration of military logistics practices to the private sector—accelerated as corporations recognized the need to improve their distribution functions and American

universities began to offer degree programs in logistics management (Russell, 2007: 16). Material requirements planning (MRP) was also developed and managers realized the impact of huge WIP inventories on manufacturing cost, quality, product development, and delivery lead-time. Manufacturers resorted to new materials management concepts to improve performance of organizations (Tan, 2002: 33).

The intense global competition in the 1980s forced world-class organizations to offer low cost, high quality and reliable products with greater design flexibility. Manufacturers utilized just-in-time (JIT) and other management initiatives to improve manufacturing efficiency and cycle time. In the fast-paced JIT manufacturing environment with little inventory to cushion production or scheduling problems, manufacturers began to realize the potential benefit and importance of strategic and cooperative buyer-supplier relationship. The concept of supply chain management emerged as manufacturers experimented with strategic partnerships with their immediate suppliers. In addition to the procurement professionals, experts in transportation and logistics carried the concept of materials management a step further to incorporate the physical distribution and transportation functions, resulting in the integrated logistics concept, also known as supply chain management (Tan, 2001; 41).

As competition in the 1990s intensified and markets became global, so did the challenges associated with getting a product and service to the right place at the right time at the lowest cost. Organizations began to realize that it is not enough to improve efficiencies within an organization, but their whole supply chain has to be made competitive. The understanding and practicing of supply chain management (SCM) has become an essential prerequisite for staying competitive in the global race and for enhancing profitably (Li, Ragu-Nathan, Ragu-Nathan & Rao 2006: 107).

1.1.3. Supply Chain Management Functions

Supply chain management functions operate on three levels: strategic level, tactical level, and operational level. It can be seen in details in Table 2.

Table 2: Supply chain management functions

	Demand Management	Distribution	Manufacturing	Materials
Strategic level	Monthly Forecasts	Enterprise Distribution Planning	Enterprise Production Planning	Enterprise Material Planning
Tactical level	Weekly Forecasts	Distribution Requirements Planning	Master Production Scheduling	Material Requirements Planning
Operational level	Orders	Inventory Deployment	Process Level Scheduling	Material Releases

(Source: Fox M., Chionglo J., Barbuceanu M., 1993, 2)

This thesis will mostly focus on the inventory process considering the ordering process in operational level. Considering these functions, stock is another vital element of Supply Chain Management at a multi-point of factories, distributors, wholesalers, retailers and so on. Inventory levels, control and visibility are key factors affecting direct operating costs and balance sheets. Other important factors are; inventory turn ver rate, volume is the product inventory and product value loss and return loss of speed. These factors directly affect the company's financial flexibility and agility.

One of the most fundamental role that inventory plays in supply chains is that of facilitating the balancing of demand and supply. To effectively manage the forward and

reverse flows in the supply chain, firms have to deal with upstream supplier exchanges and downstream customer demands. This puts an organization in the position of trying to strike a balance between fulfilling the demands of customers, which is often difficult to forecast with precision or accuracy, and maintaining adequate supply of materials and goods. This balance is often achieved through inventory.

A basic understanding of how inventory appears on the balance sheet and its impact on the income statement and cash flow statement will improve your ability to have the right item in the right quantity in the right place at the right time (Muller, 2011: 26).

1.1.4. Logistics

Logistics was first examined in scholarly writing in the early 1900s. John Crowell discussed the costs and factors affecting the distribution of farm products in the U.S. government's Report of the Industrial Commission on the Distribution of Farm Products. Later, in his An Approach to Business Problems, Arch Shaw discussed the strategic aspects of logistics. During the same year, L.D.H. Weld introduced the concept of marketing utilities (time, place, profession) and channels of distribution. In 1922, Fred Clark identified the role of logistics in marketing and in 1927 the term logistics was defined in a similar to its use today.

There had been many developments in 1960s. The first dedicated logistics texts began to appear in the early 1960s which is also the time that Peter Drucker a noted business expert, author and consultant stated that logistics was one of the last real frontiers of opportunity for organizations wishing to improve their corporate efficiency. (Lambert, Stock and Ellram, 1998: 6)

The Council of Logistics Management (formerly the National Council of Physical Distribution Management) was formed in 1963 to develop the theory and understanding of the logistics process, promote the art and science of managing logistics

systems and to foster professional dialogue and development in the field operating exclusively without profit and in cooperation with other organizations and institutions. (Lambert and Stock, 1993: 20)

During the remainder of the 1960s and on into 1980s, a multitude of textbooks, articles, monographs, journals, and conferences were devoted to the subject of logistics management. (Lambert and Stock, 1993: 20)

Beginning in the late 1970s and continuing throughout the 1980s, logistics management was significantly affected by deregulation of the transportation industry. (Lambert and Stock, 1993: 20) Widespread reductions in the economic regulation commonly referred to as deregulation relaxed government control of carriers' rates and fares, entry and exit, mergers and acquisitions and more. (Murphy and Wood, 2004: 8) As a result carriers become more creative, flexible, customer oriented and competitive in order to succeed. Shippers are now faced with many more transportation options. They can focus on negotiation of the rates, terms and services with their overall attention directed toward getting the best transportation buy.(Lambert, Stock and Ellram, 1998: 6)

During 1970s, with rising interest rates and increasing energy costs, logistics received more attention as a major cost driver. Logistics costs became a more critical issue for many organizations because of the globalization of industry. (Lambert, Stock and Ellram, 1998: 6)

Beginning in the 1970s and accelerating in the 1990s has been the development and expansion of global competition. Firms have increasingly become more international, as evidenced by the increase in foreign sourcing of raw materials, component parts, subassemblies and labor. Companies have penetrated new markets throughout the world. Enterprising firms throughout the world have recognized the need to become more globally oriented. (Lambert and Stock, 1993: 21)

For a better understanding, different logistics and logistics management definitions will be stated as following.

Murphy and Wood states the terms used to refer business logistics as following: Business Logistics, Distribution, Industrial Distribution, Logistics, Logistics Management, Materials Management, Physical Distribution and Supply Chain Management. In essence, each of the terms is associated with managing the flow of goods and information from a point of origin to a point of consumption. (Murphy and Wood, 2004: 5) But logistics management is the most widely accepted term among logistics professionals. (Lambert and Stock, 1993: 4)

A dictionary (Macmillan Contemporary Dictionary) definition of the term logistics is: The branch of military science concerned with the movement, procurement and maintenance of equipment, facilities and personnel. (Halsey, 1988: 601)

The Council of Logistics Management (CLM), which is a professional organization of logistics managers, educators and practioners formed in 1962 and named as Council of Supply Chain Management Professionals in 2005 for the purpose of continuing education and fostering the interchange of the ideas defines the term of logistics as per below:

"Logistics is the process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal and external movements."

As a result; logistics is a process that includes all the activities that have an impact on making goods and also services available to customers when and where they wish to acquire them. (Ballou, 2004: 4) Logistics concept looks at the material flow

process as a complete system, from initial need for materials to delivery of finished products or service to the customers. (Leenders, Fearon and et al., 2002: 8)

1.1.5. Logictics vs Supply Chain Management

Supply Chain Management emphasizes the logistics interactions that take place among the functions of marketing, logistics and production within a firm and those interactions that take place between the legally separate firms within the product-flow channel. (Ballou, 2004: 4)

There are many definitions for both terms, depending on which source you listen to. In North America, Logistics is often associated with transportation or distribution only. In Europe, Logistics involves the entire supply chain. For those who look for clarification on this topic, here is one explanation of the difference between the two terms that we at Logistics Advice stand behind.

Logistics Management is the management of the flow of goods, information and other resources, including energy and people, between the point of origin and the point of consumption in order to meet the requirements of consumers at the lowest cost possible.

Supply chain management involves coordinating and integrating Logistics Management (as described above) within and among companies.

Our view on these definitions is that Logistics Management involves the entire supply chain (from point of origin to point of consumption) but is often practiced at a local level (within an individual company) where Supply Chain Management specifically focuses on optimizing the flow of goods throughout the entire chain (within and among companies).

1.1.6. Logistics Activities

Ballou categorizes the logistics activities as core and support activities. Core activities are customer service standards, transportation, inventory management, order policies and information flows. He states support activities as warehousing, materials handling, purchasing, protection, production scheduling and information acquisition and maintenance. (Ballou, 2004: 10)

Murphy and Wood outline the logistics-related activities as customer service, facility location decisions, inventory management, order management, production scheduling, returned products, transportation management, demand forecasting, industrial packaging, materials handling, parts and service support, procurement, salvage and scrap disposal and warehouse management. (Murphy and Wood, 2004: 25)

Lambert, Stock and Ellram outline the logistics activities as customer service, demand forecasting/planning, inventory management, logistics communications, material handling, order processing, packaging, parts & service support, plant and warehouse site selection, procurement, return goods handling, reverse logistics, traffic and transportation, warehousing and storage (Lambert, Stock and Ellram, 1998: 15).

According to Lambert, Stock and Ellram categorization, the brief definitions of each activity is as below.

1.1.6.1. Customer Service

Customer service involves making sure that the right person receives the right product at the right place at the right time in the right condition and at the right cost.(Murphy and Wood, 2004: 25)

1.1.6.2. Demand Forecasting/Planning

Demand forecasting addresses the need for accurate information on future customer needs so that the logistics system can ensure the right products and/or services are available to meet those requirements. (Gourdin, 2001: 6)

1.1.6.3. Inventory Management

Inventory management deals with balancing the cost of maintaining additional products on hand against the risk of not having those items when the customer wants them. (Gourdin, 2001: 5) Logisticians consider three relevant costs; the cost of holding product, the cost of ordering product and the cost of being out of stock.

1.1.6.4. Logistics Communications

Communication is key to the efficient functioning of any system. Excellent communications within a system can be a key source of competitive advantage. As Lambert, Stock and Ellram state that communication must occur between organization and its suppliers and customers; within the organization such as logistics, engineering, accounting, marketing and production. (Lambert, Stock and Ellram, 1998: 18)

1.1.6.5. Materials Handling

Material handling refers to the short-distance movement of products within the confines of a facility like plant and warehouse. Since material handling tends to add costs rather than value to logistics systems, managers pursue cost-efficiency objectives such as minimizing the number of handlings and moving the product in a straight line whenever possible. (Murphy and Wood, 2004: 26)

1.1.6.6. Order Processing

Order processing entails the systems that an organization has for getting orders from customers, checking on the status of orders and communicating to customers about them, and actually filling the order and making it available to the customer.(Lambert, Stock and Ellram, 1998: 18)

1.1.6.7. Packaging

Packaging focuses on protecting the product while it is being shipped and stored. Too much packaging increases costs while inadequate protection can result in merchandise damage and customer dissatisfaction. (Gourdin, 2001: 6)

1.1.6.8. Parts and Service Support

Parts and Service support refers to after-sale support for products in the form of repair parts, regularly scheduled service, emergency service and so on. (Murphy and Wood, 2004: 26)

1.1.6.9. Plant and Warehouse Site Selection

Plant and Warehouse Site selection addresses the strategic placement of warehouse, plants and transportation resources to achieve customer service objectives and minimize cost.

1.1.6.10. Procurement

Procurement deals with the buying of goods and services that keep the organization functioning. Since these inputs can have a direct impact on both the cost

and quality of the final product/service offered to the customer, this activity is vital to the overall success of the logistics effort.

1.1.6.11. Return Goods Handling

Products can be returned for various reasons, such as product recalls, product damage, lack of demand, and customer dissatisfaction. (Murphy and Wood, 2004: 27) Return goods handling is complex because it involves moving small quantities of goods back from the customer rather than to the customer as the firm is accustomed. Many logistics systems have a difficult time handling this type of movement. Costs tend to be high. (Lambert, Stock and Ellram, 1998: 20)

1.1.6.12. Reverse Logistics

Logistics is also involved in removal and disposal of waste materials left over from the production, distribution or packaging processes. As the concern for recycling and reusable packaging grows, this issue will increase in importance. (Lambert, Stock and Ellram, 1998: 20)

1.1.6.13. Traffic and Transportation

Transportation refers to the physical movement of goods from a point of origin to a point of consumption and can involve raw materials being brought into the production process and finished goods being shipped out to the customer. Transportation involves selection of the mode (e.g., air, rail, water, truck or pipeline), the routing of the shipment, assuring of compliance with regulations in the region of the country where shipment is occurring and selection of the carrier. (Lambert, Stock and Ellram, 1998: 21)

1.1.6.14. Warehousing and Storage

Warehousing refers to places where inventory can be stored for a particular period of time. (Murphy and Wood, 2004: 27) Storage addresses the physical requirements of holding inventory.

Depending on the circumstances, an author's point of view or categorization criteria, many other activities can be included under the term logistics. Such activities might be sales forecasting, production scheduling, customer service management, overseas liaison, third party operations, and so on. According to Waters the important point is not to draw arbitrary boundaries between functions, but to recognize that they must all work together to get an efficient flow of materials.

In this thesis, we will mostly focus on inventory management and order processing.

CHAPTER 2
INVENTORY MANAGEMENT

In this chapter, inventory understanding, types of inventory according to different people, inventory control models, inventory classification with different methods, lot sizing methods will be discussed in details.

2.1. Inventory Concept

One of the aims of inventory management is to hold inventories at the lowest possible cost, given the objectives to ensure uninterrupted supplies for ongoing operations. When making decisions on inventory, management has to find a compromise between the different cost components, such as the costs of supplying inventory, inventory-holding costs and costs resulting from insufficient inventories (Hugo, Badenhorst-Weiss and Van Rooyen 2002: 169).

According to Wild, inventory control is the activity which organises the availability of items to the customers. It coordinates the purchasing, manufacturing and distribution functions to meet the marketing needs. This role includes the supply of current sales items, new products, consumables; spare parts, obsolescent items and all other supplies. Inventory enables a company to support the customer service, logistic or manufacturing activities in situations where purchasing or manufacturing of the items is not able to satisfy the demand. Lack of satisfaction could arise either because of the speed of purchasing or manufacturing is too protracted, or because quantities cannot be provided without stocks. Clodfelter adds that a good inventory control system offers the following benefits:

The proper relationship between sales and inventory can better be well maintained. Without inventory control procedures in place, the store or department can become overstocked or understocked.

Inventory control systems provide a business with information needed to take markdowns by identifying slow-selling merchandise. Discovering such items early in the season will allow a business to reduce prices or make a change in marketing strategy before consumer demand completely disappears.

Merchandise control systems allow buyers to identify best-sellers early enough in the season so that re-orders can be placed to increase total sales for the store or department.

Merchandise shortages and shrinkage, can be identified using inventory control systems. Excessive shrinkage will indicate that more effective merchandising controls need to be implemented to reduce employee theft or shoplifting.

Emphasising the pertinence of the topic, in 2001, Gourdin noted that inventory is one area of logistics that has received a great deal of management attention over the past decade. Executives now realise that holding excessive stocks is simply too expensive. Therefore, a great deal of effort has been expended to eliminate unnecessary inventory without compromising customer service. However, there are numerous situations where inventory simply must be held, particularly when meeting the needs of global customers. Management's goal should be to hold only what is necessary to satisfy customer requirements and manage it effectively' (Gourdin 2001: 82).

2.1.1. Historical review of inventory management

Inventory problems have proliferated as technological progress has increased the organisation's ability to produce goods in greater quantities, faster and with multiple design variations. The public has compounded the problem by its receptiveness to variations and frequent design changes (Tersine, 1982: 5).

Since the mid-1980s the strategic benefits of inventory management and

production planning and scheduling have become obvious. The business press has highlighted the success of Japanese, European, North American firms in achieving unparalleled effectiveness and efficiency in manufacturing and distribution. In recent years, many of the firms have raised the bar, yet again by coordinating with other firms in their supply chains. For instance, instead of responding to unknown and variable demand, they share information so that the variability of the demand they observe is significantly lower (Silver, Pyke and Peterson, 1998: 9).

Silver, Pyke and Peterson continue arguing that in the United States of America and other Western Countries, productivity improvement was pursued through reducing the amount of direct manufacturing labour expended per unit of output. This was a valid strategy because of the high labour content in many manufactured products. However, the proportion of unit cost due to labour has been steadily decreasing in recent years. In fact, the ratio of purchased materials to sales (in dollars) reached 60 percent for U.S. firms in 1985. Even large manufacturing firms, such as the U.S auto assemblers, purchase up to 60 percent of the value of the product. This implies that management of raw materials inventories is an area that shows great promise for productivity improvement. Japanese firms received much deserved attention in the mid-to late 1980s because of their remarkable performance on quality and inventory management. The tremendous interest in Just-in-Time manufacturing (JIT) indicates that work-in-process inventory management is also an area ripe for improvement.

2.1.2. Definition of inventory

There are various definitions about inventory in literature. Three of them are chosen to use in this thesis related to inventory holding topic. Inventories are stockpiles of raw materials, suppliers, components, work in process, and finished goods that appear at numerous points throughout a firm's production and logistics channel'(Ballou 2004: 326). According to Chase, Jacobs and Aquilano, inventory is the stock of any item or resource used in an organisation. An inventory system is the set of policies and controls that monitor levels of inventory and determine what levels should be maintained, when

stock should be replenished, and how large orders should be. Finally, Pycraft define inventory or stock as 'the stored accumulation of material resources in a transformation system.

2.1.3. Reasons for Holding Inventories

In environments where an organization suffers from poor cash flow or lacks strong control over;

- Electronic information transfer among all departments and all significant suppliers,
- Lead times, and
- Quality of materials received, inventory plays important roles (Muller, 2011: 45).

The interval between receiving the purchased parts and transforming them into final products varies from industries to industries depending upon the cycle time of manufacture. It is, therefore, necessary to hold inventories of various kinds to act as a buffer between supply and demand for efficient operation of the system. Thus, an effective control on inventory is a must for smooth and efficient running of the production cycle with least interruptions (Kumar, 2008: 15).

According to Max Müller, some of the more important reasons for obtaining and holding inventory are:

- Predictability: In order to engage in capacity planning and production scheduling, you need to control how much raw material, parts, and subassemblies you process at a given time. Inventory buffers what you need from what you process.

- Fluctuations in Demand: A supply of inventory on hand is protection: It is not always determined how much the pasrts are needed at any given time, but customer should always be satisfied of demand should be met. If customer behaviours are know and determined in the supply chain, surprises in fluctuations in demand are held to a minimum.

- Unreliability of Supply: Inventory protects you from unreliable suppliers or when an item is scarce and it is difficult to ensure a steady supply. Whenever possible unreliable suppliers should be rehabilitated through discussions or they should be replaced. Rehabilitation can be accomplished through master purchase orders with timed product releases, price or term penalties for nonperformance, better verbal and electronic communications between the parties, etc. This will result in a lowering of your on-hand inventory needs.

- Price Protection: Buying quantities of inventory at appropriate times helps avoid the impact of cost inflation. Note that contracting to assure a price does not require actually taking delivery at the time of purchase. Many suppliers prefer to deliver periodically rather than to ship an entire year's supply of a particular stock keeping unit (SKU) at one time. (Note: The acronym "SKU," standing for "stock keeping unit," is a common term in the inventory world. It generally stands for a specific identifying numeric or alpha-numeric identifier for a specific item).

- Quantity Discounts: Often bulk discounts are available if you buy in large rather than in small quantities.

- Lower Ordering Costs: If you buy a larger quantity of an item less frequently, the ordering costs are less than buying smaller quantities over and over again. (The costs of holding the Item for a longer period of time, however, will be greater.) In order to hold down ordering costs and to lock in favorable pricing, many

organizations issue blanket purchase orders coupled with periodic release and receiving dates of the SKUs called for.

2.1.4. Types of Inventory

According to Stock and Lambert, inventories can be categorised into six distinct forms, that are:

- Cycle stock. Cycle stock is inventory that results from the replenishment process and is required in order to meet demand under conditions of certainty, that is, when the firm can predict demand and replenishment times (lead times) almost perfectly. For example, if the rate of sales for a constant 20 units per day and the lead time is always 10 days, no inventory beyond the cycle stock would be required. While assumptions of constant demand and lead time remove the complexities involved in inventory management, let's look at such an example to clarify the basic inventory principles.

- In-transit inventories. In-transit inventories are items that are on route from one location to another. They may be considered part of cycle stock even though they are not available for sale and /or shipment until after they arrive at the destination. For the calculation of inventory carrying costs, in-transit inventories should be considered as inventory at the place of shipment origin since the items are not available for the buyer, sale, or subsequent reshipment.

- Safety or buffer stock. Safety or buffer stock is held in excess of cycle stock because of uncertainty in demand or lead time. The notion is that a portion of average inventory should be devoted to cover short-range variations in demand and lead time. Average inventory at a stock-keeping location that experiences demand or lead time variability is equal to half the order quantity plus the safety stock.

- Speculation stock. Speculation stock is inventory held for reasons other than satisfying current demand. For example, materials may be purchased in volumes larger than necessary in order to receive quantity discounts, because of a forecasted price increase or materials shortage, or to protect against the possibility of a strike.

- Seasonal stock is a form of speculative stock that involves the accumulation of inventory before a season begins in order to maintain a stable labour force and stable production runs or, in the case of agricultural products, inventory accumulated as the result of a growing season that limits availabilty throughout the year.

- Dead stock is the excess stock which is ordered before and has no usage in present. It is inventory that no one wants, at least immediately. The question is why any organisation would incur the costs associated with holding these items rather than simply disposing of them. One reason might be that management expects demand to resume at some point in the future. Alternatively, it may cost more to get rid of an item that it does to keep it. But the most compelling reason for maintaining these goods is customer service. Perhaps an important buyer has an occasional need for some of these items, so management keeps them on hand as a goodwill gesture.

The types of inventory depend on the specifics of the industry and business thus inventory found in distribution environments (mainly finished goods for resale) are fundamentally different from those found in manufacturing environments (raw materials and work in progress) (Muller, 2003: 56). In the worlds of distribution, retailing, and replacement parts, an organization deals with finished goods (Muller, 2003: 56). In the manufacturing world, an organization deals with raw materials and subassemblies. Considerations of what to buy, when to buy it, in what quantities, and so on are dramatically different in these two worlds. In distribution, you are concerned with having the right item, in the right quantity. Issues relating to having the item at the right time and

place are often dealt with by simply increasing safety stock on-hand. That is not a good solution because it leads to wasted money and space. However, traditional formulae used in computing inventory requirements in a distribution environment focus on item and quantity rather than place and time. In manufacturing, you are concerned with having the right item, in the right quantity, at the right time, in the right place (Muller, 2003: 58). For better presentation and control inventory systems has to be considered as distributed parameter systems where lead time and other time delays are clearly presented and locations are analyzed in components of state vectors.

In this thesis, safety and buffer stocks will be analyzed more often.

2.1.5. Safety/Buffer inventory

Safety stock may be defined as the minimum additional inventory, which serves as a safety margin or buffer or cushion to meet an unanticipated increase in usage resulting from an unusually high demand and or an uncontrollable late receipt of incoming inventory.

If demand forecasting could be done with perfect accuracy, then the only inventory that would be needed would be cycle inventory. Nevertheless, since every forecast has some degree of uncertainty in it, we cover that uncertainty to a greater or lesser degree by holding additional inventory in case demand is suddenly greater than anticipated. The trade-off here is to weight the costs of carrying extra inventory against the costs of losing sales or making backlogs due to insufficient inventory. On one hand, raising the level of safety inventory increases product availability and thus the margin captured from customer purchases. On the other hand raising the level of safety stocks increases holding costs. This issue is particularly important in industries where product life cycles are short and demand is very volatile. Given the product variety and high demand uncertainty in nowadays supply chains, a significant fraction of the inventory carried is safety inventory. As product variety has grown, product life cycles have shrunk, especially in the case of high-tech industries. Thus, it is more likely that a product that is attractive today will be obsolete tomorrow, which increases the cost to enterprises of carrying too much inventory. Thus, a

key to the success of any supply chain is to figure out ways to decrease the level of safety inventory carried without hurting the level of product availability under the optimal level (Chopra and Meindl, 2004: 42).

The appropriate level of safety stock is determined by the following two factors (Chopra and Meindl, 2004: 42):

1. The uncertainty of both demand and supply,
2. The desired level of product availability.

As the uncertainty of supply and demand grows the required level of safety stock increases. As the desired level of product availability increases, the required level of safety inventory also increases.

2.1.6. Inventory Costs

According to Ryzin, in almost any business analysis involving inventory, physical inventory levels must be converted to inventory costs. The exact determination of the cost rate to apply is really a cost accounting matter, but here are the major components:

- Capital Cost - This is usually an internal cost of funds rate multiplied by the value of the product. Because value (materials, labor, transportation, etc.) is added to the product as it moves along the supply chain, this cost tends to increase as product moves downstream.

- Storage Cost - Units in inventory take up physical space, and may incur costs for heating, refrigeration, insurance, etc. An activities based cost (ABC) analysis is usually needed to determine which components of these costs are actually driven by inventory levels and which can be considered more-or-less fixed. The answer will depend on the magnitude of the inventory change you are analyzing.

- Obsolescence Cost - A somewhat harder cost component to pin down is obsolescence cost. A technology or fashion shift may make your current products

obsolete and severely defate their value. The more inventory you have, the higher your exposure to this sort of loss.

- Quality Cost - High levels of inventory usually increase the chance of product damage and create slower feed-back loops between supply chain partners. The result: lower levels of quality and a rise in the myriad costs associated with low quality. Again, these costs are difficult to quantify precisely, but the current consensus is that they can be quite significant.

Typically, all these costs are rolled together into a single inventory cost rate, expressed as a percentage of the value of the product or material per unit time (e.g. 20% per year). Other equivalent terms for this same cost rate are inventory holding cost rate and inventory carrying cost rate.

According to Gourdin, there are three types of costs that must be considered in setting inventory levels.

- **Holding (or carrying)** costs are costs such as storage, handling, insurance, taxes, obsolescence, theft and interest on funds financing the goods. These charges increase as inventory levels rise. In order to minimise carrying costs, management makes frequent orders of small quantities. Holding costs are commonly assessed as a percentage of unit value, i.e. 15 percent, 20 percent, rather than attempting to derive a monetary value for each of these costs individually. This practice is a reflection of the difficulty inherent in deriving a specific per-unit cost for, for example, obsolescence or theft.

- **Ordering costs** are those costs associated with placing an order, including expenses related to personnel in a purchasing department, communications and the handling of the related paperwork. Lowering these costs would be accomplished by placing a small number of orders, each for a large quantity.

Unlike carrying costs, ordering costs are generally expressed as a monetary value per order.

- **Stock-out costs** include sales that are lost, both short and long term. These charges are probably the most difficult to compute, but arguably the most important because they represent the costs incurred by customers (internal or external) when inventory policies falter. Failure to understand these costs can lead management to maintain higher (or lower) inventory levels than customer requirements may justify.

According to Waters, inventory brings with it a number of relevant costs. These costs can include costs of goods, costs of space, cost of labor to receive, check quality, put away, retrieve, select, pack, ship, cost of deterioration, damace, obsolescence, theft (Waters, 2003: 32).

The basic costs associated with inventory are (Barfield, 2003: 14) purchasing/ production costs, ordering/ setup costs, holding(carrying)/shortage costs.

- **Purchasing Costs** may include (Ghiani, 2004, 24):

• A (fixed) reorder cost (the cost of issuing and processing an order through the purchasing and accounting departments if the goods are bought, or the cost for setting up the production process if the goods are manufactured by the firm);

• A purchasing cost or a (variable) manufacturing cost, depending on whether the goods are bought from a supplier or manufactured by the firm;

• A transportation cost, if not included in the price of the purchased goods; for the sake of simplicity, we assume in the remainder of this chapter that fixed transportation costs are included in the reorder cost, while variable transportation costs are included in the purchasing cost;

• The cost of handling the goods at the receiving point

The purchasing cost for inventory is the quoted purchase price minus any discounts allowed, plus shipping charges. For a manufacturer, production cost refers to the costs associated with purchasing direct material, paying for direct labor, incurring traceable overhead, and absorbing allocated fixed manufacturing overhead. Of these production costs, fixed manufacturing overhead is the least susceptible to cost minimization in the short run (Barfield, 2003, 24). An exception is that management is able to somewhat control the fixed component of unit product cost through capacity utilization measures within the context of product demand in the short run. Most efforts to minimize fixed manufacturing overhead costs involve long-run measures.

Purchasing/production cost is the amount to be recorded in the appropriate inventory account (raw material inventory, work-in-process inventory, finished goods inventory, or merchandise inventory) (Barfield, 2003, 32).

The two fundamental approaches to producing inventory are push systems and pull systems. In a traditional approach, production is conducted in anticipation of customer orders. In this approach, known as a push system, work centers may buy or produce inventory not currently needed because of lead-time or economic order or production quantity requirements. This excess inventory is stored until it is needed by other work centers. To reduce the cost of carrying inventory until needed at some point in the future, many companies have begun to implement pull systems of production control. In these systems, parts are delivered or produced only as they are needed by the work center for which they are intended. Although some minimal storage must exist by necessity, work centers do not produce to compensate for lead times or to meet some economic production run model (Barfield, 2003: 32).

- **Ordering/Setup costs;**

Incremental, variable costs associated with preparing, receiving, and paying for an order are called ordering costs and include the cost of forms and a variety of clerical costs (Barfield, 2003, 33). Ordering costs are traditionally expensed as

incurred by retailers and wholesalers, although under an activity-based costing system these costs can be traced to the ordered items as an additional direct cost. Retailers incur ordering costs for their entire merchandise inventory. In manufacturing companies, ordering costs are incurred for raw material purchases (Barfield, 2003: 33). If the company intends to produce rather than order a part, direct and indirect setup costs (instead of ordering costs) are created as equipment is readied for each new production run. Setup necessitates costs for changing dies or drill heads, recalibrating machinery, and resetting tolerance limits for quality control equipment. For decision analysis purposes, only the direct or incremental setup costs are relevant (Barfield, 2003: 33).

Components of order cost include (Chopra and Meindl, 2004: 34):

- Buyer time;
- Transportation cost;
- Receiving cost;
- Other costs;

Buyer time is the incremental time of the buyer placing the extra order and the cost should be included only if the buyer is utilized fully. The incremental cost of getting an idle buyer to place an order is zero and does not add to the order cost. A fixed transportation cost is often incurred regardless of the size of the order. Some receiving costs are incurred regardless of the size of the order. These include any administration work such as purchase order matching and any effort associated with updating inventory records. For all order costs it is important to determine that all costs included are the incremental change in real cost for an additional order. The order cost is often a step function: it is zero when the resource is not fully utilized and at that point, the order cost is the cost of the additional resource required (Chopra and Meindl, 2004: 16).

- **Holding (carrying)/shortage costs;**

Inventory carrying costs are the variable costs of carrying one inventory unit in stock for one year. Inventory holding costs are incurred when materials are stored for a period. Holding costs include the following (Ghian, 2004: 43):

• A warehousing cost for storage, handling, insurance, losses from obsolescence and damage. If the company runs its own warehouses, such costs include space and equipment costs, personnel wages, insurance on inventories, maintenance costs, energy costs and state taxes. Otherwise, warehousing costs amount to the fee paid for storing the goods in third-party warehouses (rent);

• An opportunity (or capital) cost representing the return on investment the firm would have realized if money had been invested in a more profitable economic activity (e.g. on the stock market) instead of inventory. This cost is generally estimated based on a standard banking interest rate. Inventory is one of the many investments made by an organization and should be expected to earn a satisfactory rate of return. Some Japanese managers have referred to inventory as a liability. One can readily understand that perspective considering that carrying costs, which can be estimated using information from various budgets, special studies, or other analytical techniques, "can easily add 20 percent to 25 percent per year to the initial cost of inventory." Although carrying inventory in excess of need generates costs, a fully depleted inventory can also generate costs.

Holding cost is usually estimated as a percentage of the cost of a production (Chopra and Meindl, 2004: 32). It is estimated as the sum of the following major components:

- Cost of capital;
- Obsolescence or spoilage cost;

- Handling cost;
- Occupancy cost;
- Miscellaneous cost;

Cost of capital is the most important component of holding cost (Chopra and Meindl, 2004: 32). The appropriate approach is to evaluate the Weighted Average Cost of Capital (WACC). This cost takes into account the return demanded on the firm's equity and the amount the firm must pay on its debt. These are weighted by the amount of debt and equity financing that the firm has. The WACC is the appropriate cost of capital for a firm that could grow its business using the funds released by reducing inventories. The obsolescence cost estimates the rate at which the value of the product stored drops either because the market value of that product drops or because the product quality deteriorates. Handling cost should only include receiving and storage costs that vary with the quantity of product received. Quantity-independent handling costs are often included in the order cost. Quantity-dependent costs are generally small and often the real does not change if quantity varies within a range. Occupancy cost should reflect the incremental change is space cost due to changing cycle inventory. As long as a marginal change in cycle inventory does not change the space requirements, the occupancy cost should be considered zero. If the firm is being charged based on the actual number of units held in storage, we have the direct occupancy cost. Firms often lease or purchase a fixed amount of space. Miscellaneous costs are other, relatively small costs like theft, security, damage, tax, and additional insurance charges that may be incurred (Chopra and Meindl, 2004: 33).

Obsolescence costs arise when stocked items lose some of their value over time. This happens, for example, when food inventories deteriorate, clothing items in stock go out of fashion, or newspapers are unsold. The value of an item at the end of its lifetime is usually referred to as its salvage value (Ghiani, 2004: 16).

Shortage costs are paid when customer orders are not met. Shortage costs depend heavily on customer behavior and are difficult to evaluate accurately.
They can be classified as follows (Chopra and Meindl, 2004: 34):

- Lost sales costs. A lost sale is likely to occur if the unavailable items can be easily obtained from a competitor. Lost sales costs include the profit that would have made on the sale, and the negative effect that the shortage could have on future sales.
- Back order costs. When goods are difficult to replace, a shortage often results in a delayed sale. Apart from the negative effect on future sales, a back order could result in a penalty.

The cost of having a stockout is not easily determinable, but some of the costs involved might include lost customer goodwill, lost contribution margin from not being able to make a sale, additional ordering, and shipping charges incurred from special orders, and possibly lost customers. This cost can be easily considered through the differences of net present value of value chain. For a manufacturer, another important stockout cost is incurred for production adjustments arising from not having inventory available. If a necessary raw material is not on hand, the production process must be rescheduled or stopped, which in turn may cause additional setup costs before production resumes (Barfield, 2003: 22). In such a complex structure of costs and incomes of dynamic inventory systems net present value approach for inventory systems control is the most appropriate one, which is shown in the subsequent section.

In making any decision that affects inventory size, the following costs must be considered (Jacobs, 2012):

- Holding (or carrying) costs
- Setup (or production change) costs
- Ordering costs
- Shortage costs

2.1.7. Inventory Control Models (Systems)

Even though there are literally millions of different types of products manufactured in the world, there are only two fundamental decisions that you have to make when controlling inventory (Nagraj, 2013: 13):

- How much to order? (The lot size)
- When to order? (The reorder point)

Inventory control is a planned approach of determining what to order, when to order and how much to order and how much to stock so that costs associated with buying and storing are optimal without interrupting production and sales (Kumar, 2008: 16). For also S. Anil Kumar, inventory control basically deals with two problems:

- When should an order be placed? (Order level), and
- How much should be ordered? (Order quantity).

These questions are answered by the use of inventory models. As you know, inventory fulfills many important functions in an organization. But as the inventory levels go up to provide these functions, the cost of storing and holding inventory also increases. Thus, we must reach a fine balance in establishing inventory levels. A major objective in controlling inventory is to minimize total inventory costs.

2.1.8. ABC Analysis

ABC analysis was discovered by Pareto, an Italian economist, approximately 100 years ago. He discovered that a small percentage of a population always has the greatest effect. Because of its easy-to implement nature and remarkable effectiveness in many inventory systems, this approach is widely used in practice (Chen, 2006: 17). Pareto's law was further expanded to the ABC classification and is summarized below. Viale has

explained ABC analysis like this: “When considering how to apply this tool to establish inventor y levels, consider the following: From a practical standpoint, ask yourself: “Which products (and which customers) generate 80 percent of the revenue?” Answer: Approximately 20 percent of the products and customers generate 80 percent of the revenue.

From the Table 3, detailed explanation on the A, B and C grouping can be viewed:

Table 3: ABC analysis grouping

20% of Customers, products, or parts=	80% of the company’s revenue and inventory investment	These are called “A”customers “A”products “A”parts
30% of customers, products, or parts=	15% of the company’s revenue and inventory investment	These are called “B”customers “B”products “B”parts
50% of customers, products, or parts=	5% of the company’s revenue and inventory investments	These are called “C”customers “C”products “C”parts

(Source: Viale J.D., 1996, 32)

The fluctuation in demand for the B and C products causes most of the product mix problems, the changes on the shop floor (capacity) and the changes in the supplier due dates Viale in 1996.

The question of when a company should start to implement ABC is first analysed by Cooper. He suggests its time for this new cost system when;

- Functional managers want to drop seemingly profitable lines,
- Profit margins are hard to explain,
- Hard to make products show big profits,
- Departments have their own cost systems,
- Competitors` prices are unrealistically low,
- Results of bids are hard to explain.

Policies based on ABC analysis leverage the sales imbalance outlined by the Pareto principle. This implies that each item should receive a weighed treatment corresponding to its class (Collignon, 2012: 34):

- A-items should have tight inventory control, more secured storage areas and better sales forecasts. Reorders should should be frequent, with weekly or even daily reorder. Avoiding stock-outs on A-items is a priority.
- Reordering C-items is made less frequently. A typically inventory policy for C-items consist of having only 1 unit on hand, and of reordering only when an actual purchase is made. This approach leads to stock-out situation after each purchase which can be an acceptable situation, as the C-items present both low demand and higher risk of excessive inventory costs. For C-items, the question is not so much how many units do we store? but rather do we even keep this item in store?
- B-items benefit from an intermediate status between A and C. An important aspect of class B is the monitoring of potential evolution toward class A or, in the contrary, toward the class C.

ABC analysis is not the only inventory categorization technique. SDE and VED analysis can also be used in such a classification but due to the scope of this thesis which is cost based, ABC analysis is the best method for classification.

2.1.9. SDE(Scarce/ Difficult/ Easily available) Analysis

This classification is carried out based on the lead time required to procure the spare part. The classification is as follows:

- Scarce (S) : Items which are imported and those items which require more than 6 months' lead time.
- Difficult (D) : Items which require more than a fortnight but less than 6 months' lead time.
- Easily available (E) : Items which are easily available ie., less than a fortnights' lead time.

This classification helps in reducing the lead time required at least in case of vital items. Ultimately, this will reduce stock-out costs in case of stock-outs. A comprehensive analysis may ultimately bring down lead time for more & more number of items. This will also result in streamlining the purchase and receiving systems and procedures.

2.1.10. VED(Vital/Essential/Desirable) Analysis

Several factors contribute to the criticality of a spare part. If a spare is for a machine on which many other processes depend, it could be of very vital importance. Also if a spare is, say, an imported component for which procurement lead time could be very high its non- availability may mean a heavy loss. Similarly spares required for fighter aircraft at the time of war could be of great value in terms of fighting capability. In general, criticality of a spare part can be determined from the production downtime loss, due to spare being not available when required.

Based on criticality, spare parts are conventionally classified into three classes, viz. vital, essential and desirable.

- Vital: A spare part will be termed vital, if on account of its non-availability there will be very high loss due to production downtime and/or a very high

cost will be involved if the part is procured on emergency basis. In a process industry, most spare parts for the bottleneck machine or process will be of vital nature. For example, bearings for a kiln in a cement plant will be considered vital.

- Essential: A spare part will be considered essential if, due to its non-availability, moderate loss is incurred. For example, bearings for motors of auxiliary pumps will be classified as essential.
- Desirable: A spare part will be desirable if the production loss is not very significant due to its non-availability. Most of the parts will fall under this category. For example, gaskets for piping connection.

SDE and VED analysis are also explained in details but the best method for this thesis is selected as ABC analysis. Because for SDE analysis, part numbers should be differentiated as scarce, desirable or essential according to their lead times and in this study all materials have the same lead time as 9 days of production in total.

The reason why VDE classification is not chosen is that all the part numbers have the same importance for the customer which means it is not possible to classify them as vital, desirable or essential. Due to these reasons above, ABC method is chosen as the classification method.

2.1.11. Material Requirements Planning(MRP)

Material Requirements Planning is a time phased priority-planning technique that calculates material requirements and schedules supply to meet demand across all products and parts in one or more plants.

Material requirement planning is not only a technique for planning “material” requirements. It is also a logic that relates all the activities in a company to customer demands. People can manage all the resources in a company by using MRP logic together with data processing in other areas. This entire system is called a Manufacturing Resources Planning System, or MRP II.

MRP is to translate the requirement of end products stated in MPS into the requirement of components and materials. MPS is the most direct input to MRP. Other input data include inventory status, bill of material (BOM), fundamental data in item master file, and shop calendar.

MPS is the schedule for end items. It states the quantity and timing of production of specific end items. Master production scheduling is a procedure to determine the production schedules and the available-to-promise (ATP) of the end products. Based on MPS, MRP calculates the replenishment plans from the items in the level below the end products down to the raw materials

BOM describes the structure of the products. It states, from level to level, the components needed to make the parent items. By using BOM, the requirements of end products are expanded to include the requirements of the components, and hence the requirements of all the lower level materials.

In expanding the lower level requirements, what we obtain are gross requirements. Gross requirement is not the real requirement. Net requirement is calculated by subtracting the inventory from the gross requirement. Since MRP is time-phased, both on-hand and on-order inventories are considered. On-hand inventory is the present inventory; on-order inventory is the future inventory, and has to be represented by both quantity and receiving date.

The attributes of all items including raw materials, works-in-process, semi-finished goods, or finished goods, are expressed in the item master file. Part number, lead-time, safety stock, lot-sizing rule, low level code, etc. are required by the MRP processor. Low level code is used to determine the sequence of MRP calculation. Safety stock and lot-sizing rule are used to decide the quantity of the material replenishments. Lead-time is used to decide the time to replenish the required materials.

MRP systems are time-phased. Time bucket is an interval used to break time into discrete chunks. The length of a time bucket is defined according to the characteristics of a business. Commonly used time bucket includes week and day, i.e., numbered-week calendar (00-99) and numbered-day calendar (M-day calendar, 000-999). Planning horizon is the amount of time the master schedule and MRP extend into the future. The planning horizon should cover at least the cumulative lead-time to produce a product.

The basic aim of MRP is to answer the following questions:

- What are we going to make? (using the forecast)
- What does it take to make it? (using master schedule and bill of materials)
- What do we have? (using inventory records)
- What do we need, and when? (using manufacturing schedules) (Silver M., 1998: 16)"

2.2. Ordering- Lot Sizing

Lot-sizing methods play an important role in MRP environment. They are used to determine order/production quantities to cover the independent demand items. Since the presentation of Wagner-Whitin (W-W) method in 1958, various methods have been developed to determine the lot-sizes in an MRP environment.

Zoller and Robrade categories lot-sizing into three different topics;

- Optimizing techniques,
- Stopping rules (heuristics),
- Heuristic algorithms.

The existing methods are classified by Lee into three categories based on the following:

- Optimizing techniques: Based on the use of optimization procedures,
- Heuristic rules: Lot-sizes are determined according to stopping rules,
- Intuitive/Experience: Based on the subjective judgment and past experience of the decision maker.

This classification scheme and associated lot-sizing methods are shown in Table 4.

Table 4: Classification of Lot-sizing Methods

Categories	**Lot-Sizing Methods**
Optimizing Techniques	Economic Order Quantity (EOQ)
	Economic Order Quantity-Discrete
	Period Order Quantity (POQ)
	Wagner-Whitin (W-W)
Heuristic Rules	Groff's Marginal Cost (GMC)
	Incremental Cost (IC)
	Incremental Order Quantity (IOQ)
	Incremental Part-Period Algorithm (IPPA)
	Least Total Cost (LTC)
	Least Unit Cost (LUC)
	Maximum Part-Period Gain (MPG)
	McLaren's Order Moment (MOM)
	Part Period Balancing (PPB)
	Silver-Meal (S-M)
	Uniform Order Quantity (UOQ)
Intuitive/Experience	Fixed Order Quantity (FOQ)
	Fixed Period Requirements (FPR)
	Lot for Lot (L4L)

(Source: Lee, 1990, 16)

2.2.1. Optimizing Techniques

In optimizing methods, lot-sizes are determined by optimization procedures to minimize total cost. There are several well known methods existing in the literature. The first method was developed by Ford W. Harris in 1913 called Economic Order Quantity

(EOQ). It is the oldest single level lot sizing method (Wemmerlöv, 1982: 22). The method uses to determine the order quantity that will minimize the total cost which is sum of the annual holding costs and annual order/setup costs.

2.2.1.1.Economic Order Quantity(EOQ)

The single-item EOQ formula finds the minimum point of the following cost function:
Purchase cost : "This is the variable cost of goods: purchase unit price(c) × annual demand quantity (D) ."

This is: *"c * D"* (1)

Ordering cost (K) : "This is the cost of placing orders: each order has a fixed cost (K), and we need to order D/Q times per year."

This is: *"K * D/Q"* (2)

Holding cost : "The average quantity in stock (between fully replenished and empty)" is Q/2, so this cost: *"h * Q/2"* (3)

"Total Cost (TC) = purchase cost or production cost (cD) + ordering cost (D*K/Q) + holding cost (h*Q/2)"

$$"TC = cD + (D*K)/Q + (h*Q)/2" \quad (4)$$

To determine the minimum point of the total cost curve, partially differentiate the total cost with respect to Q (assume all other variables are constant) and set to 0:

$$"0 = -DK/Q^2 + h/2" \quad (5)$$

Solving for Q gives Q* (the optimal order quantity):

$$"Q*^2 = 2DK/h" \quad (6)$$

Therefore:

$$"Q^*=\sqrt{2DK/h}" \quad (7)$$

Q* is independent of c; it is a function of only K, D, h. The optimal value Q* may also be found by recognizing that;

$$"TC=DK/Q+hQ/2+cD=h/2Q^*(Q-\sqrt{2DKh})^2+\sqrt{2hDK}+cD" \quad (8)$$

Where the non-negative quadratic term disappears for;

$$"Q=\sqrt{2DKh}" \quad (9)$$

Which provides the cost minimum:

$$"TCmin=\sqrt{2hDK}+cD" \quad (10)$$

This technique is relatively easy to use, but it makes a number of assumptions. Some of the more important assumptions follow:

- Demand is known and constant.
- The lead time that is, the time between the placement of the order and the receipt of the order is known and constant.
- The receipt of inventory is instantaneous. In other words, the inventory from an order arrives in one batch, at one point in time.
- Quantity discounts are not possible.
- The only variable costs are the cost of placing an order, ordering cost, and the cost of holding or storing inventory over time, carrying, or holding, cost.
- If orders are placed at the right time, stock-outs and shortages can be avoided completely.

2.2.1.2.Period Order Quantity (POQ)

It is another way to reduce the holding cost, according to Vollmann. Brown proposed POQ method. POQ method uses the EOQ formula to compute an interval between orders.

"Period order quantity= EOQ /average weekly usage" (11)

2.2.1.3. Wagner-Whitin (W-W)

This algorithm is the famous one for solving MPR Systems problem (Chyr et. al., 1999). Optimization technique with variable demand was first suggested by Wagner & Whitin (1958). It provides minimum cost assignment and results optimum solution for the state of not allowed depletion of stock and discrete time variable demands.

The formulation can be seen as below;

Periods: 1,2,3,….N

λi: demand rate in period i

h: holding cost / item / period

K: setup cost

c: unit cost

$C_i^{(j)}$: cost of producing enough items for period i through j at beginning of period i

$$C_i^{(j)} = k + c(\lambda_i + \lambda_{i+1} + \ldots + \lambda_j) + h(\lambda_{i+1} + 2\lambda_{i+2} + \ldots + (j-i)\lambda_j) \quad (12)$$

$$Ci = \min_{i \le j \le N} \left[Ci^{(j)} + Cj + 1 \right] \quad (13)$$

The rule is as Lowest cost from period i to N that will satisfies demand.

2.2.2. Heuristic Rules

In heuristic methods, lot-sizes are determined by stopping rules. Stopping rules increase the cycle length and stop when the transformation of the controllable cost is reached (Zoller & Robrade, 1988: 14).

2.2.2.1.The Least Unit Cost (LUC) and Least Total Cost(LTC)

The method accumulates the requirements until the unit cost over t periods increases (Silver, 1998: 16). The LTC method finds the order size that will cover the next n periods, where n is the period where the inventory holding cost and ordering cost are closest. The decision is made when the cumulative inventory holding cost exceed the order cost. Gorham compares the LUC and Least Total Cost (LTC) methods and concludes that the LUC method is changeable. It performs well or not according to set of data.

The formula is indicated below;

- $C(j) = (K + hr_2 + 2hr_3 + \ldots + (j-1)hr_j) / (r_1 + r_2 + \ldots + r_j)$ (14)
- C(j): average holding cost and setup cost per period

k: order cost or setup cost

h: holding cost

r: demand

The calculation should be started from period 1 to next period;

$$C(1) = K / r_1$$

$$C(2) = (K + hr_2) / (r_1 + r_2)$$

$$C(3) = (K + hr_2 + 2hr_3) / (r_1 + r_2 + r_3) \quad (15)$$

The calculation should end when $C(j) > C(j-1)$.

Set $y_1 = r_1 + r_2 + \ldots + r_j\text{-}1$

Start over at period j, repeat step (I) – (III)

Part Period Balancing (PPB) method was introduced by DeMatties and Mendoza in 1968. Part period means, holding items for a number of periods. It determines order quantities by balancing ordering costs and holding costs. DeMatties suggested that if the periods of large demand exist, the PPB method should be subjected look forward/backward. Blackburn & Millen proposed the interval between orders determined by PPB method could be increased if a closer balance is maintained. Karni proposed that pairs of lots should be joining together as a single order through an iterative procedure to reduce cost in 1988.

2.2.2.2.The Silver–Meal (S-M) method

It was composed in 1973 by Silver and Meal. It refers to production planning in manufacturing and its purpose is to determine production quantities to meet the requirement of operations at minimum cost. S-M method is identical to the LUC method except the total cost is divided by the number of periods in the lot and not by the sum of demand quantities. Silver-Meal made an observation that cost per unit is not necessarily convex. S-M method finds only the first local minimum.

The formula is indicated below;

- $C(j) = (K + hr_2 + 2hr_3 + \ldots + (j-1)hr_j) / j$ (16)
- C(j): average holding cost and setup cost per period

K: order cost or setup cost

h: holding cost

r: demand

The calculation should be started from period 1 to next period;

- $C(1) = K$
- $C(2) = (K + hr2) / 2$
- $C(3) = (K + hr2 + 2hr3) / 3$ (17)

The calculation should end when C(j) > C(j-1). Then it will follow the below steps;

- Set $y1 = r1 + r2 + \ldots + rj-1$

- Start over at period j, repeat step (I) – (III)

2.2.3. Intuitive/Experience

In Intuitive/Experience methods, lot-sizes are determined by subjective judgement of decision maker and past experience.

2.2.3.1.Lot for Lot Method

The simplest intuitive method is Lot for Lot (L4L), which is certainly be the best method for highly discontinuous demand and expensive purchased items (Silver M., 1998: 43). When orders are inexpensive and just in time inventory methods are available L4L method can be very useful because it eliminates the cost of holding inventory (Ho & Chang, 2003: 45). It states that the amount to be produced in a period id equal to that period's requirements.

2.2.3.2.Fixed Order Quantity (FOQ) method

It is to order constant quantity lots each time an ordering is performed. There is no change on quantitiy but time intervals can change.

The formula is as below;

Total annual cost = Annual purchase cost + Annual ordering cost + Annual holding cost (18)

2.2.3.3.Fixed Period Requirements (FPR) Method

Fixed Period Requirements (FPR) is to order every determined period. Under FPR method, order intervals are constant but lot-sizes are varying.

The formula is as below;

Order quantity = Average demand over the vulnerable period + Safety stock − Inventory currently on hand (plus on order, if any) (19)

CHAPTER 3

INVENTORY MANAGEMENT IN AN AUTOMOTIVE COMPANY

In this chapter, an application of inventory models and lot sizing methods in an automotive supplier company will be investigated and an optimum method will be searched. In the mean time, a different buffer stock policy will be analysed if it will give the optimal solution.

3.1. Industry Concept

The company is an automotive parts manufacturing company based in USA. It's one of the world's largest automotive parts manufacturers and has almost 200.000 employees of whom around 3500 of them are located in Turkey location. 1700 of them are based in İstanbul plant and 1800 of them are based in İzmir plant. With offices worldwide, the company operates 126 wholly owned manufacturing sites, and 15 technical centers across 32 countries.

The company is located in Eagean Free Zone in Gaziemir/İzmir and started its facilities in 1989. It has improved its ranges by differentiating the products for different requests by car manufacturers from different countries in years and according to recent information, there are approximately 1600 blue collared employees and 200 white collared employees. The production is arranged as 3 shifts per day.

The manufacturing is based on a single product but with different components inside and designed differently for different car models. Each customer requests different requirements in various shapes, components, lenghts etc. and they are changing them regarding their changes in car models. The products are sold to different countries such as France, Germany, Belgium, Sweden, Spain and some other countries in Europe, Middle East and Asia with an advantage of its strategic location. In this exercise we will

do the exercise for the goods in warehouse and a French customer where the costs will be calculated accordingly.

The company is one of the World Class Manufacturing(WCM) companies and WCM companies have 10 different technical areas to improve. One of them is about the logistics and customer service activities and another one is inventory management. In this study, we are going to study on these parameters and the key performance will be to reduce the inventory as possible within the limitations of customer and so on.

In this study, we will focus on inventory management, precisely on inventory ordering process and inventory reduction policy. These methods will be tested for a supplier of an automotive company. According to Pires in 2004, during the last one hundred years the automobile industry grew and it became one of the most representative segments of the industry, some reports showed that about 10% of the whole world trade happens in the extent of the automobile industry.

There are some more reasons to choose studying in this area and also in automotive industry;

- The company should pay extra money for the increasing stock and they can not be charged to customer due to agreement.
- There are some extra shipments due to demand variation in time which mean extra cost for company and plants do not pay due to agreement.
- Current inventory holding policy is not enough to satisfy all demand variations.
- Demand is not constant during weeks.
- Demand is not constat during year.
- Customers requests to keep their raw materials in suppliers' warehouses which means it is vital for suppliers to control the inventory.

There is one another important thing about stock policy. It is the “model year change” issue. Customers pretend to change the car models each year, maybe twice or three times in a year. It is changing from customer to customer. For our thesis, this can be implemented 3 times a year. That is why it is vital to check the stock levels frequently, especially when the ordering day is at least 2 weeks.

Lot sizing method is very important for the companies where all the parts can change 3 times per year. Each part number is a potential obsolote since the ordering of it. In order to avoid this, customer patternt should be carefully followed and should be ordered accordingly with the optimum lot sizing method and minimum stock policy.

Due to above reasons, an optimal solution is required and maybe a new inventory holding policy should be implemented.

First of all, the details regarding process flow of the related automobile manufacturing company should be given step by step.

Before starting, some definitions should be clarified.

3.1.1. Ordering day: the period where the first order is given by warehouse scheduler until the arrival of the goods to warehouse. In this study, it will be considered as 9 days.

3.1.2. Speeded truck: truck with a second driver so that the truck arrives earlier than the estimated time arrival(ETA). There is an extra cost of second driver which the supplier firm should pay.

3.1.3. Special transport: different transit types from normal truck, such as speeded truck or airfreight to maket he goods arrive earlier than expected. The reason to use special transport might be different such as;

- Customer variation before the ordering day(9 days). Customer schedule can change earlier than planned so that a quicker arrival is mandatory.
- Plant might have a lack of raw material issue even there is no demand variation at customer side and enough quantitiy is ordered by warehouse scheduler.

The cost is more than normal truck cost or speeded truck cost.

3.1.4. Special order: As described, the in normal conditions, the ordering day is 9 days. In case of any demand variation, warehouse scheduler request to plant schedulers to produce and send the goods earlier than 9 days. This is called special order.

Special orders can be shipped with different transportaitions such as;

- Normal truck if production plant has already the goods in inventory
- Speeded truck if it is acceptable for customer to receive the parts in 3 transit days.
- Airfreight if the goods should arrive urgently in 1 day.

3.1.5. Minimum stock(Buffer stock): the inventory that needs to be kept in warehouse in order to meet the customer demand variations or any extra issues(quality problems at production area, engineering changes etc.).

In this study, there is a customer agreement and customer requests to keep 5 days of minimum stock as buffer in the warehouse. 5 days of stock is calculated according to demand after ordering days which means 9 days. According to this agreement, customer requests to have the demand of days between 10th day and 15th day.

In order to calculate the minimum stock on quantity basis, the average daily consumption and number of days on hand(5 days here) is multiplied. The final multiplied quantity is what the customer requests to see in warehouse as its buffer stock. Considering this inventory, customer keeps no goods in its own warehouse building.
In case of any lack about the quantitiy changes and if the requirement is not met by supplier, supplier needs to pay the Premium cost of customer stoppage cos tor customer blockage cost.

3.1.6. Average Daily Consumption(ADC): The daily consumption of customer basing on customer forecast. Due to changing demand on daily basis, the average of desired period is taking into consideration.

3.1.7. Premium and Premium cost: In case of any variation on normal flow such as a need of speeded truck, it is called Premium and the charge fort his problem is called Premium cost.

3.1.8. Blockage cost: The cost needed to pay to customer due ton non satisfied orders on time. Warehouse schedulers inform customer about the time and number of the order so that customer can differentiate which orders will not be satisfied. Customer needs to block these cars in a different location in production area and waits the correct parts to receive from the supplier. Supplier pays a price on daily basis to customer for each day the car waits at blockage area. After receiving the right parts, the cars are released to line in the direction to final assembly as other cars. In this blockage process, the line doesn't stop because of existing pre-alerts from suplier. The costs will be clarified in details in next sections.

3.1.9. Stoppage cost: The cost needed to pay due to non satisfied orders on time but differently from blockage cost, there is no pre-alert to customer about the potential missing parts. This causes a line stoppage and also affects other cars in line. The problematic car is also removed to blockage area and waits until the correct material

receives. Due to affecting other cars in line, cost is higher than blockage cost which will be clarified in next sections.

- Low runner part: Part numbers where the ADC is lower than 10 pieces;
- High runner part: Part numbers where the ADC is more than 10 pieces.

3.2. Assumptions

In order to determine some limits for the problem, we should make some aasumptions as below.

- Goods can be transferred by truck, airfreight or speeded truck.
- In normal conditions (as explained days in process), goods will be shipped in truck.
- In case of any special transport need, speeded truck or airfreight will be used.
- Speeded truck arrives in 3 days to final destination.
- Airfreight arrive in 1 day to final destination.
- Normal transit time by truck will be considered as 5 days with no change.
- The schedule receives once per week from customer.
- The order to production plant is given once per week when schedule receives.
- It will be considered that working days per week will be 5 days for all weeks in order to calculate the average daily consumption.
- Lot sizing methods will exlude minimum stock ordering.
- No shortage cost will be considered.
- Plants will be able to prodive the orders in max 1 week – they will use their plant's buffer stock capacity if needed.

3.3. Limitations;

Customer requests to keep 5 days of minimum stock in warehouse but there is no agreement that the customer controls which days are kept or if it is realy being kept.

Process can be defined in 5 different steps;

Scheduling: the period when the order is sent to production plant by the warehouse scheduler. In this flow, it is 1 day to give the order.

Release: the period where the production scheduler receives the order from warehouse scheduler and planify the production accordingly. Additionally there is a cutting process of raw materials before final production and cutting process can be considered in here. It is 1 day in this study.

Process: the period where the actual production is realised. It is 1 day in this study. It also includes the packaging and carrying to warehouse area to ship.

Sleeping time: the period after the production period is complete and where the truck waits to dispatch from the production plant to the direction of warehouse. There might be different reasons of wait such as;
Combination with another project with different ordering day:

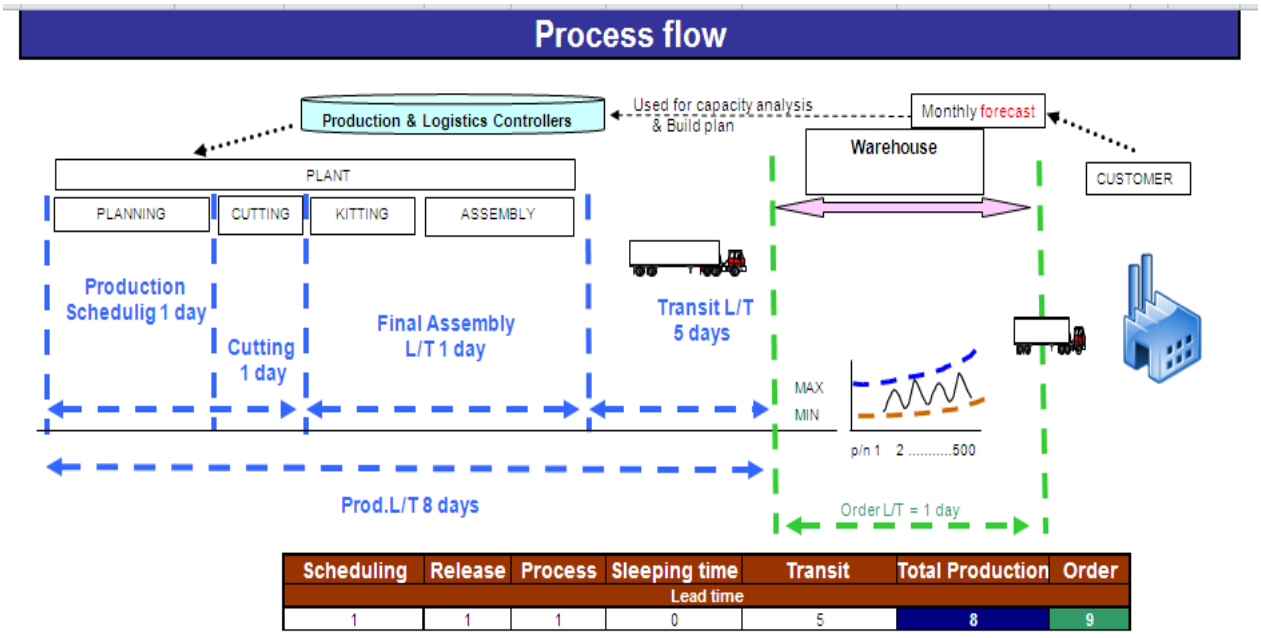
- If there will be different parts to put in the same truck and production lead times are different
- Waiting the truck to be fulfilled by other materials
- The trucks will be halfloaded from another shipping point on road.

It is zero in this study.

Transit time: the period starting from the dispatch of trucks until arrival to warehouse. It might change according to weather considitions, legal restrictions, driving restrictions and so on. It is 5 days in this study.

Combining all the paramaters until the arrival of goods to warehouse, the total production days are totally 8 days. There should be 1 more day on the flow because the customer requires the parts 1 day earlier than the usage in its production area in order to minimize the risk and any critical issue at its own area. This might be considered as the ordering day of customer. So that we can say the ordering day is 9 days for this flow. The details can be seen in Figure 1.

Figure 1: Process flow



Notes: This figure represents the actual process flow of this study which is prepared by the owner of this thesis.

3.4.Problem definition

There are some reasons as the preparation of this study. First of all, the problem should be determined.

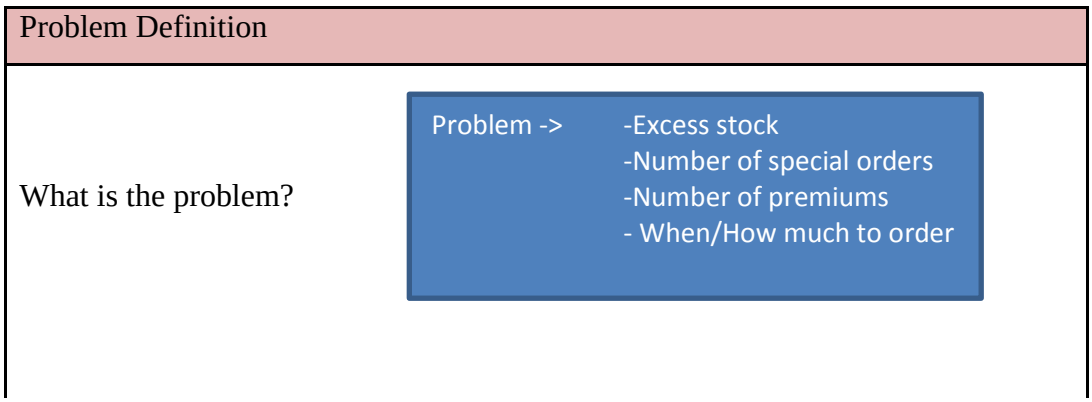
Due to customer agreement and customer request, 5 days of minimum stock should be kept in warehouse. This sometimes causes an extra stock(excess stock) to be kept because customer doesn't always consume what he reflects in schedule. Minimum stock is requested by management due to different costs. That is why it is very important to keep the right parts in warehouse. Customer does not allow the stockout situation. In case of stockout situation, the supplier pays blockage cost or stoppage cost to customer.

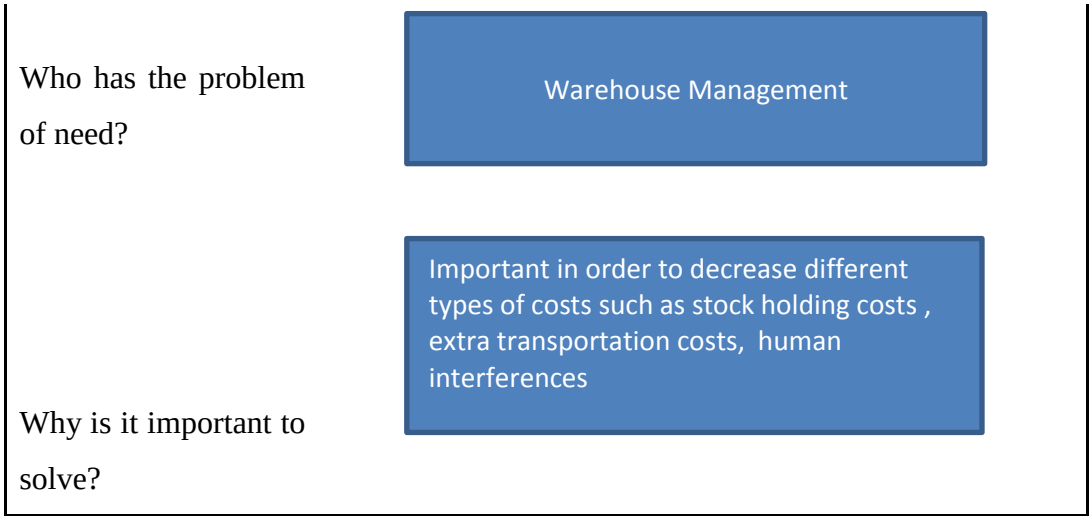
Ordering each week and relatively stock keeping in warehouse can cause cost. Due to this reason, it should be decided clearly to order each week or to keep the goods in warehouse after ordering weeks ago(when to order). In some cases, ordering before and keeping in warehouse can be more profitable and also vice versa.

In normal flow, special orders can only be realised in case of any demand variation. If the correct minimum stock policy is implemented, there might be no need to make special orders. Sometimes it might not be the only solution to keep inventory as much as can be done.

In normal flow, no premium is accepted. All goods should be carried by normal trucks. In case of any situation such as lack of minimum stock and demand variation, premium will be inevitable.

Figure 2: Problem definition





Notes: This figure represents the actual problem definition of this study which is prepared by the owner of this thesis.

The problem can be assumed as deterministic. There is not a sifnificant demand variation in the considered time period. We will assume that it will be the same in next periods.

By summarizing all these explanations, we can categorize the problem as an issue of when to order and how much to order and what to order.

3.5.Flow Diagram

The problem can be evaluated in two aspects.

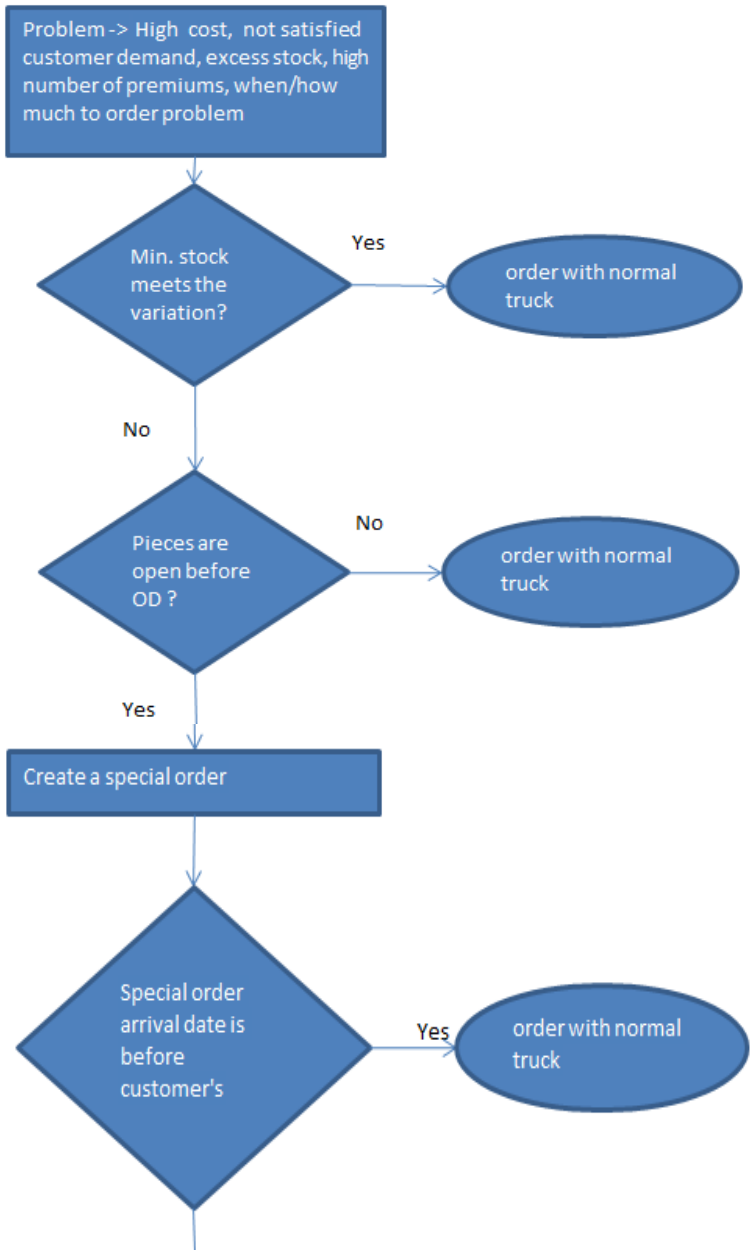
- When to order/ How much to order problem: In actual ordering system, suppliers sometimes are not possible to meet customer demand due to demand variations and can't charge the actions to meet the variation to customer. In this case, a more efficient ordering process seems mandatory.

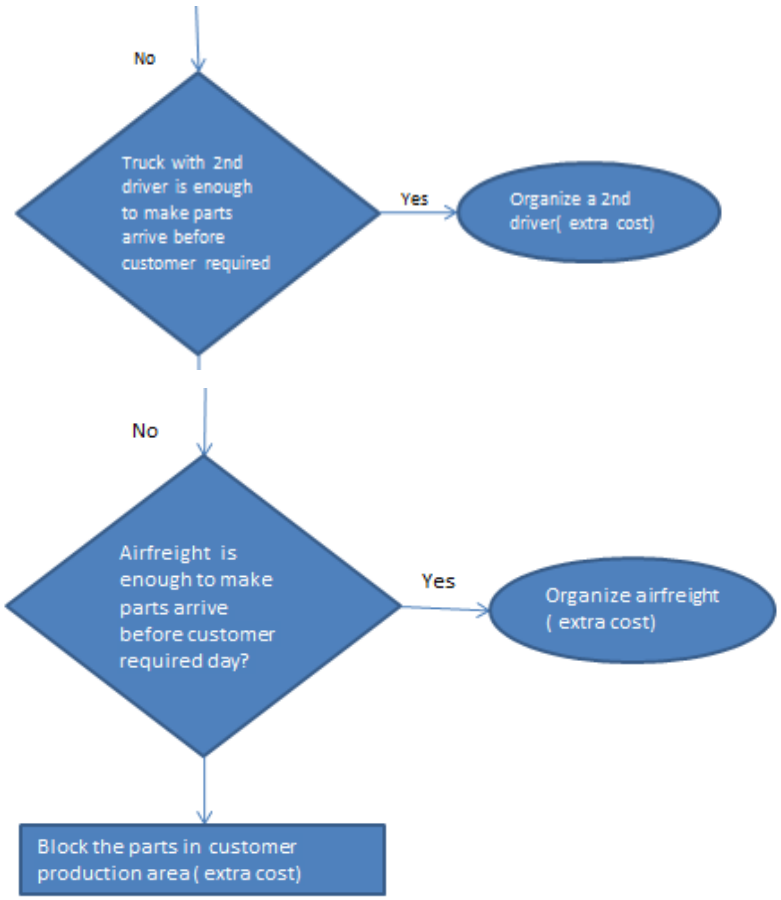
- Safety stock problem: Again, due to various changes of customer demand, suppliers have difficulties to meet them. Even they can do, some extra costs such

as premium costs, labor costs etc. should be paid and customer doesn't always take responsability on it. For such cases, minimum stock should carefully be calculated. But it isn't efficient to keep much stock due to obsolote risk. So an optimum stock quantitiy should be defined for each part number.

In figure 3, flow diagram can be seen.

Figure 3: Flow Diagram





Notes: This figures represents the actual process flow of this study which is prepared by the owner ot this thesis.

3.6.ABC Analysis

In order to decide which part numbers should be used in calculation, i made an ABC analysis to choose different parts with different average daily consumptions. In order to calculate ADC for each part number, we need to see the demand. All demand for all PNs can be seen in Appendix 1, Appendix 2, Appendix 3 and Appendix 4, Appendix 5 and Appendix 6 as “demand for all part numbers 1-2-3-4-5-6”.

In this thesis, clustering is based on the part numbers of the related supplier. For this, 196 part numbers are used to analyze.

The clustering is as below;

- %70 of total cost of inventory -> A group
- %25 of total cost of inventory -> B group
  - %70 of total cost of B group -> B1 group
  - %25 of total cost of B group -> B2 group
  - %5 of total cost of B group -> B3 group
- %5 of total cost of inventory -> C group

After doing the analysis, i chose 1 sample from each group to understand which method will give the optimum solution according to different groups.

Also, i grouped the part numbers as if they are low-runners or high-runners. The details can be seen in Appendix 7 as ABC Analysis results".

3.7.Current Lot Size and Reorder Point Situation

Before to start to analyze the actual sitaution, we should know the details about holding cost, ordering cost and demand for the determined period.
In this thesis, ordering cost will be considered as same for all part numbers and it will be taken as 202 euro which includes different parameters such as;

- Scheduling cost
- Approval of order cost
- Reception of goods in warehouse
- Transportation cost between different locations

Holding cost will be taken as 2,92 euro which includes different parameters such as;

- Warehousing cost
- Handling cost
- Insurance cost

In actual sitation, warehouse schedulers send orders each week to plant schedulers and there is one arrival to warehouse each week. The ordering is based on lot for lot method which means the ordering will be based on the next period order and there will be no holding cost.

There should be some considerations such as the ordering will be done on weekly basis and there is an ordering cost for each period and no minimum stock will be considered during this period.

3.8.Current Minimum Stock Policy

There is an agreement between customer and supplier. According to this agreement, supplier should keep 5 days of minimum stock in its own warehouse and customer will keep zero stock in its own place.

5 days of minimum stock means to keep the demand of 1 week. In order to find the inventory on quantity basis, average daily consumption(ADC) should be calculated. ADC is calculated by taking the average of working days in one period. To find the minimum stock quantitiy, ADC and 5 days should be multiplied.

Customer part numbers are classified as high runner parts and low runner parts. In current situation, for each part number, five days of minimum stock are kept in warehouse.

3.9.Proposed Lot Size and Reorder Point Situation

In order to find the optimal solution, Lot for Lot, Silver Meal, Economic Order Quantity, Least Unit Cost and Fixed Period Requirements methods are compared.

Throughout the application of Silver Meal method, optimum lot size and order week will be decided. It is aimed to see if it is more profitable to order each week or to

order in determined times and hold the inventory in warehouse with a holding cost in details.

As explained in ABC analysis section, the classification is done for five groups and within these five groups, one part number is chosen from each group. Lot sizing methods will be applied for these part numbers which can be seen in Table 5.

Table 5: PNs to analyze

Number	CPN	DPN	Total	ADC	unit price	ADC*price	Total Annual Cost	Group
5	T9HAB0273	15543441	3964	34,5	170,8	5888,8	1531082,9	A
25	T9PPL0807	15518950	1375	12,0	139,8	1671,5	434595,7	B-1
45	T9HAB0247	15540673	240	2,1	197,3	411,8	107062,1	B-2
50	T9PPL0809	15518952	394	3,4	99,2	339,7	88330,0	B-3
58	T9PPL0826	15518969	316	2,7	91,9	252,4	65635,1	C

After a changing of minimum inventory holding days basing on low/high runner part numbers, the policy might be changed. Throughout this change, inventory level in warehouse will be affected and also i aim to see the improvement on premium costs if there will be.

3.10. Lot Sizing Results

In previous section, i determined 5 different part numbers to analyze. As explained before, ordering cost is 202 euro and holding cost is approximately 2,95 euro. The details of each method calculation will be found in tables between

Before to see the results, below assumotions should be considered;

- Stock for 1st week will be considered as in stock. For example for first PN, first week demand is 120 and we will consider the actual stock as 120 before starting.
- Ordering cost/holding cost will be the same for all PNs, independent from box-type, truck loading capacity and so on.

Analysis results can be seen in Table 6.

Table 6: Lot-sizing results

	High-runner	High-runner	Low-runner	Low-runner	Low-runner
	A	B-1	B-2	B-3	C
	T9HAB0273	T9PPL0807	T9HAB0247	T9PPL0809	T9PPL0826
L4L	€ 4.656	€ 4.656	€ 4.656	€ 4.656	€ 4.656
EOQ	€ 11.503	€ 6.999	€ 3.212	€ 4.598	€ 3.913
Fixed Period	€ 13.006	€ 5.288	€ 2.345	€ 2.765	€ 2.708
Least Unit Cost	€ 5.350	€ 3.855	€ 2.600	€ 3.571	€ 2.762
Silver Meal	€ 4.494	€ 3.753	€ 2.132	€ 2.336	€ 2.419

3.11. Findings from Lot Sizing Results

- The actual, L4L method doesn't give the optimum results in terms of cost which means there is a need for method change.
- The actual method gives better results for some groups but not the best solution.
- Silver Meal gives the best results which means least cost for all part numbers.
- ABC analysis is an important key factor to understand the optimum method to apply while ordering.

- For all A,B,C groups or low/high runner part numbers, Silver Meal has the least cost.
- Silver Meal gives a better solution than actual method but it takes more time to calculate than L4L method. L4L method can be applied quicker than other methods.
- Economic Order Quantity which is the most common method gives better results than actual method but not better than Silver Meal for high runners.

3.12. Min Stock Calculation Results

The study was performed for all part numbers because according to customer agreement, there should be enough stock in warehouse(five days). It is a new heuristic method what was created for this thesis and it will be seen if the proposal is giving better results than the actual method.

According to the outcomes of the study, new minimum stock holding policy has better results than the actual one. The actual inventory cost is € 695.410 where the proposed inventory cost is € 628.831.

In order to implement the proposed calculation, the below formula should be implemented;

- if average daily consumption is lower and/or equal to 10 pieces, take min DOH as 7 days
- if average daily consumption is higher than 10 pieces, tak emin DOH as 4 days.

Details can be seen in Appendix 27.

3.13. Findinds from Min Stock Calculation

- New minimum stock holding policy gives better results than actual method.

- Less inventory is going to be kept in warehouse which will also avoid potential obsolete risks.
- New method will provide less extra orders due to a better stock holding policy.
- New method will provide less premiums an this will reduce premium costs.

CONCLUSION

In this study, actual lot sizing method and minimum stock holding policy were analyzed and tried to chech other lot sizing methods and to discover if there can be another way to keep minimum stock with a different policy. The study was performed in an automotive manufacturing supplier company and its warehouse.

There is a huge competition between automotive suppliers and corporates choose different locations to continue manufacturing if the costs can't compete with different suppliers. The related company is manufacturing basing on assembly and labor-costs have a huge importance in this process. But reducting labor costs can't always be possible due to different reasons such as competition with different coountry policies, different country labor costs and so on. In this case, companies focus on reduction of other costs such as transportation costs, ordering costs, warehousing costs. By achieving these kinds of goals companies can move their values one step further than the rivals.

There are 3 main questions;

- What to order
- When to order
- How much to order

In this study, i tried to find the optimum solution to find the optimum lot sizing method for the determined period of customer by searching answers for these 3 questions.

Inventory control has a significant value for automotive supplier companies. Stockout is not accepted by firms so there should be a defined stock policy. In this thesis, i tried to find another implementation to avoid stockouts.

Another important factor is that customers have a tendency to change all their models 3 or 4 times per year. This is called "model year change". It means that they are

changing the car model or making a specific change on the design or spesification of the car. This directly reflects our minimum stock policy to avoid any potential obsolote risk. That is one of the reaons that automotive manufacturing companies should focus on lot sizing problems and buffer stock holding policies.

When we take a look at the results, first of all we can say that there is room for improvement on both lot sizing method and buffer stock holding policy. Five different methods were compared, economic order quantity, lot for lot, fixed perior requirement, Silver Meal, least unit cost and in Table 6 are indicated. According to these figures, the best solution for all the groups is Silver Meal. The worst result belongs to economic order quantitiy model. Although Silver Meal gives the least cost, it takes too much time to calculate and the method is open to make mistakes if it is done manually. If any excel formula is implemented, it will be calculated in a less period of time.

It should also be noted that results can't be the same for different companies or different demand or different time intervals. In below situation, we would have different results and choose different methods;

- If the demand variation is more than the actual
- Ordering costs or holdig costs are different for other companies

If demand variation is not significant or ignored and costs are similar with my study, this methods will give the same results if applied in another company.

In optimum minimum stock policy decision, ordering costs and holding costs are ignored. In this thesis, a new heuristic method was developped and implemented where there is not such a study before. So that this thesis can be considered as a key to change the minimum stock holding policy for not only automotive supplier companies but also other business areas. In order to implement this, users should use the actual demand of customer, number of working days in related period and the part numbers. After taking these parameters into consideration, it will be easy to implement in any business area.

If such a problem will be searched in another company, minimum days on hand calculations can be changed and this study can be used as a leading study. It can change according to customer requests.

REFERENCES

Ackerman K. Practical Handbook of Warehousing, The Traffic Service Corporation, Ohio, 1987.

Adeleke, K. "Inventory Production Control Model With Back Order When Shortages Are Allowed", Journal of Modern Mathematics and Statistics, vol:4, p:78-83

Ballou Ronald. Basic Business Logistics: Transportation, Materials Management, Physical Distribution (2nd edition), Prentice Hall, Englewood Cliffs, 1987.

Ballou R. H. and Masters James M. "Commercial software for locating warehouses and other facilities", Journal of Business Logistics, Vol.:14, 1993.

Ballou, R. H. Business Logistics/Supply Chain Management, Pearson Prentice Hall, Ohio, 2004.

Barfield J. T. and Raiborn C. A. and Kinney M. R. Cost Accounting: Traditions and Innovations, Mason, OH South Western, 2003.

Blackburn, J. D. and Millen, R. A. Heuristic lot-sizing performance in a rolling schedule environment, Decision Science, Ohio, 1980.

Bowersox, D.J. and Closs D.J. Logistical Management: The integrated supply chain process. The McGraw Hill Companies, Inc. New York, 1996.

Cavinato J. "A Total Cost/Value Model for Supply Chain Competitiveness", Journal of Business Logistics, Oxford, 1992, pp.285-301.

Chase R.B, Jacobs and Aquilanon J. Operations management for competitive advantage, International edition. Mc Graw Hill. NY, 2004.

Chen, Y.C. and Kuo, J.Y. “Applying Moving Back PropagationNeural Network and Moving Fuzzy Neuron Network to PredicttheRequirement of Critical Spare Parts”, Expert Systems with Applications, Vol. 36, No. 7, 2009, pp.4358– 4367.

Chopra S. and Meindl P. Supply Chain Management: Strategy, Planning, and Operation. Prentice Hall of India, Delhi, 2001.

Chorafas Dimitris N. Warehousing: Planning Organising and Controlling the Storage and Distribution of Goods, MacMillan, London, 1974.

Cilliers, W.W. and Nagel P.J.A. “Logistics Trends in South Africa”, International Journal of Physical Distribution & Logistics Management, Vol :24, No.7, 1994.

Clodfelter R. Retail buying from basics to fashion. 2nd edition, Richard Clodfelter, USA, 2003.

Cooper M. C. and L. M. Ellram. “Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy”, International Journal of Logistics Management, 1993, pp.13-24.

Cooper Martha C. and Douglas M. Lambert, Janus D. Pagh. “Supply Chain Management: More than a new name for Logistic”, The International Journal of Logistic Management, Vol: 8, 1997, pp. 1-14.

Cooper J. Strategy Planning in Logistics and Transportation. Cranfield University School of management, London Kogan Page, London, 1993.

Crowell, J.F. Report of the Industrial Commission on the Distribution of Farm Products, U.S. Government Printing Office, Washington, D.C, 1901.

De Villiers G. South African and International bodies relevant to the Logistics Profession, Logistics News, Arizona, 1996.

Dear A. Working Towards Just-In-Time. Kogan Page Ltd., 120 Pentonville Rd, London Ni 9JN, 1988.

DeMatties, J. J. "An economic lot-sizing technique I: The part-period algorithm", IBM Systems Journal, 1968, pp.30-38.

Edwards Graham N. The Demand distribution of spare parts in a large chemical manufacturing Company, (MBA thesis), University of the Witwatersrand, South Africa, 1984.

Ganeshan, R, and Harrison Terry P. An Introduction to Supply Chain Management, Department of Management Sciences and Information Systems, USA, 1995.

Ghiani G., Laporte G., Musmanno R. Introduction to Logistics Systems Planning and Control. West Sussex, John Wiley & Sons, UK, 2004, pp.352.

Gorham, T. Dynamic order quantities, Production and Inventory Management, USA, 1968, pp.75-81.

Gourdin K N. Global logistics Management: A competitive advantage for the new millennium, BLACKWELL Business, USA, 2001.

Gürçay, G. Yöneticiler İçin Temel Stok Kontrolü, Çatı Kitapları, İstanbul, 2012.

Handfield R. B. and Nichols E. L. Introduction to Supply Chain Management, Prentice-Hall, New Jersey, 1999, pp.1-183.

Hermelin Victor. Production and Inventory Management in a flow production Environment, M. Com (University of Natal), USA, 1991.

Ho, J. C., & Chang, Y. L., 2003. A new MRP/GT lot sizing heuristic: a simulation study, Production Planning & Control, USA, 215-224.

Hugo W M J, Badenhorst-Weiss J.A. and Van Rooyen D.C. Purchasing and supply Management 4th edition, J.L Van Schaik Publishers, Pretoria, 2002.

Jacobs H.E. Investigation into the Application of Just-In-Time Principles in small South African Firms, Rand Afrikaans University, South Africa, 1997.

Jacobs, F.R. and Chase, R. Operations and Supply Chain Management: The Core, The McGraw-Hill/Irwin Series Operations and Decision Sciences, USA, 2012.

Karle M.P. "Just-In-Time Implementation in South Africa", FWP Journal vol:28, No:8, 1988.

Karni, R. "A uniform order quantity (UOQ) lot-sizing technique varying demand rates", Production and Inventory Management, 1980, pp:29-37.

Karni, R. "Maximum part period gain -A lot-sizing procedure for unconstrained and constrained requirements planning systems", Production and Inventory Management, 1981, pp:91-98.

Kumar, A.,and Sharman,G. "We love your product, but where is it?", McKinsey Quarterly, 1992, pp:24-44.

Küçük, O. Stok Yönetimi, Seçkin Yayıncılık, Ankara, 2011.

Lambert Douglas M. and Stock James R. Strategic Physical Distribution Management, Richard D. Irwin, USA, 1982.

Lambert Douglas M. and Stock James R. - Strategic Logistics Management (3rd edition), Irwin Inc., Illinois, 1993.

Lambert Douglas M. "An Evaluation of Process- oriented Supply Chain Management Frameworks", The International Journal of Business Logistic, Vol.26, No.1, 2005, pp:25-45.

Lambert, D.M., Stock, J.R. and Ellram, L.M. Fundamentals of Logistics Management, Irwin- McGraw-Hill, International Edition, 1998.

Lattmann, P. "WMS: Lower costs, more options for growing companies", ID Systems vol.8, 2000.

Lee Y, Cetinkaya S, Wagelmans. "A Dynamic Lot-Sizing Model with Demand Time Windows", Management Science, 2001, pp:1384-1395

Li. S., Ragu-Nathan, B., Ragu-Nathan, T.S. and Rao, S. "The impact of supply chain management practices on competitive advantage and organizational performance", International Journal of Management Science, 2006, pp:107-124.

Mentzer J. T. , DeWitt V, Keebler K. S., Min S., Nix N. W. and Smith. C. D. "Defining Supply Chain Management", Journal of Business Logistics, 2001, pp:22-24.

Mentzer J. T. and Khan K. B. "A framework of logistics Research", Journal of business logistics, 1995, pp:231-250.

Mentzer John, et al. "Defining Supply Chain Management", Journal of Business Logistics, Vol:22, 2001.

Muller, M. Essentials of Inventory management, Amacom, USA, 2003.

Muller, M. Essentials of Inventory Management 2nd editon, Amacom, USA, 2011.

Murphy, P.R., Wood, D.F. Contemporary Logistics, Person Education, Upper Saddle River, New Jersey, 2004.

Novack R. A. and Simco S. W. "The industrial procurement process: a supply chain perspective", Journal of Business Logistics, 1991, pp:145-67.

Pycraft S. Operations Management Southern Africa edition, Pearson education, South Africa, 2000.

Ram Ganeshan and Terry P. Harrison. An Introduction to Supply Chain Management, USA, 1995.

Regan, C. Amelia, and Song Jiongjiong. An industry in Transition: Third Party Logistics in the Information Age, Transportation Research Board 80th Annual Meeting, Washington DC, 2000.

Ryzin Garrett. Analyzing Inventory Cost and Service in Supply Chains, Columbia Business School, 2001.

Russo Joseph. A Case study: Development of a Strategic Plan for the Logistics of Parts Distribution, (M.Sc Engineering thesis), University of the Witwatersrand, South Africa 1991.

Scheurkogel & Visser, J.H. Die Verhoging van Produktiwiteit in Suid Afrika. University of Stellenbosch, South Africa, 1975.

Scott C. and Westbrook R. “New Strategic Tools for Supply Chain Management”, International Journal of Physical Distribution & Logistics Management, 1991, pp:23-33.

Silver, E. A., & Meal, H. C. “A heuristic for selecting lot sizing quantities for the case of a deterministic time-varying demand rate and discrete opportunities for replenishment”, Production and Inventory Management, 1973, pp:64-74.

Silver, E. A. “Comments on a near optimal lot-sizing model”, Production and Inventory Management, 1983, pp: 115-116.

Silver, E. A., & Miltenburg, J. “Two modifications of Silver-Meal lot-sizing heuristic”, INFOR, 1984, pp:56-69.

Silver, E. A., Pyke, D. F., & Peterson, R. Inventory Management and Production Planning and Scheduling, 3rd Edition, John Wiley & Sons, New York, 1998.

Smith Spencer B. Computer Based Production and Inventory Control. Prentice Hall Inc., New Jersey, 1989.

Tan, K.C. “A Framework of Supply Chain Management Literature”, European Journal of Purchasing and Supply Management, 2001, pp:39-48.

Telledis Georgios. Holistic Inventory Management Methods, (MBA thesis), University of the Witwatersrand, South Africa 1996.

TERSINE R J. Principle of inventory and material management. 2nd edition. North Holland, Holland, 1982.

Tilleman Allan L. Inventory spares Management policies of Mining Equipment suppliers, MBA thesis, University of the Witwatersrand, 1988.

Towill D. R., N. M. Naim and J. Wikner. "Industrial Dynamics Simulation Models in the Design of Supply Chains", International Journal of Physical Distribution and Logistics Management, 1992, pp. 3-13.

Tyndall, Gene, Christopher Gopal, Wolfgang Partsch, and John Kamauff. Super-charging Supply Chains: New Ways to Increase Value Through Operational Excellence, John Wiley & Sons, New York, 1998.

Viale, J. D. Inventory Management: From Warehouse to Distribution Center, Menlo Park, CA, Course Technology Crisp, USA, 1996.

Vollmann, Thomas E., William L. Berry, and D. Clay Whybark. Manufacturing Planning and Control Systems, 3d ed. Homewoodil, Irwin, 1992.

Zoller, K. and Robrade. "Efficient heuristics for dynamic lot-sizing", International Journal of Production Research 26, 1988, pp:249- 265.

http://www2.aku.edu.tr/~oaydemir/sayfalar/Stoklar.doc.doc (15.03.2014)

http://sparepartsmanagement.co.in/Inventory%20analyses.html (16.02.2015)

http://www.logisticsadvice.com/company.html (16.02.2015)

http://www.ftpress.com/articles/article.aspx?p=2192703&seqNum=2 (15.06.2015)

APPENDICES

APPENDIX 1: Demand for all part numbers -1

Number	CPN	DPN	26.08.2013	02.09.2013	09.09.2013	16.09.2013
1	T9HAB0271	15543439	384	522	121	359
2	T9PPL0950	15543446	266	358	63	262
3	T9HAB0265	15543433	100	273	1	11
4	T9PPL0954	15543450	386	213	309	228
5	T9HAB0273	15543441	120	56	155	58
6	T9HAB0242	15540668	76	157	168	273
7	T9PPL0949	15543445	50	156	136	161
8	T9HAB0262	15543430	0	70	4	42
9	T9PPL0957	15543453	60	88	257	99
10	T9HAB0243	15540669	1	1	54	231
11	T9HAB0264	15543432	176	1	306	212
12	T9HAB0238	15531665	0	160	769	269
13	T9PPL0952	15543448	40	300	150	283
14	T9PPL0951	15543447	196	1	35	59
15	T9PPL0953	15543449	31	48	43	226
16	T9PPL0803	15518946	0	31	0	2
17	T9HAB0202	15518857	179	94	95	5
18	T9HAB0263	15543431	55	150	5	80
19	T9PPL0956	15543452	78	20	86	100
20	T9HAB0270	15543438	0	15	9	61
21	T9PPL0959	15543455	0	63	55	158
22	T9PPL0961	33112341	0	0	0	0
23	T9HAB0266	15543434	20	0	10	0
24	T9HAB0283	33112354	0	0	0	0
25	T9PPL0807	15518950	34	145	160	58
26	T9HAB0272	15543440	0	0	2	26
27	T9HAB0218	15518873	0	0	43	60

28	T9PPL0832	15518975	0	7	155	26
29	T9PPL0814	15518957	0	0	0	6
30	T9HAB0274	33112345	0	0	0	0
31	T9PPL0830	15518973	5	10	43	9
32	T9PPL0819	15518962	0	0	4	76
33	T9PPL0802	15518945	0	0	0	0
34	T9HAB0254	15540680	0	0	1	0
35	T9PPL0958	15543454	60	30	2	15
36	T9HAB0269	15543437	0	31	2	14
37	T9PPL0823	15518966	0	10	121	35
38	T9HAB0278	33112349	0	0	0	0
39	T9PPL0962	33112342	0	0	0	0
40	T9PPL0811	15518954	0	84	109	23
41	T9HAB0201	15518856	0	30	51	12
42	T9HAB0246	15540672	0	0	1	8
43	T9PPL0821	15518964	0	0	1	0
44	T9HAB0267	15543435	0	0	3	27
45	T9HAB0247	15540673	0	0	1	21
46	T9PPL0960	33112340	0	0	0	0
47	T9PPL0963	33112343	0	0	0	0
48	T9HAB0279	33112350	0	0	0	0
49	T9HAB0230	15518885	0	0	0	5
50	T9PPL0809	15518952	0	0	0	1
51	T9HAB0281	33112352	0	0	0	0
52	T9HAB0255	15540681	0	0	0	0
53	T9HAB0216	15518871	0	0	1	22
54	T9HAB0282	33112353	0	0	0	0
55	T9PPL1005	15549624	0	0	0	0
56	T9PPL1005	15549624	0	0	0	0
57	T9HAB0280	33112351	0	0	0	0

58	T9PPL0826	15518969	0	5	45	8
59	T9PPL0828	15518971	0	0	0	0
60	T9HAB0239	15531666	0	0	0	0
61	T9HAB0276	33112347	0	0	0	0
62	T9PPL1091	15549715	0	0	0	0
63	T9PPL1091	15549715	0	0	0	0
64	T9HAB0275	33112346	0	0	0	0
65	T9HAB0206	15518861	0	0	1	26
66	T9HAB0350	15548468	0	0	1	0
67	T9HAB0350	15548468	0	0	1	0
68	T9PPL1082	15549706	0	0	0	7
69	T9PPL1082	15549706	0	0	0	7
70	T9PPL0815	15518958	0	0	0	0
71	T9HAB0451	15548505	0	0	0	0
72	T9HAB0451	15548505	0	0	0	0
73	T9PPL1099	15549723	0	0	0	0
74	T9PPL1099	15549723	0	0	0	0
75	T9HAB0277	33112348	0	0	0	0
76	T9PPL1067	15549690	0	0	0	2
77	T9PPL1067	15549690	0	0	0	2
78	T9HAB0219	15518874	0	0	1	7
79	T9PPL1007	15549626	0	0	0	0
80	T9PPL1007	15549626	0	0	0	0
81	T9HAB0229	15518884	0	0	0	0
82	T9HAB0362	15548492	0	0	0	0
83	T9HAB0362	15548492	0	0	0	0
84	T9PPL1100	15549724	0	0	0	6
85	T9PPL1100	15549724	0	0	0	6
86	T9PPL1071	15549694	0	0	0	0
87	T9PPL1071	15549694	0	0	0	0

88	T9PPL0831	15518974	0	0	1	0
89	T9HAB0452	15548506	0	0	0	0
90	T9HAB0367	15548497	0	0	0	0
91	T9HAB0367	15548497	0	0	0	0
92	T9HAB0401	15548499	0	0	1	3
93	T9HAB0401	15548499	0	0	1	3
94	T9HAB0228	15518883	0	0	1	6
95	T9HAB0221	15518876	0	0	0	0
96	T9HAB0450	15548504	0	0	0	0
97	T9HAB0450	15548504	0	0	0	0
98	T9HAB0368	15548515	0	0	0	0
99	T9HAB0368	15548515	0	0	0	0
100	T9PPL1069	15549692	0	0	0	0
101	T9HAB0207	15518862	0	1	10	0
102	T9PPL1096	15549720	0	0	0	0
103	T9PPL0955	15543451	0	0	0	0
104	T9HAB0314	15548486	0	0	0	1
105	T9HAB0314	15548486	0	0	0	1
106	T9PPL1098	15549722	0	0	0	0
107	T9PPL1015	15549634	0	0	0	0
108	T9PPL1015	15549634	0	0	0	0
109	T9HAB0317	15548489	0	0	0	1
110	T9HAB0317	15548489	0	0	0	1
111	T9HAB0200	15518855	0	0	0	0
112	T9HAB0356	15548478	0	0	0	0
113	T9HAB0351	15548469	0	0	0	0
114	T9HAB0351	15548469	0	0	0	0
115	T9HAB0300	15548462	0	0	0	0
116	T9HAB0300	15548462	0	0	0	0
117	T9PPL1070	15549693	0	0	0	0

118	T9PPL1080	15549704	0	0	0	0
119	T9HAB0303	15548465	0	0	0	1
120	T9HAB0303	15548465	0	0	0	1
121	T9HAB0311	15548483	0	0	0	2
122	T9HAB0311	15548483	0	0	0	2
123	T9HAB0364	15548494	0	0	0	0
124	T9HAB0364	15548494	0	0	0	0
125	T9PPL1063	15549686	0	0	0	0
126	T9HAB0301	15548463	0	0	2	1
127	T9HAB0301	15548463	0	0	2	1
128	T9HAB0402	15548500	0	0	0	2
129	T9HAB0402	15548500	0	0	0	2
130	T9PPL1001	15549620	0	0	0	0
131	T9PPL1001	15549620	0	0	0	0
132	T9PPL1065	15549688	0	0	0	0
133	T9PPL1065	15549688	0	0	0	0
134	T9HAB0400	15548498	0	0	0	1
135	T9HAB0400	15548498	0	0	0	1
136	T9PPL1009	15549628	0	0	0	0
137	T9PPL1068	15549691	0	0	0	0
138	T9PPL1002	15549621	0	0	0	0
139	T9PPL1002	15549621	0	0	0	0
140	T9HAB0353	15548471	0	0	0	0
141	T9HAB0353	15548471	0	0	0	0
142	T9PPL1088	15549712	0	0	4	0
143	T9PPL1088	15549712	0	0	4	0
144	T9HAB0312	15548484	0	0	0	2
145	T9HAB0312	15548484	0	0	0	2
146	T9HAB0307	15548475	0	0	0	0
147	T9PPL1066	15549689	0	0	0	0

148	T9HAB0360	15548490	0	0	0	0
149	T9HAB0360	15548490	0	0	0	0
150	T9HAB0453	15548507	0	0	0	0
151	T9HAB0363	15548493	0	0	0	0
152	T9HAB0302	15548464	0	0	1	1
153	T9HAB0302	15548464	0	0	1	1
154	T9HAB0361	15548491	0	0	0	0
155	T9HAB0310	15548482	0	0	0	0
156	T9HAB0310	15548482	0	0	0	0
157	T9HAB0357	15548479	0	0	0	0
158	T9HAB0357	15548479	0	0	0	0
159	T9HAB0318	15548510	0	0	0	0
160	T9PPL1013	15549632	0	0	0	0
161	T9HAB0355	15548473	0	0	0	0
162	T9PPL1014	15549633	0	0	0	0
163	T9HAB0370	15548517	0	0	0	0
164	T9HAB0319	15548511	0	0	0	0
165	T9PPL1101	15549725	0	0	0	0
166	T9HAB0322	15548514	0	0	0	0
167	T9PPL1006	15549625	0	0	0	0
168	T9PPL1083	15549707	0	0	0	1
169	T9PPL1083	15549707	0	0	0	1
170	T9PPL1089	15549713	0	0	1	0
171	T9PPL1089	15549713	0	0	1	0
172	T9PPL0880	15519023	0	2	0	0
173	T9PPL1017	15549636	0	0	0	0
174	T9PPL1023	15549642	0	0	0	0
175	T9PPL0909	15519062	0	0	1	1
176	T9PPL1021	15549640	0	0	0	0
177	T9PPL1022	15549641	0	0	0	0

178	T9PPL1022	15549641	0	0	0	0
179	T9HAB0320	15548512	0	0	0	0
180	T9HAB0366	15548496	0	0	0	0
181	T9HAB0354	15548472	0	0	0	0
182	T9HAB0352	15548470	0	0	0	1
183	T9HAB0352	15548470	0	0	0	1
184	T9PPL0881	15519024	0	1	0	0
185	T9PPL1109	33108865	0	0	0	0
186	T9PPL1064	15549687	0	0	0	0
187	T9PPL1054	15549676	0	0	0	0
188	T9HAB0232	15518887	0	1	0	0
189	T9PPL1104	15549728	0	0	1	0
190	T9HAB0324	15548521	0	0	0	0
191	T9HAB0323	15548520	0	0	0	0
192	T9HAB0305	15548467	0	0	0	0
193	T9HAB0305	15548467	0	0	0	0
194	T9HAB0359	15548481	0	0	1	0
195	T9HAB0313	15548485	0	0	0	0
196	T9HAB0306	15548474	0	0	0	0

APPENDIX 2: Demand for all part numbers -2

Number	CPN	DPN	23.09.2013	30.09.2013	07.10.2013	14.10.2013
1	T9HAB0271	15543439	508	539	545	495
2	T9PPL0950	15543446	372	431	301	279
3	T9HAB0265	15543433	8	18	141	130
4	T9PPL0954	15543450	315	364	434	394
5	T9HAB0273	15543441	89	101	147	129
6	T9HAB0242	15540668	346	291	245	226

7	T9PPL0949	15543445	233	132	280	259
8	T9HAB0262	15543430	56	69	197	173
9	T9PPL0957	15543453	136	127	166	147
10	T9HAB0243	15540669	309	300	186	166
11	T9HAB0264	15543432	303	224	90	82
12	T9HAB0238	15531665	357	332	209	214
13	T9PPL0952	15543448	404	356	303	277
14	T9PPL0951	15543447	85	103	207	186
15	T9PPL0953	15543449	323	135	91	82
16	T9PPL0803	15518946	0	0	0	0
17	T9HAB0202	15518857	7	95	53	54
18	T9HAB0263	15543431	115	64	109	101
19	T9PPL0956	15543452	129	120	132	120
20	T9HAB0270	15543438	80	91	101	95
21	T9PPL0959	15543455	225	191	105	97
22	T9PPL0961	33112341	0	0	0	0
23	T9HAB0266	15543434	0	2	46	40
24	T9HAB0283	33112354	0	0	0	0
25	T9PPL0807	15518950	34	189	101	89
26	T9HAB0272	15543440	33	57	64	57
27	T9HAB0218	15518873	70	55	69	50
28	T9PPL0832	15518975	32	39	67	59
29	T9PPL0814	15518957	0	1	0	0
30	T9HAB0274	33112345	0	0	0	0
31	T9PPL0830	15518973	5	37	36	31
32	T9PPL0819	15518962	83	47	35	32
33	T9PPL0802	15518945	0	1	0	0
34	T9HAB0254	15540680	0	0	0	0
35	T9PPL0958	15543454	24	19	30	32
36	T9HAB0269	15543437	23	27	29	26

37	T9PPL0823	15518966	42	62	67	62
38	T9HAB0278	33112349	0	0	0	0
39	T9PPL0962	33112342	0	0	0	0
40	T9PPL0811	15518954	14	28	32	31
41	T9HAB0201	15518856	17	34	42	39
42	T9HAB0246	15540672	14	17	10	10
43	T9PPL0821	15518964	0	16	21	20
44	T9HAB0267	15543435	35	25	37	33
45	T9HAB0247	15540673	19	25	14	11
46	T9PPL0960	33112340	0	0	0	0
47	T9PPL0963	33112343	0	0	0	0
48	T9HAB0279	33112350	0	0	0	0
49	T9HAB0230	15518885	0	0	0	0
50	T9PPL0809	15518952	0	12	8	6
51	T9HAB0281	33112352	0	0	0	0
52	T9HAB0255	15540681	0	0	0	0
53	T9HAB0216	15518871	27	44	59	46
54	T9HAB0282	33112353	0	0	0	0
55	T9PPL1005	15549624	1	0	0	0
56	T9PPL1005	15549624	1	0	0	0
57	T9HAB0280	33112351	0	0	0	0
58	T9PPL0826	15518969	3	22	17	14
59	T9PPL0828	15518971	0	0	0	0
60	T9HAB0239	15531666	0	0	0	0
61	T9HAB0276	33112347	0	0	0	0
62	T9PPL1091	15549715	1	0	0	4
63	T9PPL1091	15549715	1	0	0	4
64	T9HAB0275	33112346	0	0	0	0
65	T9HAB0206	15518861	39	25	25	24
66	T9HAB0350	15548468	0	0	0	0

67	T9HAB0350	15548468	0	0	0	0
68	T9PPL1082	15549706	5	6	2	5
69	T9PPL1082	15549706	5	6	2	5
70	T9PPL0815	15518958	0	0	0	0
71	T9HAB0451	15548505	2	0	0	2
72	T9HAB0451	15548505	2	0	0	2
73	T9PPL1099	15549723	0	0	0	0
74	T9PPL1099	15549723	0	0	0	0
75	T9HAB0277	33112348	0	0	0	0
76	T9PPL1067	15549690	1	1	2	1
77	T9PPL1067	15549690	1	1	2	1
78	T9HAB0219	15518874	0	0	0	0
79	T9PPL1007	15549626	1	0	0	1
80	T9PPL1007	15549626	1	0	0	1
81	T9HAB0229	15518884	0	0	0	0
82	T9HAB0362	15548492	1	0	0	0
83	T9HAB0362	15548492	1	0	0	0
84	T9PPL1100	15549724	2	2	4	0
85	T9PPL1100	15549724	2	2	4	0
86	T9PPL1071	15549694	0	0	0	0
87	T9PPL1071	15549694	0	0	0	0
88	T9PPL0831	15518974	0	4	0	0
89	T9HAB0452	15548506	0	0	0	0
90	T9HAB0367	15548497	0	0	0	0
91	T9HAB0367	15548497	0	0	0	0
92	T9HAB0401	15548499	2	2	3	0
93	T9HAB0401	15548499	2	2	3	0
94	T9HAB0228	15518883	0	2	0	0
95	T9HAB0221	15518876	0	0	0	0
96	T9HAB0450	15548504	1	0	0	0

97	T9HAB0450	15548504	1	0	0	0
98	T9HAB0368	15548515	0	0	0	0
99	T9HAB0368	15548515	0	0	0	0
100	T9PPL1069	15549692	0	0	0	0
101	T9HAB0207	15518862	0	0	0	0
102	T9PPL1096	15549720	0	0	0	0
103	T9PPL0955	15543451	0	0	8	7
104	T9HAB0314	15548486	0	0	3	1
105	T9HAB0314	15548486	0	0	3	1
106	T9PPL1098	15549722	0	0	0	0
107	T9PPL1015	15549634	1	0	0	0
108	T9PPL1015	15549634	1	0	0	0
109	T9HAB0317	15548489	1	1	0	0
110	T9HAB0317	15548489	1	1	0	0
111	T9HAB0200	15518855	0	3	0	0
112	T9HAB0356	15548478	0	0	0	0
113	T9HAB0351	15548469	1	0	1	0
114	T9HAB0351	15548469	1	0	1	0
115	T9HAB0300	15548462	0	4	1	2
116	T9HAB0300	15548462	0	4	1	2
117	T9PPL1070	15549693	0	0	0	0
118	T9PPL1080	15549704	0	0	0	0
119	T9HAB0303	15548465	0	1	0	4
120	T9HAB0303	15548465	0	1	0	4
121	T9HAB0311	15548483	1	0	0	0
122	T9HAB0311	15548483	1	0	0	0
123	T9HAB0364	15548494	1	0	1	0
124	T9HAB0364	15548494	1	0	1	0
125	T9PPL1063	15549686	0	0	2	4
126	T9HAB0301	15548463	2	0	0	1

127	T9HAB0301	15548463	2	0	0	1
128	T9HAB0402	15548500	0	0	1	2
129	T9HAB0402	15548500	0	0	1	2
130	T9PPL1001	15549620	0	0	0	0
131	T9PPL1001	15549620	0	0	0	0
132	T9PPL1065	15549688	0	0	0	0
133	T9PPL1065	15549688	0	0	0	0
134	T9HAB0400	15548498	0	0	0	1
135	T9HAB0400	15548498	0	0	0	1
136	T9PPL1009	15549628	0	0	0	0
137	T9PPL1068	15549691	0	0	0	0
138	T9PPL1002	15549621	0	0	0	0
139	T9PPL1002	15549621	0	0	0	0
140	T9HAB0353	15548471	0	0	0	0
141	T9HAB0353	15548471	0	0	0	0
142	T9PPL1088	15549712	0	0	0	0
143	T9PPL1088	15549712	0	0	0	0
144	T9HAB0312	15548484	0	1	0	2
145	T9HAB0312	15548484	0	1	0	2
146	T9HAB0307	15548475	0	0	0	0
147	T9PPL1066	15549689	0	0	0	0
148	T9HAB0360	15548490	0	0	0	0
149	T9HAB0360	15548490	0	0	0	0
150	T9HAB0453	15548507	0	0	0	0
151	T9HAB0363	15548493	0	0	0	0
152	T9HAB0302	15548464	0	0	0	0
153	T9HAB0302	15548464	0	0	0	0
154	T9HAB0361	15548491	0	0	0	0
155	T9HAB0310	15548482	0	0	0	0
156	T9HAB0310	15548482	0	0	0	0

157	T9HAB0357	15548479	0	0	0	0
158	T9HAB0357	15548479	0	0	0	0
159	T9HAB0318	15548510	0	0	0	0
160	T9PPL1013	15549632	0	0	0	0
161	T9HAB0355	15548473	0	0	0	0
162	T9PPL1014	15549633	0	0	0	0
163	T9HAB0370	15548517	0	0	0	0
164	T9HAB0319	15548511	0	0	0	0
165	T9PPL1101	15549725	0	0	0	0
166	T9HAB0322	15548514	0	0	0	0
167	T9PPL1006	15549625	0	0	0	0
168	T9PPL1083	15549707	0	0	0	0
169	T9PPL1083	15549707	0	0	0	0
170	T9PPL1089	15549713	0	0	0	1
171	T9PPL1089	15549713	0	0	0	1
172	T9PPL0880	15519023	0	0	0	0
173	T9PPL1017	15549636	0	0	0	0
174	T9PPL1023	15549642	0	0	0	0
175	T9PPL0909	15519062	0	0	0	0
176	T9PPL1021	15549640	0	0	0	0
177	T9PPL1022	15549641	0	0	0	0
178	T9PPL1022	15549641	0	0	0	0
179	T9HAB0320	15548512	0	0	0	0
180	T9HAB0366	15548496	0	0	0	0
181	T9HAB0354	15548472	0	0	0	0
182	T9HAB0352	15548470	0	0	0	0
183	T9HAB0352	15548470	0	0	0	0
184	T9PPL0881	15519024	0	0	0	0
185	T9PPL1109	33108865	0	0	0	0
186	T9PPL1064	15549687	0	0	0	0

187	T9PPL1054	15549676	0	0	0	0
188	T9HAB0232	15518887	0	0	0	0
189	T9PPL1104	15549728	0	0	0	0
190	T9HAB0324	15548521	0	0	0	1
191	T9HAB0323	15548520	0	0	0	0
192	T9HAB0305	15548467	0	0	0	0
193	T9HAB0305	15548467	0	0	0	0
194	T9HAB0359	15548481	0	0	0	0
195	T9HAB0313	15548485	0	0	0	0
196	T9HAB0306	15548474	0	0	0	0

APPENDIX 3: Demand for all part numbers -3

Number	CPN	DPN	21.10.2013	28.10.2013	04.11.2013	11.11.2013
1	T9HAB0271	15543439	498	490	515	472
2	T9PPL0950	15543446	274	275	416	373
3	T9HAB0265	15543433	130	131	338	302
4	T9PPL0954	15543450	388	391	377	348
5	T9HAB0273	15543441	130	132	159	130
6	T9HAB0242	15540668	220	222	252	201
7	T9PPL0949	15543445	257	261	272	244
8	T9HAB0262	15543430	176	175	210	197
9	T9PPL0957	15543453	144	149	201	181
10	T9HAB0243	15540669	160	157	157	128
11	T9HAB0264	15543432	86	86	122	111
12	T9HAB0238	15531665	199	200	272	227
13	T9PPL0952	15543448	273	274	275	245
14	T9PPL0951	15543447	181	185	144	131
15	T9PPL0953	15543449	84	83	90	84

16	T9PPL0803	15518946	0	0	305	143
17	T9HAB0202	15518857	51	52	286	191
18	T9HAB0263	15543431	101	104	17	19
19	T9PPL0956	15543452	119	118	152	146
20	T9HAB0270	15543438	94	98	66	68
21	T9PPL0959	15543455	96	97	112	100
22	T9PPL0961	33112341	0	0	0	0
23	T9HAB0266	15543434	37	38	87	81
24	T9HAB0283	33112354	0	0	0	0
25	T9PPL0807	15518950	91	84	81	52
26	T9HAB0272	15543440	55	59	57	51
27	T9HAB0218	15518873	51	60	136	114
28	T9PPL0832	15518975	55	59	114	91
29	T9PPL0814	15518957	0	0	4	5
30	T9HAB0274	33112345	0	0	0	0
31	T9PPL0830	15518973	32	33	58	198
32	T9PPL0819	15518962	31	33	45	36
33	T9PPL0802	15518945	0	0	2	5
34	T9HAB0254	15540680	0	0	52	7
35	T9PPL0958	15543454	31	28	48	46
36	T9HAB0269	15543437	25	25	32	30
37	T9PPL0823	15518966	62	66	96	67
38	T9HAB0278	33112349	0	0	0	0
39	T9PPL0962	33112342	0	0	0	0
40	T9PPL0811	15518954	27	26	37	29
41	T9HAB0201	15518856	36	36	20	18
42	T9HAB0246	15540672	8	9	25	20
43	T9PPL0821	15518964	21	18	52	82
44	T9HAB0267	15543435	36	35	3	4
45	T9HAB0247	15540673	15	15	8	9

46	T9PPL0960	33112340	0	0	0	0
47	T9PPL0963	33112343	0	0	0	0
48	T9HAB0279	33112350	0	0	0	0
49	T9HAB0230	15518885	0	0	20	157
50	T9PPL0809	15518952	10	11	12	15
51	T9HAB0281	33112352	0	0	0	0
52	T9HAB0255	15540681	0	0	23	3
53	T9HAB0216	15518871	47	42	32	23
54	T9HAB0282	33112353	0	0	0	0
55	T9PPL1005	15549624	0	1	1	0
56	T9PPL1005	15549624	0	1	1	0
57	T9HAB0280	33112351	0	0	0	0
58	T9PPL0826	15518969	15	14	11	7
59	T9PPL0828	15518971	0	0	16	9
60	T9HAB0239	15531666	0	0	0	40
61	T9HAB0276	33112347	0	0	0	0
62	T9PPL1091	15549715	6	5	6	3
63	T9PPL1091	15549715	6	5	6	3
64	T9HAB0275	33112346	0	0	0	0
65	T9HAB0206	15518861	23	24	20	0
66	T9HAB0350	15548468	0	0	0	1
67	T9HAB0350	15548468	0	0	0	1
68	T9PPL1082	15549706	1	0	2	1
69	T9PPL1082	15549706	1	0	2	1
70	T9PPL0815	15518958	0	0	0	0
71	T9HAB0451	15548505	1	1	0	2
72	T9HAB0451	15548505	1	1	0	2
73	T9PPL1099	15549723	1	5	3	1
74	T9PPL1099	15549723	1	5	3	1
75	T9HAB0277	33112348	0	0	0	0

76	T9PPL1067	15549690	7	8	0	1
77	T9PPL1067	15549690	7	8	0	1
78	T9HAB0219	15518874	0	0	1	5
79	T9PPL1007	15549626	0	1	0	2
80	T9PPL1007	15549626	0	1	0	2
81	T9HAB0229	15518884	0	0	2	17
82	T9HAB0362	15548492	0	1	1	0
83	T9HAB0362	15548492	0	1	1	0
84	T9PPL1100	15549724	0	2	2	1
85	T9PPL1100	15549724	0	2	2	1
86	T9PPL1071	15549694	1	0	5	2
87	T9PPL1071	15549694	1	0	5	2
88	T9PPL0831	15518974	0	1	4	1
89	T9HAB0452	15548506	0	0	0	0
90	T9HAB0367	15548497	1	0	0	0
91	T9HAB0367	15548497	1	0	0	0
92	T9HAB0401	15548499	1	6	6	3
93	T9HAB0401	15548499	1	6	6	3
94	T9HAB0228	15518883	0	0	9	10
95	T9HAB0221	15518876	0	0	0	0
96	T9HAB0450	15548504	3	1	0	0
97	T9HAB0450	15548504	3	1	0	0
98	T9HAB0368	15548515	0	0	1	0
99	T9HAB0368	15548515	0	0	1	0
100	T9PPL1069	15549692	0	0	0	0
101	T9HAB0207	15518862	0	0	3	2
102	T9PPL1096	15549720	0	0	0	0
103	T9PPL0955	15543451	8	7	0	0
104	T9HAB0314	15548486	5	4	0	1
105	T9HAB0314	15548486	5	4	0	1

106	T9PPL1098	15549722	0	0	0	0
107	T9PPL1015	15549634	0	2	0	0
108	T9PPL1015	15549634	0	2	0	0
109	T9HAB0317	15548489	0	2	2	2
110	T9HAB0317	15548489	0	2	2	2
111	T9HAB0200	15518855	0	1	0	1
112	T9HAB0356	15548478	0	0	0	0
113	T9HAB0351	15548469	0	0	0	0
114	T9HAB0351	15548469	0	0	0	0
115	T9HAB0300	15548462	0	3	1	1
116	T9HAB0300	15548462	0	3	1	1
117	T9PPL1070	15549693	0	0	0	2
118	T9PPL1080	15549704	0	0	0	0
119	T9HAB0303	15548465	0	6	1	0
120	T9HAB0303	15548465	0	6	1	0
121	T9HAB0311	15548483	0	1	1	0
122	T9HAB0311	15548483	0	1	1	0
123	T9HAB0364	15548494	0	0	1	1
124	T9HAB0364	15548494	0	0	1	1
125	T9PPL1063	15549686	1	4	0	0
126	T9HAB0301	15548463	2	0	2	0
127	T9HAB0301	15548463	2	0	2	0
128	T9HAB0402	15548500	1	0	0	1
129	T9HAB0402	15548500	1	0	0	1
130	T9PPL1001	15549620	0	0	1	0
131	T9PPL1001	15549620	0	0	1	0
132	T9PPL1065	15549688	0	0	0	0
133	T9PPL1065	15549688	0	0	0	0
134	T9HAB0400	15548498	0	2	2	1
135	T9HAB0400	15548498	0	2	2	1

136	T9PPL1009	15549628	0	0	0	0
137	T9PPL1068	15549691	0	0	0	0
138	T9PPL1002	15549621	0	0	0	1
139	T9PPL1002	15549621	0	0	0	1
140	T9HAB0353	15548471	3	0	0	0
141	T9HAB0353	15548471	3	0	0	0
142	T9PPL1088	15549712	0	0	0	0
143	T9PPL1088	15549712	0	0	0	0
144	T9HAB0312	15548484	0	1	0	0
145	T9HAB0312	15548484	0	1	0	0
146	T9HAB0307	15548475	0	0	0	1
147	T9PPL1066	15549689	0	0	0	0
148	T9HAB0360	15548490	0	1	0	0
149	T9HAB0360	15548490	0	1	0	0
150	T9HAB0453	15548507	0	0	0	0
151	T9HAB0363	15548493	0	0	0	0
152	T9HAB0302	15548464	0	0	2	0
153	T9HAB0302	15548464	0	0	2	0
154	T9HAB0361	15548491	0	0	0	0
155	T9HAB0310	15548482	0	0	0	0
156	T9HAB0310	15548482	0	0	0	0
157	T9HAB0357	15548479	0	0	0	1
158	T9HAB0357	15548479	0	0	0	1
159	T9HAB0318	15548510	0	0	0	0
160	T9PPL1013	15549632	0	0	0	0
161	T9HAB0355	15548473	0	0	0	0
162	T9PPL1014	15549633	0	0	0	0
163	T9HAB0370	15548517	0	0	0	0
164	T9HAB0319	15548511	0	0	0	0
165	T9PPL1101	15549725	0	0	0	1

166	T9HAB0322	15548514	0	0	0	0
167	T9PPL1006	15549625	0	0	0	0
168	T9PPL1083	15549707	0	0	0	0
169	T9PPL1083	15549707	0	0	0	0
170	T9PPL1089	15549713	0	0	0	0
171	T9PPL1089	15549713	0	0	0	0
172	T9PPL0880	15519023	0	0	0	0
173	T9PPL1017	15549636	0	0	0	0
174	T9PPL1023	15549642	0	0	0	0
175	T9PPL0909	15519062	0	0	0	0
176	T9PPL1021	15549640	0	0	0	0
177	T9PPL1022	15549641	0	1	0	0
178	T9PPL1022	15549641	0	1	0	0
179	T9HAB0320	15548512	0	0	0	0
180	T9HAB0366	15548496	0	0	0	0
181	T9HAB0354	15548472	0	0	0	0
182	T9HAB0352	15548470	0	0	0	0
183	T9HAB0352	15548470	0	0	0	0
184	T9PPL0881	15519024	0	0	0	0
185	T9PPL1109	33108865	1	0	0	0
186	T9PPL1064	15549687	0	0	0	0
187	T9PPL1054	15549676	1	0	0	0
188	T9HAB0232	15518887	0	0	0	0
189	T9PPL1104	15549728	0	0	0	0
190	T9HAB0324	15548521	0	0	0	0
191	T9HAB0323	15548520	1	0	0	0
192	T9HAB0305	15548467	1	0	0	0
193	T9HAB0305	15548467	1	0	0	0
194	T9HAB0359	15548481	0	0	0	0
195	T9HAB0313	15548485	0	0	0	0

196	T9HAB0306	15548474	0	0	0	0

APPENDIX 4: Demand for all part numbers -4

Number	CPN	DPN	18.11.2013	25.11.2013	02.12.2013	09.12.2013
1	T9HAB0271	15543439	521	472	534	511
2	T9PPL0950	15543446	475	429	427	426
3	T9HAB0265	15543433	388	354	395	399
4	T9PPL0954	15543450	433	396	394	391
5	T9HAB0273	15543441	175	166	199	211
6	T9HAB0242	15540668	58	62	95	99
7	T9PPL0949	15543445	312	286	256	256
8	T9HAB0262	15543430	250	230	223	225
9	T9PPL0957	15543453	231	207	346	340
10	T9HAB0243	15540669	108	114	132	129
11	T9HAB0264	15543432	138	127	156	153
12	T9HAB0238	15531665	143	133	160	153
13	T9PPL0952	15543448	324	295	56	57
14	T9PPL0951	15543447	177	157	147	146
15	T9PPL0953	15543449	111	102	145	144
16	T9PPL0803	15518946	249	143	134	137
17	T9HAB0202	15518857	159	226	191	200
18	T9HAB0263	15543431	17	15	21	19
19	T9PPL0956	15543452	165	155	164	163
20	T9HAB0270	15543438	84	77	52	54
21	T9PPL0959	15543455	130	112	131	127
22	T9PPL0961	33112341	0	0	263	262
23	T9HAB0266	15543434	105	96	83	82
24	T9HAB0283	33112354	180	182	120	119

25	T9PPL0807	15518950	38	65	32	29
26	T9HAB0272	15543440	64	62	72	79
27	T9HAB0218	15518873	68	62	89	95
28	T9PPL0832	15518975	108	107	108	114
29	T9PPL0814	15518957	0	1	76	74
30	T9HAB0274	33112345	174	157	209	204
31	T9PPL0830	15518973	41	71	58	65
32	T9PPL0819	15518962	42	39	56	58
33	T9PPL0802	15518945	180	180	45	46
34	T9HAB0254	15540680	0	5	41	39
35	T9PPL0958	15543454	58	52	67	68
36	T9HAB0269	15543437	39	34	38	38
37	T9PPL0823	15518966	87	85	37	35
38	T9HAB0278	33112349	75	76	136	133
39	T9PPL0962	33112342	0	0	183	183
40	T9PPL0811	15518954	25	30	23	23
41	T9HAB0201	15518856	26	23	49	49
42	T9HAB0246	15540672	26	27	22	24
43	T9PPL0821	15518964	48	51	30	37
44	T9HAB0267	15543435	6	4	3	4
45	T9HAB0247	15540673	7	11	15	12
46	T9PPL0960	33112340	0	0	45	51
47	T9PPL0963	33112343	0	0	76	76
48	T9HAB0279	33112350	60	57	38	44
49	T9HAB0230	15518885	180	26	0	0
50	T9PPL0809	15518952	16	20	32	31
51	T9HAB0281	33112352	56	43	55	57
52	T9HAB0255	15540681	0	3	20	21
53	T9HAB0216	15518871	8	3	8	5
54	T9HAB0282	33112353	31	44	45	47

55	T9PPL1005	15549624	0	0	2	0
56	T9PPL1005	15549624	0	0	2	0
57	T9HAB0280	33112351	36	29	42	42
58	T9PPL0826	15518969	9	8	17	18
59	T9PPL0828	15518971	5	10	17	20
60	T9HAB0239	15531666	0	5	38	41
61	T9HAB0276	33112347	32	29	29	28
62	T9PPL1091	15549715	4	7	21	0
63	T9PPL1091	15549715	4	7	21	0
64	T9HAB0275	33112346	25	20	33	35
65	T9HAB0206	15518861	0	0	0	0
66	T9HAB0350	15548468	1	1	8	0
67	T9HAB0350	15548468	1	1	8	0
68	T9PPL1082	15549706	3	2	15	0
69	T9PPL1082	15549706	3	2	15	0
70	T9PPL0815	15518958	0	4	26	23
71	T9HAB0451	15548505	3	3	19	0
72	T9HAB0451	15548505	3	3	19	0
73	T9PPL1099	15549723	0	5	21	0
74	T9PPL1099	15549723	0	5	21	0
75	T9HAB0277	33112348	24	23	21	19
76	T9PPL1067	15549690	0	1	15	0
77	T9PPL1067	15549690	0	1	15	0
78	T9HAB0219	15518874	0	6	16	14
79	T9PPL1007	15549626	1	0	5	0
80	T9PPL1007	15549626	1	0	5	0
81	T9HAB0229	15518884	0	0	0	1
82	T9HAB0362	15548492	0	2	8	0
83	T9HAB0362	15548492	0	2	8	0
84	T9PPL1100	15549724	4	1	4	0

85	T9PPL1100	15549724	4	1	4	0
86	T9PPL1071	15549694	1	1	13	0
87	T9PPL1071	15549694	1	1	13	0
88	T9PPL0831	15518974	0	1	5	2
89	T9HAB0452	15548506	0	0	0	0
90	T9HAB0367	15548497	1	0	13	0
91	T9HAB0367	15548497	1	0	13	0
92	T9HAB0401	15548499	4	2	4	0
93	T9HAB0401	15548499	4	2	4	0
94	T9HAB0228	15518883	0	0	3	2
95	T9HAB0221	15518876	0	1	9	12
96	T9HAB0450	15548504	0	3	7	0
97	T9HAB0450	15548504	0	3	7	0
98	T9HAB0368	15548515	0	1	1	0
99	T9HAB0368	15548515	0	1	1	0
100	T9PPL1069	15549692	0	1	1	0
101	T9HAB0207	15518862	1	2	2	2
102	T9PPL1096	15549720	0	0	0	0
103	T9PPL0955	15543451	0	0	0	0
104	T9HAB0314	15548486	1	0	1	0
105	T9HAB0314	15548486	1	0	1	0
106	T9PPL1098	15549722	0	0	0	0
107	T9PPL1015	15549634	0	1	2	0
108	T9PPL1015	15549634	0	1	2	0
109	T9HAB0317	15548489	1	0	4	0
110	T9HAB0317	15548489	1	0	4	0
111	T9HAB0200	15518855	0	0	2	1
112	T9HAB0356	15548478	0	0	0	0
113	T9HAB0351	15548469	0	3	4	0
114	T9HAB0351	15548469	0	3	4	0

115	T9HAB0300	15548462	1	0	3	0
116	T9HAB0300	15548462	1	0	3	0
117	T9PPL1070	15549693	0	0	0	0
118	T9PPL1080	15549704	0	0	0	0
119	T9HAB0303	15548465	0	0	0	0
120	T9HAB0303	15548465	0	0	0	0
121	T9HAB0311	15548483	0	1	3	0
122	T9HAB0311	15548483	0	1	3	0
123	T9HAB0364	15548494	0	0	3	0
124	T9HAB0364	15548494	0	0	3	0
125	T9PPL1063	15549686	0	0	0	0
126	T9HAB0301	15548463	0	0	2	0
127	T9HAB0301	15548463	0	0	2	0
128	T9HAB0402	15548500	2	1	1	0
129	T9HAB0402	15548500	2	1	1	0
130	T9PPL1001	15549620	0	1	0	0
131	T9PPL1001	15549620	0	1	0	0
132	T9PPL1065	15549688	0	1	2	0
133	T9PPL1065	15549688	0	1	2	0
134	T9HAB0400	15548498	1	0	2	0
135	T9HAB0400	15548498	1	0	2	0
136	T9PPL1009	15549628	0	0	0	0
137	T9PPL1068	15549691	0	0	0	0
138	T9PPL1002	15549621	0	0	0	0
139	T9PPL1002	15549621	0	0	0	0
140	T9HAB0353	15548471	0	0	3	0
141	T9HAB0353	15548471	0	0	3	0
142	T9PPL1088	15549712	0	0	0	0
143	T9PPL1088	15549712	0	0	0	0
144	T9HAB0312	15548484	0	0	0	0

145	T9HAB0312	15548484	0	0	0	0
146	T9HAB0307	15548475	0	1	0	0
147	T9PPL1066	15549689	1	1	0	0
148	T9HAB0360	15548490	0	1	2	0
149	T9HAB0360	15548490	0	1	2	0
150	T9HAB0453	15548507	0	0	0	0
151	T9HAB0363	15548493	0	2	4	0
152	T9HAB0302	15548464	0	0	0	0
153	T9HAB0302	15548464	0	0	0	0
154	T9HAB0361	15548491	0	0	6	0
155	T9HAB0310	15548482	0	1	1	0
156	T9HAB0310	15548482	0	1	1	0
157	T9HAB0357	15548479	0	0	0	0
158	T9HAB0357	15548479	0	0	0	0
159	T9HAB0318	15548510	0	0	0	0
160	T9PPL1013	15549632	0	0	2	0
161	T9HAB0355	15548473	0	0	3	0
162	T9PPL1014	15549633	0	0	0	0
163	T9HAB0370	15548517	0	0	0	0
164	T9HAB0319	15548511	0	0	0	0
165	T9PPL1101	15549725	0	0	0	0
166	T9HAB0322	15548514	0	0	0	0
167	T9PPL1006	15549625	0	0	0	0
168	T9PPL1083	15549707	0	0	0	0
169	T9PPL1083	15549707	0	0	0	0
170	T9PPL1089	15549713	0	0	0	0
171	T9PPL1089	15549713	0	0	0	0
172	T9PPL0880	15519023	0	0	0	0
173	T9PPL1017	15549636	0	0	1	0
174	T9PPL1023	15549642	1	0	0	0

175	T9PPL0909	15519062	0	0	0	0
176	T9PPL1021	15549640	0	1	0	0
177	T9PPL1022	15549641	0	0	1	0
178	T9PPL1022	15549641	0	0	1	0
179	T9HAB0320	15548512	0	0	0	0
180	T9HAB0366	15548496	0	0	2	0
181	T9HAB0354	15548472	0	1	0	0
182	T9HAB0352	15548470	0	0	1	0
183	T9HAB0352	15548470	0	0	1	0
184	T9PPL0881	15519024	0	0	0	0
185	T9PPL1109	33108865	0	0	0	0
186	T9PPL1064	15549687	0	0	0	0
187	T9PPL1054	15549676	0	0	0	0
188	T9HAB0232	15518887	0	0	0	0
189	T9PPL1104	15549728	0	0	0	0
190	T9HAB0324	15548521	0	0	0	0
191	T9HAB0323	15548520	0	0	0	0
192	T9HAB0305	15548467	0	0	0	0
193	T9HAB0305	15548467	0	0	0	0
194	T9HAB0359	15548481	0	0	0	0
195	T9HAB0313	15548485	0	0	0	0
196	T9HAB0306	15548474	0	0	0	0

APPENDIX 5: Demand for all part numbers -5

Number	CPN	DPN	16.12.2013	06.01.2014	13.01.2014	20.01.2014
1	T9HAB0271	15543439	473	103	446	464
2	T9PPL0950	15543446	393	83	285	302
3	T9HAB0265	15543433	364	78	286	309

4	T9PPL0954	15543450	360	71	353	374
5	T9HAB0273	15543441	189	40	200	211
6	T9HAB0242	15540668	99	20	84	94
7	T9PPL0949	15543445	236	49	170	185
8	T9HAB0262	15543430	211	45	179	191
9	T9PPL0957	15543453	315	66	309	335
10	T9HAB0243	15540669	115	26	79	89
11	T9HAB0264	15543432	143	30	116	122
12	T9HAB0238	15531665	137	26	130	136
13	T9PPL0952	15543448	53	11	59	63
14	T9PPL0951	15543447	134	26	97	105
15	T9PPL0953	15543449	135	27	135	141
16	T9PPL0803	15518946	121	27	230	244
17	T9HAB0202	15518857	179	33	173	181
18	T9HAB0263	15543431	20	3	15	14
19	T9PPL0956	15543452	149	32	150	157
20	T9HAB0270	15543438	52	11	48	50
21	T9PPL0959	15543455	120	30	97	109
22	T9PPL0961	33112341	236	50	224	236
23	T9HAB0266	15543434	72	14	64	65
24	T9HAB0283	33112354	111	22	179	192
25	T9PPL0807	15518950	25	5	15	16
26	T9HAB0272	15543440	71	10	61	69
27	T9HAB0218	15518873	94	16	92	95
28	T9PPL0832	15518975	101	17	87	89
29	T9PPL0814	15518957	69	13	110	116
30	T9HAB0274	33112345	186	37	167	179
31	T9PPL0830	15518973	57	12	58	59
32	T9PPL0819	15518962	52	12	43	51
33	T9PPL0802	15518945	43	10	71	75

34	T9HAB0254	15540680	40	6	134	142
35	T9PPL0958	15543454	65	10	69	64
36	T9HAB0269	15543437	33	7	32	34
37	T9PPL0823	15518966	31	6	17	16
38	T9HAB0278	33112349	123	23	87	93
39	T9PPL0962	33112342	166	33	130	140
40	T9PPL0811	15518954	23	4	18	21
41	T9HAB0201	15518856	44	6	31	38
42	T9HAB0246	15540672	19	3	25	28
43	T9PPL0821	15518964	30	7	24	27
44	T9HAB0267	15543435	5	1	3	2
45	T9HAB0247	15540673	12	2	7	10
46	T9PPL0960	33112340	44	8	42	46
47	T9PPL0963	33112343	72	17	57	62
48	T9HAB0279	33112350	42	5	42	45
49	T9HAB0230	15518885	1	0	0	0
50	T9PPL0809	15518952	33	6	36	36
51	T9HAB0281	33112352	55	14	41	42
52	T9HAB0255	15540681	14	4	28	28
53	T9HAB0216	15518871	6	2	6	6
54	T9HAB0282	33112353	39	11	28	29
55	T9PPL1005	15549624	0	0	17	17
56	T9PPL1005	15549624	0	0	17	17
57	T9HAB0280	33112351	35	9	34	45
58	T9PPL0826	15518969	17	4	18	17
59	T9PPL0828	15518971	18	3	26	29
60	T9HAB0239	15531666	32	9	24	24
61	T9HAB0276	33112347	27	5	26	24
62	T9PPL1091	15549715	0	3	14	8
63	T9PPL1091	15549715	0	3	14	8

64	T9HAB0275	33112346	28	8	31	26
65	T9HAB0206	15518861	1	0	0	0
66	T9HAB0350	15548468	0	0	16	15
67	T9HAB0350	15548468	0	0	16	15
68	T9PPL1082	15549706	0	0	7	7
69	T9PPL1082	15549706	0	0	7	7
70	T9PPL0815	15518958	21	2	9	11
71	T9HAB0451	15548505	0	0	23	14
72	T9HAB0451	15548505	0	0	23	14
73	T9PPL1099	15549723	0	1	6	3
74	T9PPL1099	15549723	0	1	6	3
75	T9HAB0277	33112348	17	5	12	16
76	T9PPL1067	15549690	0	0	6	7
77	T9PPL1067	15549690	0	0	6	7
78	T9HAB0219	15518874	15	2	14	18
79	T9PPL1007	15549626	0	0	9	9
80	T9PPL1007	15549626	0	0	9	9
81	T9HAB0229	15518884	0	1	7	10
82	T9HAB0362	15548492	0	0	14	12
83	T9HAB0362	15548492	0	0	14	12
84	T9PPL1100	15549724	0	0	4	3
85	T9PPL1100	15549724	0	0	4	3
86	T9PPL1071	15549694	0	0	3	3
87	T9PPL1071	15549694	0	0	3	3
88	T9PPL0831	15518974	4	0	6	10
89	T9HAB0452	15548506	0	0	4	3
90	T9HAB0367	15548497	0	0	6	6
91	T9HAB0367	15548497	0	0	6	6
92	T9HAB0401	15548499	0	3	2	5
93	T9HAB0401	15548499	0	3	2	5

94	T9HAB0228	15518883	2	1	4	1
95	T9HAB0221	15518876	11	2	5	4
96	T9HAB0450	15548504	0	0	5	1
97	T9HAB0450	15548504	0	0	5	1
98	T9HAB0368	15548515	0	0	5	6
99	T9HAB0368	15548515	0	0	5	6
100	T9PPL1069	15549692	0	0	4	2
101	T9HAB0207	15518862	3	1	1	2
102	T9PPL1096	15549720	0	0	1	2
103	T9PPL0955	15543451	0	0	0	0
104	T9HAB0314	15548486	0	0	0	0
105	T9HAB0314	15548486	0	0	0	0
106	T9PPL1098	15549722	0	0	2	2
107	T9PPL1015	15549634	0	0	4	2
108	T9PPL1015	15549634	0	0	4	2
109	T9HAB0317	15548489	0	0	0	0
110	T9HAB0317	15548489	0	0	0	0
111	T9HAB0200	15518855	3	0	4	7
112	T9HAB0356	15548478	0	0	3	4
113	T9HAB0351	15548469	0	0	3	0
114	T9HAB0351	15548469	0	0	3	0
115	T9HAB0300	15548462	0	0	2	0
116	T9HAB0300	15548462	0	0	2	0
117	T9PPL1070	15549693	0	0	1	3
118	T9PPL1080	15549704	0	0	1	2
119	T9HAB0303	15548465	0	0	1	0
120	T9HAB0303	15548465	0	0	1	0
121	T9HAB0311	15548483	0	1	0	0
122	T9HAB0311	15548483	0	1	0	0
123	T9HAB0364	15548494	0	0	0	1

124	T9HAB0364	15548494	0	0	0	1
125	T9PPL1063	15549686	0	0	0	0
126	T9HAB0301	15548463	0	0	0	1
127	T9HAB0301	15548463	0	0	0	1
128	T9HAB0402	15548500	0	0	0	0
129	T9HAB0402	15548500	0	0	0	0
130	T9PPL1001	15549620	0	0	1	1
131	T9PPL1001	15549620	0	0	1	1
132	T9PPL1065	15549688	0	0	3	0
133	T9PPL1065	15549688	0	0	3	0
134	T9HAB0400	15548498	0	0	0	0
135	T9HAB0400	15548498	0	0	0	0
136	T9PPL1009	15549628	0	0	1	1
137	T9PPL1068	15549691	0	0	1	1
138	T9PPL1002	15549621	0	0	2	0
139	T9PPL1002	15549621	0	0	2	0
140	T9HAB0353	15548471	0	0	0	1
141	T9HAB0353	15548471	0	0	0	1
142	T9PPL1088	15549712	0	0	0	0
143	T9PPL1088	15549712	0	0	0	0
144	T9HAB0312	15548484	0	0	0	0
145	T9HAB0312	15548484	0	0	0	0
146	T9HAB0307	15548475	0	0	0	0
147	T9PPL1066	15549689	0	0	0	1
148	T9HAB0360	15548490	0	0	3	0
149	T9HAB0360	15548490	0	0	3	0
150	T9HAB0453	15548507	0	0	0	0
151	T9HAB0363	15548493	0	0	0	0
152	T9HAB0302	15548464	0	0	0	0
153	T9HAB0302	15548464	0	0	0	0

154	T9HAB0361	15548491	0	0	0	0
155	T9HAB0310	15548482	0	0	1	2
156	T9HAB0310	15548482	0	0	1	2
157	T9HAB0357	15548479	0	0	1	0
158	T9HAB0357	15548479	0	0	1	0
159	T9HAB0318	15548510	0	0	0	1
160	T9PPL1013	15549632	0	0	1	0
161	T9HAB0355	15548473	0	0	1	0
162	T9PPL1014	15549633	0	0	0	0
163	T9HAB0370	15548517	0	0	2	0
164	T9HAB0319	15548511	0	0	0	2
165	T9PPL1101	15549725	0	0	0	1
166	T9HAB0322	15548514	0	0	0	0
167	T9PPL1006	15549625	0	0	0	0
168	T9PPL1083	15549707	0	0	0	0
169	T9PPL1083	15549707	0	0	0	0
170	T9PPL1089	15549713	0	0	0	0
171	T9PPL1089	15549713	0	0	0	0
172	T9PPL0880	15519023	0	0	0	0
173	T9PPL1017	15549636	0	0	1	0
174	T9PPL1023	15549642	0	0	2	0
175	T9PPL0909	15519062	0	0	0	0
176	T9PPL1021	15549640	0	0	1	0
177	T9PPL1022	15549641	0	0	0	0
178	T9PPL1022	15549641	0	0	0	0
179	T9HAB0320	15548512	0	0	0	1
180	T9HAB0366	15548496	0	0	0	0
181	T9HAB0354	15548472	0	0	1	0
182	T9HAB0352	15548470	0	0	0	0
183	T9HAB0352	15548470	0	0	0	0

184	T9PPL0881	15519024	0	0	0	0
185	T9PPL1109	33108865	0	0	0	0
186	T9PPL1064	15549687	0	0	1	0
187	T9PPL1054	15549676	0	0	0	0
188	T9HAB0232	15518887	0	0	0	0
189	T9PPL1104	15549728	0	0	0	0
190	T9HAB0324	15548521	0	0	0	0
191	T9HAB0323	15548520	0	0	0	0
192	T9HAB0305	15548467	0	0	0	0
193	T9HAB0305	15548467	0	0	0	0
194	T9HAB0359	15548481	0	0	0	0
195	T9HAB0313	15548485	0	0	0	0
196	T9HAB0306	15548474	0	0	0	0

APPENDIX 6: Demand for all part numbers -6

Number	CPN	DPN	27.01.2014	03.02.2014	10.02.2014	17.02.2014	Total
1	T9HAB0271	15543439	468	510	578	615	2171
2	T9PPL0950	15543446	301	152	167	182	802
3	T9HAB0265	15543433	309	85	91	102	587
4	T9PPL0954	15543450	370	642	716	785	2513
5	T9HAB0273	15543441	203	291	321	352	1167
6	T9HAB0242	15540668	94	20	29	28	171
7	T9PPL0949	15543445	181	96	111	120	508
8	T9HAB0262	15543430	190	99	109	114	512
9	T9PPL0957	15543453	340	137	150	166	793
10	T9HAB0243	15540669	88	114	133	147	482
11	T9HAB0264	15543432	123	47	51	58	279
12	T9HAB0238	15531665	140	36	39	53	268
13	T9PPL0952	15543448	62	26	33	32	153

14	T9PPL0951	15543447	104	68	77	80	329
15	T9PPL0953	15543449	139	53	58	63	313
16	T9PPL0803	15518946	241	98	119	129	587
17	T9HAB0202	15518857	179	47	62	62	350
18	T9HAB0263	15543431	17	105	115	127	364
19	T9PPL0956	15543452	160	109	127	133	529
20	T9HAB0270	15543438	56	58	57	65	236
21	T9PPL0959	15543455	107	108	118	125	458
22	T9PPL0961	33112341	242	224	259	275	1000
23	T9HAB0266	15543434	67	27	32	32	158
24	T9HAB0283	33112354	192	254	282	305	1033
25	T9PPL0807	15518950	18	4	6	4	32
26	T9HAB0272	15543440	59	8	16	14	97
27	T9HAB0218	15518873	104	148	168	174	594
28	T9PPL0832	15518975	89	52	69	76	286
29	T9PPL0814	15518957	116	182	202	219	719
30	T9HAB0274	33112345	178	51	66	67	362
31	T9PPL0830	15518973	59	28	35	38	160
32	T9PPL0819	15518962	52	31	41	44	168
33	T9PPL0802	15518945	75	69	80	85	309
34	T9HAB0254	15540680	142	17	20	26	205
35	T9PPL0958	15543454	64	27	33	29	153
36	T9HAB0269	15543437	32	1	0	1	34
37	T9PPL0823	15518966	15	11	11	11	48
38	T9HAB0278	33112349	90	135	158	163	546
39	T9PPL0962	33112342	132	51	57	61	301
40	T9PPL0811	15518954	19	13	11	18	61
41	T9HAB0201	15518856	36	27	27	30	120
42	T9HAB0246	15540672	29	4	2	8	43
43	T9PPL0821	15518964	31	30	35	40	136
44	T9HAB0267	15543435	4	9	9	11	33
45	T9HAB0247	15540673	6	7	6	7	26
46	T9PPL0960	33112340	46	13	16	18	93
47	T9PPL0963	33112343	64	20	31	25	140
48	T9HAB0279	33112350	49	45	52	57	203

49	T9HAB0230	15518885	0	7	12	9	28
50	T9PPL0809	15518952	36	25	24	24	109
51	T9HAB0281	33112352	45	12	13	17	87
52	T9HAB0255	15540681	28	6	8	7	49
53	T9HAB0216	15518871	4	7	12	11	34
54	T9HAB0282	33112353	30	34	39	44	147
55	T9PPL1005	15549624	18	41	65	59	183
56	T9PPL1005	15549624	18	41	65	59	183
57	T9HAB0280	33112351	34	17	23	20	94
58	T9PPL0826	15518969	15	12	10	10	47
59	T9PPL0828	15518971	28	4	5	6	43
60	T9HAB0239	15531666	23	11	13	16	63
61	T9HAB0276	33112347	25	10	11	14	60
62	T9PPL1091	15549715	9	32	44	44	129
63	T9PPL1091	15549715	9	32	44	44	129
64	T9HAB0275	33112346	27	8	15	9	59
65	T9HAB0206	15518861	1	1	2	1	5
66	T9HAB0350	15548468	14	48	77	72	211
67	T9HAB0350	15548468	14	48	77	72	211
68	T9PPL1082	15549706	9	39	9	12	69
69	T9PPL1082	15549706	9	39	9	12	69
70	T9PPL0815	15518958	10	3	3	6	22
71	T9HAB0451	15548505	12	32	39	34	117
72	T9HAB0451	15548505	12	32	39	34	117
73	T9PPL1099	15549723	3	5	18	18	44
74	T9PPL1099	15549723	3	5	18	18	44
75	T9HAB0277	33112348	15	4	6	10	35
76	T9PPL1067	15549690	7	18	0	2	27
77	T9PPL1067	15549690	7	18	0	2	27
78	T9HAB0219	15518874	17	4	3	3	27
79	T9PPL1007	15549626	8	21	28	23	80
80	T9PPL1007	15549626	8	21	28	23	80
81	T9HAB0229	15518884	7	22	21	25	75
82	T9HAB0362	15548492	12	15	15	14	56
83	T9HAB0362	15548492	12	15	15	14	56

84	T9PPL1100	15549724	1	17	13	16	47
85	T9PPL1100	15549724	1	17	13	16	47
86	T9PPL1071	15549694	2	8	10	8	28
87	T9PPL1071	15549694	2	8	10	8	28
88	T9PPL0831	15518974	7	7	5	7	26
89	T9HAB0452	15548506	4	22	28	29	83
90	T9HAB0367	15548497	8	10	9	6	33
91	T9HAB0367	15548497	8	10	9	6	33
92	T9HAB0401	15548499	2	6	5	5	18
93	T9HAB0401	15548499	2	6	5	5	18
94	T9HAB0228	15518883	2	4	5	5	16
95	T9HAB0221	15518876	5	3	3	1	12
96	T9HAB0450	15548504	1	7	18	16	42
97	T9HAB0450	15548504	1	7	18	16	42
98	T9HAB0368	15548515	5	11	14	12	42
99	T9HAB0368	15548515	5	11	14	12	42
100	T9PPL1069	15549692	0	6	8	9	23
101	T9HAB0207	15518862	2	0	0	0	2
102	T9PPL1096	15549720	2	4	8	6	20
103	T9PPL0955	15543451	0	0	0	0	0
104	T9HAB0314	15548486	0	8	0	3	11
105	T9HAB0314	15548486	0	8	0	3	11
106	T9PPL1098	15549722	2	0	6	6	14
107	T9PPL1015	15549634	2	1	6	4	13
108	T9PPL1015	15549634	2	1	6	4	13
109	T9HAB0317	15548489	0	10	0	0	10
110	T9HAB0317	15548489	0	10	0	0	10
111	T9HAB0200	15518855	3	0	0	1	4
112	T9HAB0356	15548478	4	3	8	5	20
113	T9HAB0351	15548469	1	5	3	1	10
114	T9HAB0351	15548469	1	5	3	1	10
115	T9HAB0300	15548462	0	3	0	2	5
116	T9HAB0300	15548462	0	3	0	2	5
117	T9PPL1070	15549693	1	2	2	2	7
118	T9PPL1080	15549704	1	5	3	1	10

119	T9HAB0303	15548465	0	1	1	1	3
120	T9HAB0303	15548465	0	1	1	1	3
121	T9HAB0311	15548483	1	5	1	2	9
122	T9HAB0311	15548483	1	5	1	2	9
123	T9HAB0364	15548494	1	5	0	2	8
124	T9HAB0364	15548494	1	5	0	2	8
125	T9PPL1063	15549686	0	0	0	0	0
126	T9HAB0301	15548463	0	1	1	2	4
127	T9HAB0301	15548463	0	1	1	2	4
128	T9HAB0402	15548500	0	4	0	3	7
129	T9HAB0402	15548500	0	4	0	3	7
130	T9PPL1001	15549620	1	1	1	3	6
131	T9PPL1001	15549620	1	1	1	3	6
132	T9PPL1065	15549688	0	1	0	1	2
133	T9PPL1065	15549688	0	1	0	1	2
134	T9HAB0400	15548498	1	2	1	0	4
135	T9HAB0400	15548498	1	2	1	0	4
136	T9PPL1009	15549628	1	1	2	2	6
137	T9PPL1068	15549691	0	1	1	2	4
138	T9PPL1002	15549621	0	1	1	1	3
139	T9PPL1002	15549621	0	1	1	1	3
140	T9HAB0353	15548471	0	0	1	0	1
141	T9HAB0353	15548471	0	0	1	0	1
142	T9PPL1088	15549712	0	0	0	1	1
143	T9PPL1088	15549712	0	0	0	1	1
144	T9HAB0312	15548484	0	0	0	1	1
145	T9HAB0312	15548484	0	0	0	1	1
146	T9HAB0307	15548475	1	1	1	2	5
147	T9PPL1066	15549689	0	1	0	0	1
148	T9HAB0360	15548490	0	0	0	0	0
149	T9HAB0360	15548490	0	0	0	0	0
150	T9HAB0453	15548507	3	2	1	1	7
151	T9HAB0363	15548493	0	0	0	0	0
152	T9HAB0302	15548464	0	2	0	0	2
153	T9HAB0302	15548464	0	2	0	0	2

154	T9HAB0361	15548491	0	0	0	0	0
155	T9HAB0310	15548482	0	0	0	1	1
156	T9HAB0310	15548482	0	0	0	1	1
157	T9HAB0357	15548479	0	0	1	2	3
158	T9HAB0357	15548479	0	0	1	2	3
159	T9HAB0318	15548510	0	1	1	2	4
160	T9PPL1013	15549632	0	0	0	0	0
161	T9HAB0355	15548473	0	0	0	0	0
162	T9PPL1014	15549633	2	0	1	1	4
163	T9HAB0370	15548517	0	1	1	0	2
164	T9HAB0319	15548511	0	1	0	1	2
165	T9PPL1101	15549725	0	1	0	0	1
166	T9HAB0322	15548514	0	3	0	0	3
167	T9PPL1006	15549625	1	2	0	0	3
168	T9PPL1083	15549707	0	1	0	0	1
169	T9PPL1083	15549707	0	1	0	0	1
170	T9PPL1089	15549713	0	0	0	0	0
171	T9PPL1089	15549713	0	0	0	0	0
172	T9PPL0880	15519023	0	0	0	0	0
173	T9PPL1017	15549636	0	1	0	0	1
174	T9PPL1023	15549642	0	0	0	0	0
175	T9PPL0909	15519062	0	0	0	0	0
176	T9PPL1021	15549640	0	0	0	0	0
177	T9PPL1022	15549641	0	0	0	0	0
178	T9PPL1022	15549641	0	0	0	0	0
179	T9HAB0320	15548512	0	0	0	1	1
180	T9HAB0366	15548496	0	0	0	0	0
181	T9HAB0354	15548472	0	0	0	0	0
182	T9HAB0352	15548470	0	0	0	0	0
183	T9HAB0352	15548470	0	0	0	0	0
184	T9PPL0881	15519024	0	0	0	0	0
185	T9PPL1109	33108865	0	0	0	0	0
186	T9PPL1064	15549687	0	0	0	0	0
187	T9PPL1054	15549676	0	0	0	0	0
188	T9HAB0232	15518887	0	0	0	0	0

189	T9PPL1104	15549728	0	0	0	0	0
190	T9HAB0324	15548521	0	0	0	0	0
191	T9HAB0323	15548520	0	0	0	0	0
192	T9HAB0305	15548467	0	0	0	0	0
193	T9HAB0305	15548467	0	0	0	0	0
194	T9HAB0359	15548481	0	0	0	0	0
195	T9HAB0313	15548485	0	1	0	0	1
196	T9HAB0306	15548474	0	0	0	1	1

APPENDIX 7: ABC analysis results

Number	CPN	DPN	Total	ADC	unit price	ADC*price	Total Annual Cost	Group
1	T9HAB0271	15543439	11143	96,9	171,1	16582,7	4311507,7	A
2	T9PPL0950	15543446	7292	63,4	134,6	8535,4	2219215,6	A
3	T9HAB0265	15543433	4743	41,2	184,4	7606,9	1977806,3	A
4	T9PPL0954	15543450	9432	82,0	86,4	7089,6	1843291,7	A
5	T9HAB0273	15543441	3964	34,5	170,8	5888,8	1531082,9	A
6	T9HAB0242	15540668	3459	30,1	182,2	5480,3	1424867,4	A
7	T9PPL0949	15543445	4699	40,9	133,5	5453,3	1417855,8	A
8	T9HAB0262	15543430	3435	29,9	174,3	5206,9	1353784,3	A
9	T9PPL0957	15543453	4697	40,8	126,8	5180,6	1346952,6	A
10	T9HAB0243	15540669	3124	27,2	189,3	5143,2	1337229,6	A
11	T9HAB0264	15543432	3063	26,6	184,0	4901,6	1274415,8	A
12	T9HAB0238	15531665	4494	39,1	86,8	3390,4	881511,8	A
13	T9PPL0952	15543448	4251	37,0	90,8	3354,6	872194,3	A
14	T9PPL0951	15543447	2831	24,6	135,0	3323,6	864134,4	A
15	T9PPL0953	15543449	2573	22,4	131,2	2935,2	763160,7	A
16	T9PPL0803	15518946	2353	20,5	135,2	2766,7	719346,9	A
17	T9HAB0202	15518857	2854	24,8	96,6	2396,9	623184,5	A
18	T9HAB0263	15543431	1408	12,2	182,4	2233,5	580698,4	A
19	T9PPL0956	15543452	2984	25,9	82,2	2131,6	554219,6	B-1
20	T9HAB0270	15543438	1442	12,5	167,9	2105,8	547513,6	B-1

21	T9PPL0959	15543455	2613	22,7	80,7	1833,0	476570,3	B-1
22	T9PPL0961	33112341	2271	19,7	89,0	1758,1	457118,7	B-1
23	T9HAB0266	15543434	1100	9,6	178,1	1703,5	442902,1	B-1
24	T9HAB0283	33112354	2138	18,6	90,3	1679,2	436583,3	B-1
25	T9PPL0807	15518950	1375	12,0	139,8	1671,5	434595,7	B-1
26	T9HAB0272	15543440	1046	9,1	172,6	1570,2	408247,4	B-1
27	T9HAB0218	15518873	1913	16,6	86,1	1431,6	372213,2	B-1
28	T9PPL0832	15518975	1721	15,0	91,4	1367,7	355594,5	B-1
29	T9PPL0814	15518957	1194	10,4	129,5	1344,5	349582,4	B-1
30	T9HAB0274	33112345	1675	14,6	87,2	1269,9	330184,7	B-1
31	T9PPL0830	15518973	1078	9,4	130,1	1219,1	316960,1	B-1
32	T9PPL0819	15518962	943	8,2	137,5	1127,3	293086,0	B-1
33	T9PPL0802	15518945	967	8,4	131,8	1108,4	288192,9	B-1
34	T9HAB0254	15540680	672	5,8	185,5	1084,1	281861,3	B-1
35	T9PPL0958	15543454	971	8,4	127,3	1074,4	279352,5	B-2
36	T9HAB0269	15543437	553	4,8	197,4	949,1	246764,0	B-2
37	T9PPL0823	15518966	1052	9,1	100,5	919,3	239008,9	B-2
38	T9HAB0278	33112349	1292	11,2	75,7	850,9	221239,8	B-2
39	T9PPL0962	33112342	1136	9,9	81,4	803,6	208935,1	B-2
40	T9PPL0811	15518954	668	5,8	103,8	603,0	156780,2	B-2
41	T9HAB0201	15518856	721	6,3	89,5	560,8	145811,3	B-2
42	T9HAB0246	15540672	339	2,9	190,2	560,6	145760,6	B-2
43	T9PPL0821	15518964	621	5,4	95,8	517,5	134559,4	B-2
44	T9HAB0267	15543435	299	2,6	185,7	482,9	125553,5	B-2
45	T9HAB0247	15540673	240	2,1	197,3	411,8	107062,1	B-2
46	T9PPL0960	33112340	329	2,9	135,5	387,6	100773,6	B-2
47	T9PPL0963	33112343	500	4,3	88,2	383,4	99693,0	B-2
48	T9HAB0279	33112350	536	4,7	80,9	376,9	97988,3	B-3
49	T9HAB0230	15518885	417	3,6	100,3	363,8	94589,4	B-3
50	T9PPL0809	15518952	394	3,4	99,2	339,7	88330,0	B-3
51	T9HAB0281	33112352	450	3,9	83,5	326,7	84952,2	B-3
52	T9HAB0255	15540681	193	1,7	193,0	324,0	84228,2	B-3
53	T9HAB0216	15518871	421	3,7	85,9	314,5	81761,9	C
54	T9HAB0282	33112353	421	3,7	80,0	292,8	76127,1	C
55	T9PPL1005	15549624	222	1,9	138,7	267,8	69635,4	C

56	T9PPL1005	15549624	222	1,9	138,7	267,8	69635,4	C
57	T9HAB0280	33112351	366	3,2	83,2	264,9	68879,3	C
58	T9PPL0826	15518969	316	2,7	91,9	252,4	65635,1	C
59	T9PPL0828	15518971	196	1,7	130,3	222,1	57739,9	C
60	T9HAB0239	15531666	276	2,4	90,5	217,2	56472,0	C
61	T9HAB0276	33112347	260	2,3	95,9	216,8	56360,8	C
62	T9PPL1091	15549715	211	1,8	112,4	206,3	53638,8	C
63	T9PPL1091	15549715	211	1,8	112,4	206,3	53638,8	C
64	T9HAB0275	33112346	265	2,3	88,9	204,9	53286,7	C
65	T9HAB0206	15518861	213	1,9	97,4	180,4	46914,1	C
66	T9HAB0350	15548468	254	2,2	80,8	178,4	46394,5	C
67	T9HAB0350	15548468	254	2,2	80,8	178,4	46394,5	C
68	T9PPL1082	15549706	132	1,1	139,7	160,3	41682,4	C
69	T9PPL1082	15549706	132	1,1	139,7	160,3	41682,4	C
70	T9PPL0815	15518958	118	1,0	132,9	136,4	35452,7	C
71	T9HAB0451	15548505	187	1,6	79,9	130,0	33797,2	C
72	T9HAB0451	15548505	187	1,6	79,9	130,0	33797,2	C
73	T9PPL1099	15549723	90	0,8	149,8	117,2	30483,1	C
74	T9PPL1099	15549723	90	0,8	149,8	117,2	30483,1	C
75	T9HAB0277	33112348	172	1,5	78,2	116,9	30401,8	C
76	T9PPL1067	15549690	79	0,7	149,6	102,8	26719,9	C
77	T9PPL1067	15549690	79	0,7	149,6	102,8	26719,9	C
78	T9HAB0219	15518874	126	1,1	89,6	98,2	25524,3	C
79	T9PPL1007	15549626	109	0,9	102,6	97,2	25274,4	C
80	T9PPL1007	15549626	109	0,9	102,6	97,2	25274,4	C
81	T9HAB0229	15518884	113	1,0	92,8	91,2	23713,5	C
82	T9HAB0362	15548492	95	0,8	90,8	75,0	19504,4	C
83	T9HAB0362	15548492	95	0,8	90,8	75,0	19504,4	C
84	T9PPL1100	15549724	82	0,7	104,2	74,3	19310,4	C
85	T9PPL1100	15549724	82	0,7	104,2	74,3	19310,4	C
86	T9PPL1071	15549694	57	0,5	147,2	73,0	18968,3	C
87	T9PPL1071	15549694	57	0,5	147,2	73,0	18968,3	C
88	T9PPL0831	15518974	65	0,6	126,7	71,6	18612,0	C
89	T9HAB0452	15548506	90	0,8	79,0	61,8	16072,7	C
90	T9HAB0367	15548497	60	0,5	98,9	51,6	13417,4	C

91	T9HAB0367	15548497	60	0,5	98,9	51,6	13417,4	C
92	T9HAB0401	15548499	65	0,6	79,6	45,0	11690,4	C
93	T9HAB0401	15548499	65	0,6	79,6	45,0	11690,4	C
94	T9HAB0228	15518883	57	0,5	90,5	44,8	11658,8	C
95	T9HAB0221	15518876	56	0,5	89,7	43,7	11361,9	C
96	T9HAB0450	15548504	63	0,5	75,3	41,2	10718,2	C
97	T9HAB0450	15548504	63	0,5	75,3	41,2	10718,2	C
98	T9HAB0368	15548515	56	0,5	82,0	39,9	10379,4	C
99	T9HAB0368	15548515	56	0,5	82,0	39,9	10379,4	C
100	T9PPL1069	15549692	31	0,3	143,8	38,8	10076,4	C
101	T9HAB0207	15518862	32	0,3	104,6	29,1	7564,7	C
102	T9PPL1096	15549720	23	0,2	141,8	28,4	7374,1	C
103	T9PPL0955	15543451	30	0,3	94,1	24,6	6383,8	C
104	T9HAB0314	15548486	28	0,2	96,5	23,5	6110,1	C
105	T9HAB0314	15548486	28	0,2	96,5	23,5	6110,1	C
106	T9PPL1098	15549722	18	0,2	145,2	22,7	5910,2	C
107	T9PPL1015	15549634	25	0,2	99,2	21,6	5608,7	C
108	T9PPL1015	15549634	25	0,2	99,2	21,6	5608,7	C
109	T9HAB0317	15548489	24	0,2	99,5	20,8	5396,8	C
110	T9HAB0317	15548489	24	0,2	99,5	20,8	5396,8	C
111	T9HAB0200	15518855	26	0,2	86,8	19,6	5103,5	C
112	T9HAB0356	15548478	27	0,2	82,7	19,4	5050,7	C
113	T9HAB0351	15548469	22	0,2	88,2	16,9	4385,0	C
114	T9HAB0351	15548469	22	0,2	88,2	16,9	4385,0	C
115	T9HAB0300	15548462	23	0,2	81,4	16,3	4230,2	C
116	T9HAB0300	15548462	23	0,2	81,4	16,3	4230,2	C
117	T9PPL1070	15549693	13	0,1	142,6	16,1	4191,2	C
118	T9PPL1080	15549704	13	0,1	136,3	15,4	4004,6	C
119	T9HAB0303	15548465	17	0,1	94,0	13,9	3613,3	C
120	T9HAB0303	15548465	17	0,1	94,0	13,9	3613,3	C
121	T9HAB0311	15548483	19	0,2	83,9	13,9	3602,3	C
122	T9HAB0311	15548483	19	0,2	83,9	13,9	3602,3	C
123	T9HAB0364	15548494	16	0,1	96,3	13,4	3482,5	C
124	T9HAB0364	15548494	16	0,1	96,3	13,4	3482,5	C
125	T9PPL1063	15549686	11	0,1	138,2	13,2	3437,2	C

126	T9HAB0301	15548463	17	0,1	88,5	13,1	3401,5	C
127	T9HAB0301	15548463	17	0,1	88,5	13,1	3401,5	C
128	T9HAB0402	15548500	18	0,2	78,6	12,3	3198,7	C
129	T9HAB0402	15548500	18	0,2	78,6	12,3	3198,7	C
130	T9PPL1001	15549620	10	0,1	130,7	11,4	2955,9	C
131	T9PPL1001	15549620	10	0,1	130,7	11,4	2955,9	C
132	T9PPL1065	15549688	8	0,1	146,2	10,2	2644,0	C
133	T9PPL1065	15549688	8	0,1	146,2	10,2	2644,0	C
134	T9HAB0400	15548498	14	0,1	74,9	9,1	2370,7	C
135	T9HAB0400	15548498	14	0,1	74,9	9,1	2370,7	C
136	T9PPL1009	15549628	8	0,1	127,6	8,9	2307,0	C
137	T9PPL1068	15549691	6	0,1	139,2	7,3	1888,1	C
138	T9PPL1002	15549621	6	0,1	134,2	7,0	1819,9	C
139	T9PPL1002	15549621	6	0,1	134,2	7,0	1819,9	C
140	T9HAB0353	15548471	8	0,1	93,6	6,5	1693,5	C
141	T9HAB0353	15548471	8	0,1	93,6	6,5	1693,5	C
142	T9PPL1088	15549712	5	0,0	139,3	6,1	1574,5	C
143	T9PPL1088	15549712	5	0,0	139,3	6,1	1574,5	C
144	T9HAB0312	15548484	7	0,1	91,0	5,5	1440,3	C
145	T9HAB0312	15548484	7	0,1	91,0	5,5	1440,3	C
146	T9HAB0307	15548475	7	0,1	90,6	5,5	1433,5	C
147	T9PPL1066	15549689	4	0,0	145,0	5,0	1311,5	C
148	T9HAB0360	15548490	7	0,1	79,6	4,8	1259,1	C
149	T9HAB0360	15548490	7	0,1	79,6	4,8	1259,1	C
150	T9HAB0453	15548507	7	0,1	77,7	4,7	1230,0	C
151	T9HAB0363	15548493	6	0,1	88,5	4,6	1200,7	C
152	T9HAB0302	15548464	6	0,1	86,5	4,5	1173,0	C
153	T9HAB0302	15548464	6	0,1	86,5	4,5	1173,0	C
154	T9HAB0361	15548491	6	0,1	83,4	4,4	1131,9	C
155	T9HAB0310	15548482	6	0,1	80,1	4,2	1086,6	C
156	T9HAB0310	15548482	6	0,1	80,1	4,2	1086,6	C
157	T9HAB0357	15548479	5	0,0	90,2	3,9	1020,1	C
158	T9HAB0357	15548479	5	0,0	90,2	3,9	1020,1	C
159	T9HAB0318	15548510	5	0,0	82,5	3,6	932,8	C
160	T9PPL1013	15549632	3	0,0	135,6	3,5	919,4	C

161	T9HAB0355	15548473	4	0,0	96,3	3,3	870,5	C
162	T9PPL1014	15549633	4	0,0	94,7	3,3	856,0	C
163	T9HAB0370	15548517	4	0,0	92,9	3,2	840,1	C
164	T9HAB0319	15548511	4	0,0	85,8	3,0	776,2	C
165	T9PPL1101	15549725	3	0,0	108,7	2,8	737,5	C
166	T9HAB0322	15548514	3	0,0	98,6	2,6	669,0	C
167	T9PPL1006	15549625	3	0,0	98,0	2,6	664,6	C
168	T9PPL1083	15549707	2	0,0	144,3	2,5	652,6	C
169	T9PPL1083	15549707	2	0,0	144,3	2,5	652,6	C
170	T9PPL1089	15549713	2	0,0	143,9	2,5	650,8	C
171	T9PPL1089	15549713	2	0,0	143,9	2,5	650,8	C
172	T9PPL0880	15519023	2	0,0	141,7	2,5	640,6	C
173	T9PPL1017	15549636	3	0,0	90,7	2,4	615,3	C
174	T9PPL1023	15549642	3	0,0	90,2	2,4	612,1	C
175	T9PPL0909	15519062	2	0,0	132,8	2,3	600,4	C
176	T9PPL1021	15549640	2	0,0	128,9	2,2	582,8	C
177	T9PPL1022	15549641	2	0,0	125,5	2,2	567,3	C
178	T9PPL1022	15549641	2	0,0	125,5	2,2	567,3	C
179	T9HAB0320	15548512	2	0,0	93,1	1,6	421,0	C
180	T9HAB0366	15548496	2	0,0	91,5	1,6	413,9	C
181	T9HAB0354	15548472	2	0,0	88,9	1,5	402,0	C
182	T9HAB0352	15548470	2	0,0	85,9	1,5	388,3	C
183	T9HAB0352	15548470	2	0,0	85,9	1,5	388,3	C
184	T9PPL0881	15519024	1	0,0	146,3	1,3	330,8	C
185	T9PPL1109	33108865	1	0,0	142,9	1,2	323,0	C
186	T9PPL1064	15549687	1	0,0	141,6	1,2	320,1	C
187	T9PPL1054	15549676	1	0,0	135,5	1,2	306,3	C
188	T9HAB0232	15518887	1	0,0	105,0	0,9	237,5	C
189	T9PPL1104	15549728	1	0,0	103,5	0,9	234,0	C
190	T9HAB0324	15548521	1	0,0	102,1	0,9	230,7	C
191	T9HAB0323	15548520	1	0,0	99,5	0,9	225,0	C
192	T9HAB0305	15548467	1	0,0	97,0	0,8	219,2	C
193	T9HAB0305	15548467	1	0,0	97,0	0,8	219,2	C
194	T9HAB0359	15548481	1	0,0	95,7	0,8	216,3	C
195	T9HAB0313	15548485	1	0,0	89,0	0,8	201,2	C

196	T9HAB0306	15548474	1	0,0	83,3	0,7	188,3	C

APPENDIX 8: L4L Calculation-1

	T9HAB0273			T9PPL0807		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases
26.08.2013	120	120	56	34	34	145
02.09.2013	56	0	155	145	0	160
09.09.2013	155	0	58	160	0	58
16.09.2013	58	0	89	58	0	34
23.09.2013	89	0	101	34	0	189
30.09.2013	101	0	147	189	0	101
07.10.2013	147	0	129	101	0	89
14.10.2013	129	0	130	89	0	91
21.10.2013	130	0	132	91	0	84
28.10.2013	132	0	159	84	0	81
04.11.2013	159	0	130	81	0	52
11.11.2013	130	0	175	52	0	38
18.11.2013	175	0	166	38	0	65
25.11.2013	166	0	199	65	0	32
02.12.2013	199	0	211	32	0	29
09.12.2013	211	0	189	29	0	25
16.12.2013	189	0	40	25	0	5
06.01.2014	40	0	200	5	0	15
13.01.2014	200	0	211	15	0	16
20.01.2014	211	0	203	16	0	18
27.01.2014	203	0	291	18	0	4

03.02.2014	291	0	321	4	0	6
10.02.2014	321	0	352	6	0	4
17.02.2014	352	0		4	0	
		Total Cost	€ 4.656		Total Cost	€ 4.656

APPENDIX 9: L4L Calculation-2

	T9HAB0247			**T9PPL0809**		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases
26.08.2013	0	0	0	0	0	0
02.09.2013	0	0	1	0	0	0
09.09.2013	1	0	21	0	0	1
16.09.2013	21	0	19	1	0	0
23.09.2013	19	0	25	0	0	12
30.09.2013	25	0	14	12	0	8
07.10.2013	14	0	11	8	0	6
14.10.2013	11	0	15	6	0	10
21.10.2013	15	0	15	10	0	11
28.10.2013	15	0	8	11	0	12
04.11.2013	8	0	9	12	0	15
11.11.2013	9	0	7	15	0	16
18.11.2013	7	0	11	16	0	20
25.11.2013	11	0	15	20	0	32
02.12.2013	15	0	12	32	0	31
09.12.2013	12	0	12	31	0	33
16.12.2013	12	0	2	33	0	6
06.01.2014	2	0	7	6	0	36

13.01.2014	7	0	10	36	0	36
20.01.2014	10	0	6	36	0	36
27.01.2014	6	0	7	36	0	25
03.02.2014	7	0	6	25	0	24
10.02.2014	6	0	7	24	0	24
17.02.2014	7	0		24	0	
		Total Cost	€ 4.656		Total Cost	€ 4.656

APPENDIX 10: L4L Calculation-3

Weeks	Net Requirement	Projected available inventory	Planned order releases
26.08.2013	0	0	5
02.09.2013	5	0	45
09.09.2013	45	0	8
16.09.2013	8	0	3
23.09.2013	3	0	22
30.09.2013	22	0	17
07.10.2013	17	0	14
14.10.2013	14	0	15
21.10.2013	15	0	14
28.10.2013	14	0	11
04.11.2013	11	0	7
11.11.2013	7	0	9
18.11.2013	9	0	8
25.11.2013	8	0	17
02.12.2013	17	0	18

09.12.2013	18	0	17
16.12.2013	17	0	4
06.01.2014	4	0	18
13.01.2014	18	0	17
20.01.2014	17	0	15
27.01.2014	15	0	12
03.02.2014	12	0	10
10.02.2014	10	0	10
17.02.2014	10	0	
		Total Cost	€ 4.656

APPENDIX 11: EOQ-1

	T9HAB0273			**T9PPL0807**		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases
EOQ	266,5			156,9		
26.08.2013	120	120	266	34	34	157
02.09.2013	56	210		145	12	157
09.09.2013	155	55	266	160	9	157
16.09.2013	58	263		58	108	
23.09.2013	89	174		34	74	157
30.09.2013	101	73	266	189	42	157
07.10.2013	147	192		101	98	
14.10.2013	129	63	266	89	9	157
21.10.2013	130	199		91	75	157
28.10.2013	132	67	266	84	148	
04.11.2013	159	174		81	67	

11.11.2013	130	44	266	52	15	157
18.11.2013	175	135	266	38	134	
25.11.2013	166	235		65	69	
02.12.2013	199	36	266	32	37	
09.12.2013	211	91	266	29	8	157
16.12.2013	189	168		25	140	
06.01.2014	40	128	266	5	135	
13.01.2014	200	194	266	15	120	
20.01.2014	211	249		16	104	
27.01.2014	203	46	266	18	86	
03.02.2014	291	21	300	4	82	
10.02.2014	321	0	352	6	76	
17.02.2014	352	0		4	72	
		Total Cost	€ 11.503		Total Cost	€ 6.999

APPENDIX 12: EOQ-2

	T9HAB0247			**T9PPL0809**		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases
EOQ	65,6			84,0		
26.08.2013	0	34	66	0	34	84
02.09.2013	0	66		0	84	
09.09.2013	1	65		0	84	
16.09.2013	21	44		1	83	
23.09.2013	19	25		0	83	
30.09.2013	25	0	66	12	71	
07.10.2013	14	52		8	63	

14.10.2013	11	41		6	57	
21.10.2013	15	26		10	47	
28.10.2013	15	11		11	36	
04.11.2013	8	3	66	12	24	
11.11.2013	9	60		15	9	84
18.11.2013	7	53		16	77	
25.11.2013	11	42		20	57	
02.12.2013	15	27		32	25	84
09.12.2013	12	15		31	78	
16.12.2013	12	3		33	45	
06.01.2014	2	1	66	6	39	
13.01.2014	7	60		36	3	84
20.01.2014	10	50		36	51	
27.01.2014	6	44		36	15	84
03.02.2014	7	37		25	74	
10.02.2014	6	31		24	50	
17.02.2014	7	24		24	26	
		Total Cost	€ 3.212		Total Cost	€ 4.598

APPENDIX 13: EOQ-3

	T9PPL0826		
Weeks	Net Requirement	Projected available inventory	Planned order releases
EOQ	75,2		
26.08.2013	0	34	75
02.09.2013	5	70	
09.09.2013	45	25	

16.09.2013	8	17	
23.09.2013	3	14	75
30.09.2013	22	67	
07.10.2013	17	50	
14.10.2013	14	36	
21.10.2013	15	21	
28.10.2013	14	7	75
04.11.2013	11	71	
11.11.2013	7	64	
18.11.2013	9	55	
25.11.2013	8	47	
02.12.2013	17	30	
09.12.2013	18	12	75
16.12.2013	17	70	
06.01.2014	4	66	
13.01.2014	18	48	
20.01.2014	17	31	
27.01.2014	15	16	
03.02.2014	12	4	75
10.02.2014	10	69	
17.02.2014	10	59	
		Total Cost	€ 3.913

APPENDIX 14: Fixed Period-1

	T9HAB0273			**T9PPL0807**		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases

EOQ	266,5			156,9		
26.08.2013	120	120	149	145	-145	
02.09.2013	56	213		160	-305	
09.09.2013	155	58		58	-363	324
16.09.2013	58	0	337	34	-73	
23.09.2013	89	248		189	-262	
30.09.2013	101	147		101	-363	264
07.10.2013	147	0	391	89	-188	
14.10.2013	129	262		91	-279	
21.10.2013	130	132		84	-363	171
28.10.2013	132	0	464	81	-273	
04.11.2013	159	305		52	-325	
11.11.2013	130	175		38	-363	126
18.11.2013	175	0	576	65	-302	
25.11.2013	166	410		32	-334	
02.12.2013	199	211		29	-363	45
09.12.2013	211	0	429	25	-343	
16.12.2013	189	240		5	-348	
06.01.2014	40	200		15	-363	38
13.01.2014	200	0	705	16	-341	
20.01.2014	211	494		18	-359	
27.01.2014	203	291		4	-363	10
03.02.2014	291	0	673	6	-359	
10.02.2014	321	352		4	-363	
17.02.2014	352	0		4	-367	
		Total Cost	€ 13.006		Total Cost	€ 5.288

APPENDIX 15: Fixed Period-2

	T9HAB0247			T9PPL0809		
Weeks	Net Requirement	Projected available inventory	Planned order releases	Net Requirement	Projected available inventory	Planned order releases
EOQ	65,6			84,0		
26.08.2013	0	0	22	0	0	1
02.09.2013	0	22		0	1	
09.09.2013	1	21		0	1	
16.09.2013	21	0	58	1	0	20
23.09.2013	19	39		0	20	
30.09.2013	25	14		12	8	
07.10.2013	14	0	41	8	0	27
14.10.2013	11	30		6	21	
21.10.2013	15	15		10	11	
28.10.2013	15	0	24	11	0	43
04.11.2013	8	16		12	31	
11.11.2013	9	7		15	16	
18.11.2013	7	0	38	16	0	82
25.11.2013	11	27		20	62	
02.12.2013	15	12		32	30	
09.12.2013	12	0	21	31	-1	76
16.12.2013	12	9		33	42	
06.01.2014	2	7		6	36	
13.01.2014	7	0	23	36	0	97
20.01.2014	10	13		36	61	
27.01.2014	6	7		36	25	
03.02.2014	7	0	13	25	0	48
10.02.2014	6	7		24	24	
17.02.2014	7	0		24	0	

Total Cost	€ 2.345

Total Cost	€ 2.765

APPENDIX 16: Fixed Period-3

	T9PPL0826		
Weeks	Net Requirement	Projected available inventory	Planned order releases
EOQ	75,2		
26.08.2013	0	0	58
02.09.2013	5	53	
09.09.2013	45	8	42
16.09.2013	8	42	
23.09.2013	3	39	
30.09.2013	22	17	
07.10.2013	17	0	43
14.10.2013	14	29	
21.10.2013	15	14	
28.10.2013	14	0	27
04.11.2013	11	16	
11.11.2013	7	9	
18.11.2013	9	0	43
25.11.2013	8	35	
02.12.2013	17	18	
09.12.2013	18	0	39
16.12.2013	17	22	

06.01.2014	4	18	
13.01.2014	18	0	44
20.01.2014	17	27	
27.01.2014	15	12	
03.02.2014	12	0	20
10.02.2014	10	10	
17.02.2014	10	0	
		Total Cost	€ 2.708

APPENDIX 17: Least Unit Cost-1

Period	**moving period**	**Possible order quantity**	**Holding cost**	**Stock cost/unit**	**Order cost/unit**	**Total unit cost**	**holding cost**	**order cost**	**Total Cost**
1	-	-	-	-	-	-			
2	0	56	0	0	4	4			
3	1	211	457	2	1	3	457	202	659
4	2	269	800	3	1	4			
4	0	58	0	0	3	3			
5	1	147	263	2	1	3	263	202	465
6	2	248	859	3	1	4			
6	0	101	0	0	2	2	0	202	202
7	1	248	434	2	1	3			
7	0	147	0	0	1	1	0	202	202
8	1	276	381	1	1	2			
8	0	129	0	0	2	2	0	202	202
9	1	259	384	1	1	2			
9	0	130	0	0	2	2	0	202	202
10	1	262	390	1	1	2			

10	0	132	0	0	2	2	0	202	202
11	1	291	469	2	1	2			
11	0	159	0	0	1	1	0	202	202
12	1	289	384	1	1	2			
12	0	130	0	0	2	2	0	202	202
13	1	305	517	2	1	2			
13	0	175	0	0	1	1	0	202	202
14	1	341	490	1	1	2			
14	0	166	0	0	1	1	0	202	202
15	1	365	587	2	1	2			
15	0	199	0	0	1	1	0	202	202
16	1	410	623	2	0	2			
16	0	211	0	0	1	1	0	202	202
17	1	400	558	1	1	2			
17	0	189	0	0	1	1	0	202	202
18	1	229	118	1	1	1			
18	0	40	0	0	5	5			
19	1	240	590	2	1	3	590	202	792
20	2	451	1836	4	0	5			
20	0	211	0	0	1	1	0	202	202
21	1	414	599	1	0	2			
21	0	203	0	0	1	1	0	202	202
22	1	494	859	2	0	2			
22	0	291	0	0	1	1	0	202	202
23	1	612	947	2	0	2			
23	0	321	0	0	1	1	0	202	202
24	1	673	1039	2	0	2			
24	0	352	0	0	1	1	0	202	202
								Total Cost	€ 5.350,48

APPENDIX 18: Least Unit Cost-2

Period	moving period	Possible order quantitiy	Holding cost	Stock cost/unit	Order cost/unit	Total unit cost	holding cost	order cost	Total Cost
1	-	-	-	-	-	-			
2	0	145	0	0	1	1			
3	1	305	472	2	1	2	472	202	674
4	2	363	643	2	1	2			
4	0	58	0	0	3	3			
5	1	92	100	1	2	3	100	202	302
6	2	281	1116	4	1	5			
6	0	189	0	0	1	1	0	202	202
7	1	290	298	1	1	2			
7	0	101	0	0	2	2	0	202	202
8	1	190	263	1	1	2			
8	0	89	0	0	2	2	0	202	202
9	1	180	269	1	1	3			
9	0	91	0	0	2	2	0	202	202
10	1	175	248	1	1	3			
10	0	84	0	0	2	2	0	202	202
11	1	165	239	1	1	3			
11	0	81	0	0	2	2	0	202	202
12	1	133	153	1	2	3			
12	0	52	0	0	4	4			
13	1	90	112	1	2	3	112	202	314
14	2	155	384	2	1	4			
14	0	65	0	0	3	3			
15	1	97	94	1	2	3			
16	2	126	171	1	2	3			
17	3	151	221	1	1	3			
18	4	156	59	0	1	2	546	202	748

19	5	171	221	1	1	2			
19	0	15	0	0	13	13			
20	1	31	47	2	7	8			
21	2	49	106	2	4	6			
22	3	53	35	1	4	4	189	202	391
23	4	59	71	1	3	5			
23	0	6	0	0	34	34			
24	1	10	12	1	20	21	12	202	214
								Total Cost	€ 3.855,50

APPENDIX 19: Least Unit Cost-3

Period	**moving period**	**Possible order quantitiy**	**Holding cost**	**Stock cost/unit**	**Order cost/unit**	**Total unit cost**	**holding cost**	**order cost**	**Total Cost**
1	-	-	-	-	-	-			
2	0	0	0	0	0	0			
3	1	1	3	3	202	205			
4	2	22	124	6	9	15			
5	3	41	168	4	5	9			
6	4	66	295	4	3	8			
7	5	80	207	3	3	5			
8	6	91	195	2	2	4	992	202	1194
9	7	106	310	3	2	5			
9	0	15	0	0	13	13			
10	1	30	44	1	7	8			
11	2	38	47	1	5	7			
12	3	47	80	2	4	6			
13	4	54	83	2	4	5	254	202	456

14	5	65	162	2	3	6			
14	0	11	0	0	18	18			
15	1	26	44	2	8	9			
16	2	38	71	2	5	7			
17	3	50	106	2	4	6			
18	4	52	24	0	4	4	245	202	447
19	5	59	103	2	3	5			
19	0	7	0	0	29	29			
20	1	17	30	2	12	14			
21	2	23	35	2	9	10			
22	3	30	62	2	7	9			
23	4	36	71	2	6	8			
24	5	43	103	2	5	7	301	202	503
								Total Cost	€ 2.599,58

APPENDIX 20: Least Unit Cost-4

Period	**moving period**	**Possible order quantitiy**	**Holding cost**	**Stock cost/unit**	**Order cost/unit**	**Total unit cost**	**holding cost**	**order cost**	**Total Cost**
1	-	-	-	-	-	-			
2	0	0	0	0	0	0			
3	1	0	0	0	0	0			
4	2	1	6	6	202	208			
5	3	1	0	0	202	202			
6	4	26	295	11	8	19			
7	5	34	118	3	6	9			
8	6	40	106	3	5	8	525	202	727

9	7	50	207	4	4	8			
9	0	10	0	0	20	20			
10	1	21	32	2	10	11			
11	2	33	71	2	6	8			
12	3	48	133	3	4	7			
13	4	64	189	3	3	6			
14	5	84	295	4	2	6	720	202	922
15	6	116	567	5	2	7			
15	0	32	0	0	6	6			
16	1	63	91	1	3	5			
17	2	96	195	2	2	4			
18	3	102	53	1	2	3	339	202	541
19	4	138	425	3	1	5			
19	0	36	0	0	6	6			
20	1	72	106	1	3	4			
21	2	108	213	2	2	4			
22	3	133	221	2	2	3			
23	4	157	283	2	1	3			
24	5	181	354	2	1	3	1178	202	1380
								Total Cost	€ 3.570,64

APPENDIX 21: Least Unit Cost-5

Period	moving period	Possible order quantitiy	Holding cost	Stock cost/unit	Order cost/unit	Total unit cost	Holding cost	Order Cost	Total Cost
1	-	-	-	-	-	-			
2	0	5	0	0	40	40			
3	1	50	133	3	4	7			
4	2	54	24	0	4	4			

5	3	57	27	0	4	4	183	202	385
6	4	79	260	3	3	6			
6	0	22	0	0	9	9			
7	1	39	50	1	5	6			
8	2	53	83	2	4	5			
9	3	68	133	2	3	5			
10	4	82	165	2	2	4			
11	5	93	162	2	2	4			
12	6	100	124	1	2	3	717	202	919
13	7	109	186	2	2	4			
13	0	9	0	0	22	22			
14	1	17	24	1	12	13			
15	2	34	100	3	6	9			
16	3	52	159	3	4	7			
17	4	69	201	3	3	6			
18	5	73	59	1	3	4	543	202	745
19	6	91	319	4	2	6			
19	0	18	0	0	11	11			
20	1	35	50	1	6	7			
21	2	50	89	2	4	6			
22	3	62	106	2	3	5			
23	4	72	118	2	3	4			
24	5	82	148	2	2	4	511	202	713

Total Cost € 2.761,92

APPENDIX 22: Silver Meal-1

Period	Demand	Period to carry	Order Cost	Holding Cost	Lot Cost	Period Cost	Holding Cost	Ordering Cost
1	120	0	€ 202	€ -	€ 202	€ 202		202
2	56	1	€ -	€ 165	€ 165	€ 184	165	
3	155	2	€ -	€ 915	€ 915	€ 427		
3	155	0	€ 202	€ -	€ 202	€ 202		202
4	58	1	€ -	€ 171	€ 171	€ 187	171	
5	89	2	€ -	€ 525	€ 525	€ 300		
5	89	0	€ 202	€ -	€ 202	€ 202		202
6	101	1	€ -	€ 298	€ 298	€ 250		
6	101	0	€ 202	€ -	€ 202	€ 202		202
7	147	1	€ -	€ 434	€ 434	€ 318		
7	147	0	€ 202	€ -	€ 202	€ 202		202
8	129	1	€ -	€ 381	€ 381	€ 291		
8	129	0	€ 202	€ -	€ 202	€ 202		202
9	130	1	€ -	€ 384	€ 384	€ 293		
9	130	0	€ 202	€ -	€ 202	€ 202		202
10	132	1	€ -	€ 390	€ 390	€ 296		
10	132	0	€ 202	€ -	€ 202	€ 202		202
11	159	1	€ -	€ 469	€ 469	€ 336		
11	159	0	€ 202	€ -	€ 202	€ 202		202
12	130	1	€ -	€ 384	€ 384	€ 293		
12	130	0	€ 202	€ -	€ 202	€ 202		202
13	175	1	€ -	€ 517	€ 517	€ 359		
13	175	0	€ 202	€ -	€ 202	€ 202		202
14	166	1	€ -	€ 490	€ 490	€ 346		
14	166	0	€ 202	€ -	€ 202	€ 202		202
15	199	1	€ -	€ 587	€ 587	€ 395		
15	199	0	€ 202	€ -	€ 202	€ 202		202
16	211	1	€ -	€ 623	€ 623	€ 412		
16	211	0	€ 202	€ -	€ 202	€ 202		202
17	189	1	€ -	€ 558	€ 558	€ 380		
17	189	0	€ 202	€ -	€ 202	€ 202		202

18	40	1	€ -	€ 118	€ 118	€ 160	118,06	
19	200	2	€ -	€ 1.181	€ 1.181	€ 500		
19	200	0	€ 202	€ -	€ 202	€ 202		202
20	211	1	€ -	€ 623	€ 623	€ 412		
20	211	0	€ 202	€ -	€ 202	€ 202		202
21	203	1	€ -	€ 599	€ 599	€ 401		
22	291	0	€ 202	€ -	€ 202	€ 202		202
23	321	1	€ -	€ 947	€ 947	€ 575		
23	321	0	€ 202	€ -	€ 202	€ 202		202
24	352	1	€ -	€ 1.039	€ 1.039	€ 620		
24	352	0	€ 202	€ -	€ 202	€ 202		202

€ 454 € 4.040

Total

Cost € 4.494

APPENDIX 23: Silver Meal-2

Period	**Demand**	**Period to carry**	**Order Cost**	**Holding Cost**	**Lot Cost**	**Period Cost**	**Holding Cost**	**Ordering Cost**
1	34	0	€ 202	€ -	€ 202	€ 202	0	202
2	145	1	€ -	€ 428	€ 428	€ 315		
2	145	0	€ 202	-	€ 202	€ 202		202
3	160	1	€ -	€ 472	€ 472	€ 337		
3	160	0	€ 202	-	€ 202	€ 202		202
4	58	1	€ -	€ 171	€ 202	€ 187	171,189	
5	34	2	€ -	€ 201	€ 201	€ 191		

5	34	0	€ 202	-	€ 202	€ 202		202
6	189	1	€ -	€ 558	€ 202	€ 380		
6	189	0	€ 202	-	€ 202	€ 202		202
7	101	1	€ -	€ 298	€ 202	€ 250		
7	101	0	€ 202	-	€ 202	€ 202		202
8	89	1	€ -	€ 263	€ 202	€ 232		
8	89	0	€ 202	-	€ 202	€ 202		202
9	91	1	€ -	€ 269	€ 202	€ 235		
9	91	0	€ 202	-	€ 202	€ 202		202
10	84	1	€ -	€ 248	€ 202	€ 225		
10	84	0	€ 202	-	€ 202	€ 202		202
11	81	1	€ -	€ 239	€ 202	€ 220		
11	81	0	€ 202	-	€ 202	€ 202		202
12	52	1	€ -	€ 153	€ 202	€ 178	153,48	
13	38	2	€ -	€ 201	€ 201	€ 193		
13	38	0	€ 202	-	€ 202	€ 202		202
14	65	1	€ -	€ 192	€ 202	€ 197		
15	32	2	€ -	€ 189	€ 189	€ 194	380,748	
16	29	3	€ -	€ 257	€ 257	€ 210		
16	29	0	€ 202	-	€ 202	€ 202		202
17	25	1	€ -	€ 74	€ 202	€ 138		
18	5	2	€ -	€ 15	€ 15	€ 102	103,304	
19	15	3	€ -	€ 44	€ 44	€ 110		
19	15	0	€ 202	-	€ 202	€ 202		202
20	16	1	€ -	€ 47	€ 202	€ 125		
21	18	2	€ -	€ 106	€ 106	€ 118		
22	4	3	€ -	€ 35	€ 35	€ 98		
23	6	4	€ -	€ 71	€ 71	€ 92		
24	4	5	€ -	€ 59	€ 59	€ 87	318,766	

€ 1.127 € 2.626

Total Cost € 3.753

APPENDIX 24: Silver Meal-3

Period	Demand	Period to carry	Order Cost	Holding Cost	Lot Cost	Period Cost	Holding Cost	Ordering Cost
1	0	0	€ 202	€ -	€ 202	€ 202		202
2	0	1	€ -	€ -	€ -	€ 202		
3	1	2	€ -	€ 6	€ 6	€ 102	5,9031	
4	21	3	€ -	€ 63	€ 63	€ 131		
4	21	0	€ 202	€ -	€ 202	€ 202		202
5	19	1	€ -	€ 56	€ 56	€ 111	56,079	
6	25	2	€ -	€ 148	€ 148	€ 135		
6	25	0	€ 202	€ -	€ 202	€ 202		202
7	14	1	€ -	€ 41	€ 41	€ 122		
8	11	2	€ -	€ 65	€ 65	€ 103	106	
9	15	3	€ -	€ 133	€ 133	€ 110		
9	15	0	€ 202	€ -	€ 202	€ 202		202
10	15	1	€ -	€ 44	€ 44	€ 123		
11	8	2	€ -	€ 47	€ 47	€ 98	91	
12	9	3	€ -	€ 80	€ 80	€ 110		
12	9	0	€ 202	€ -	€ 202	€ 202		202
13	7	1	€ -	€ 21	€ 21	€ 111		
14	11	2	€ -	€ 65	€ 65	€ 96	86	
15	15	3	€ -	€ 133	€ 133	€ 133		
16	12	0	€ 202	€ -	€ 202	€ 202		202

17	12	1	€ -	€ 35	€ 35	€ 119		
18	2	2	€ -	€ 12	€ 12	€ 83	47	
19	7	3	€ -	€ 62	€ 62	€ 92		
19	7	0	€ 202	€ -	€ 202	€ 202		202
20	10	1	€ -	€ 30	€ 30	€ 116		
21	6	2	€ -	€ 35	€ 35	€ 89	65	
22	7	3	€ -	€ 62	€ 62	€ 100		
22	7	0	€ 202	€ -	€ 202	€ 202		202
23	6	1	€ -	€ 18	€ 18	€ 110		
24	7	2	€ -	€ 41	€ 41	€ 87	59	

515,98 1616

Total

Cost € 2.132

APPENDIX 25: Silver Meal-4

Period	Demand	Period to carry	Order Cost	Holding Cost	Lot Cost	Period Cost	Holding Cost	Ordering Cost
1	0	0	€ 202	€ -	€ 202	€ 202		202
2	0	1	€ -	€ -	€ -	€ 105		
3	0	2	€ -	€ -	€ -	€ 67		
4	1	3	€ -	€ 9	€ 9	€ 53		
5	0	4	€ -	€ -	€ -	€ 42	9	
6	12	5	€ -	€ 177	€ 177	€ 65		
6	12	0	€ 202	€ -	€ 202	€ 202		202
7	8	1	€ -	€ 24	€ 24	€ 113		

8	6	2	€ -	€ 35	€ 35	€ 87,0	59	
9	10	3	€ -	€ 89	€ 89	€ 87,4		
9	10	0	€ 202	€ -	€ 202	€ 202		202
10	11	1	€ -	€ 32	€ 32	€ 117		
11	12	2	€ -	€ 71	€ 71	€ 102	103	
12	15	3	€ -	€ 133	€ 133	€ 109,5		
12	15	0	€ 202	€ -	€ 202	€ 202		202
13	16	1	€ -	€ 47	€ 47	€ 125		
14	20	2	€ -	€ 118	€ 118	€ 122	165	
15	32	3	€ -	€ 283	€ 283	€ 162,7		
16	31	0	€ 202	€ -	€ 202	€ 202		202
17	33	1	€ -	€ 97	€ 97	€ 150		
18	6	2	€ -	€ 35	€ 35	€ 112	133	
19	36	3	€ -	€ 319	€ 319	€ 163,4		
19	36	0	€ 202	€ -	€ 202	€ 202		202
20	36	1	€ -	€ 106	€ 106	€ 154	106	
21	36	2	€ -	€ 213	€ 213	€ 174		
21	36	0	€ 202	€ -	€ 202	€ 202		202
22	25	1	€ -	€ 74	€ 74	€ 138	74	
23	24	2	€ -	€ 142	€ 142	€ 139		
23	24	0	€ 202	€ -	€ 202	€ 202		202
24	24	1	€ -	€ 71	€ 71	€ 136	71	

	720	1616
Total Cost		€ 2.336

APPENDIX 26: Silver Meal-5

Period	Demand	Period to carry	Order Cost	Holding Cost	Lot Cost	Period Cost	Holding Cost	Ordering Cost

1	0	0	€ 202	€ -	€ 202	€ 202		202
2	5	1	€ -	€ 15	€ 15	€ 108	15	
3	45	2	€ -	€ 266	€ 266	€ 161		
3	45	0	€ 202	€ -	€ 202	€ 202		202
4	8	1	€ -	€ 24	€ 24	€ 113		
5	3	2	€ -	€ 18	€ 18	€ 81	41	
6	22	3	€ -	€ 13.332	€ 13.332	€ 110		
6	22	0	€ 202	€ -	€ 202	€ 202		202
7	17	1	€ -	€ 50	€ 50	€ 126		
8	14	2	€ -	€ 83	€ 83	€ 112	133	
9	15	3	€ -	€ 9.090	€ 9.090	€ 117		
9	15	0	€ 202	€ -	€ 202	€ 202		202
10	14	1	€ -	€ 41	€ 41	€ 122		
11	11	2	€ -	€ 65	€ 65	€ 103		
12	7	3	€ -	€ 62	€ 62	€ 93	168	
13	9	4	€ -	€ 106	€ 106	€ 95		
13	9	0	€ 202	€ -	€ 202	€ 202		202
14	8	1	€ -	€ 24	€ 24	€ 113		
15	17	2	€ -	€ 100	€ 100	€ 109	124	
16	18	3	€ -	€ 10.908	€ 10.908	€ 121		
17	17	0	€ 202	€ -	€ 202	€ 202		202
18	4	1	€ -	€ 12	€ 12	€ 106,9		
19	18	2	€ -	€ 106	€ 106	€ 106,7	118	
20	17	3	€ -	€ 10.302	€ 10.302	€ 118		
20	17	0	€ 202	€ -	€ 202	€ 202		202
21	15	1	€ -	€ 44	€ 44	€ 123,1		
22	12	2	€ -	€ 71	€ 71	€ 105,7		
23	10	3	€ -	€ 89	€ 89	€ 101	204	
24	10	4	€ -	€ 118	€ 118	€ 105		
24	10	0	€ 202	€ -	€ 202	€ 202		202

803 1616

€

Total Cost 2.419

APPENDIX 27: Min Calculation

No	CPN	DPN	Total	ADC	unit price	Current Min (DOH)	Min proposal (DOH)	Current Min (€)	Min proposal to be used (€)
1	T9HAB0271	15543439	11143	96,9	171	5	4	€ 82.914	€ 66.331
2	T9PPL0950	15543446	7292	63,4	135	5	4	€ 42.677	€ 34.142
3	T9HAB0265	15543433	4743	41,2	184	5	4	€ 38.035	€ 30.428
4	T9PPL0954	15543450	9432	82,0	86	5	4	€ 35.448	€ 28.358
5	T9HAB0273	15543441	3964	34,5	171	5	4	€ 29.444	€ 23.555
6	T9HAB0242	15540668	3459	30,1	182	5	4	€ 27.401	€ 21.921
7	T9PPL0949	15543445	4699	40,9	133	5	4	€ 27.266	€ 21.813
8	T9HAB0262	15543430	3435	29,9	174	5	4	€ 26.034	€ 20.827
9	T9PPL0957	15543453	4697	40,8	127	5	4	€ 25.903	€ 20.722
10	T9HAB0243	15540669	3124	27,2	189	5	4	€ 25.716	€ 20.573
11	T9HAB0264	15543432	3063	26,6	184	5	4	€ 24.508	€ 19.606
12	T9HAB0238	15531665	4494	39,1	87	5	4	€ 16.952	€ 13.562
13	T9PPL0952	15543448	4251	37,0	91	5	4	€ 16.773	€ 13.418
14	T9PPL0951	15543447	2831	24,6	135	5	4	€	€

								16.618	13.294
15	T9PPL0953	15543449	2573	22,4	131	5	4	€ 14.676	€ 11.741
16	T9PPL0803	15518946	2353	20,5	135	5	4	€ 13.834	€ 11.067
17	T9HAB0202	15518857	2854	24,8	97	5	4	€ 11.984	€ 9.587
18	T9HAB0263	15543431	1408	12,2	182	5	4	€ 11.167	€ 8.934
19	T9PPL0956	15543452	2984	25,9	82	5	4	€ 10.658	€ 8.526
20	T9HAB0270	15543438	1442	12,5	168	5	4	€ 10.529	€ 8.423
21	T9PPL0959	15543455	2613	22,7	81	5	4	€ 9.165	€ 7.332
22	T9PPL0961	33112341	2271	19,7	89	5	4	€ 8.791	€ 7.033
23	T9HAB0266	15543434	1100	9,6	178	5	7	€ 8.517	€ 11.924
24	T9HAB0283	33112354	2138	18,6	90	5	4	€ 8.396	€ 6.717
25	T9PPL0807	15518950	1375	12,0	140	5	4	€ 8.358	€ 6.686
26	T9HAB0272	15543440	1046	9,1	173	5	7	€ 7.851	€ 10.991
27	T9HAB0218	15518873	1913	16,6	86	5	4	€ 7.158	€ 5.726
28	T9PPL0832	15518975	1721	15,0	91	5	4	€ 6.838	€ 5.471
29	T9PPL0814	15518957	1194	10,4	130	5	4	€ 6.723	€ 5.378
30	T9HAB0274	33112345	1675	14,6	87	5	4	€ 6.350	€ 5.080

31	T9PPL0830	15518973	1078	9,4	130	5	7	€ 6.095	€ 8.534
32	T9PPL0819	15518962	943	8,2	137	5	7	€ 5.636	€ 7.891
33	T9PPL0802	15518945	967	8,4	132	5	7	€ 5.542	€ 7.759
34	T9HAB0254	15540680	672	5,8	186	5	7	€ 5.420	€ 7.589
35	T9PPL0958	15543454	971	8,4	127	5	7	€ 5.372	€ 7.521
36	T9HAB0269	15543437	553	4,8	197	5	7	€ 4.745	€ 6.644
37	T9PPL0823	15518966	1052	9,1	100	5	7	€ 4.596	€ 6.435
38	T9HAB0278	33112349	1292	11,2	76	5	4	€ 4.255	€ 3.404
39	T9PPL0962	33112342	1136	9,9	81	5	7	€ 4.018	€ 5.625
40	T9PPL0811	15518954	668	5,8	104	5	7	€ 3.015	€ 4.221
41	T9HAB0201	15518856	721	6,3	89	5	7	€ 2.804	€ 3.926
42	T9HAB0246	15540672	339	2,9	190	5	7	€ 2.803	€ 3.924
43	T9PPL0821	15518964	621	5,4	96	5	7	€ 2.588	€ 3.623
44	T9HAB0267	15543435	299	2,6	186	5	7	€ 2.414	€ 3.380
45	T9HAB0247	15540673	240	2,1	197	5	7	€ 2.059	€ 2.882
46	T9PPL0960	33112340	329	2,9	135	5	7	€ 1.938	€ 2.713
47	T9PPL0963	33112343	500	4,3	88	5	7	€	€

								1.917	2.684
48	T9HAB0279	33112350	536	4,7	81	5	7	€ 1.884	€ 2.638
49	T9HAB0230	15518885	417	3,6	100	5	7	€ 1.819	€ 2.547
50	T9PPL0809	15518952	394	3,4	99	5	7	€ 1.699	€ 2.378
51	T9HAB0281	33112352	450	3,9	84	5	7	€ 1.634	€ 2.287
52	T9HAB0255	15540681	193	1,7	193	5	7	€ 1.620	€ 2.268
53	T9HAB0216	15518871	421	3,7	86	5	7	€ 1.572	€ 2.201
54	T9HAB0282	33112353	421	3,7	80	5	7	€ 1.464	€ 2.050
55	T9PPL1005	15549624	222	1,9	139	5	7	€ 1.339	€ 1.875
56	T9PPL1005	15549624	222	1,9	139	5	7	€ 1.339	€ 1.875
57	T9HAB0280	33112351	366	3,2	83	5	7	€ 1.325	€ 1.854
58	T9PPL0826	15518969	316	2,7	92	5	7	€ 1.262	€ 1.767
59	T9PPL0828	15518971	196	1,7	130	5	7	€ 1.110	€ 1.555
60	T9HAB0239	15531666	276	2,4	91	5	7	€ 1.086	€ 1.520
61	T9HAB0276	33112347	260	2,3	96	5	7	€ 1.084	€ 1.517
62	T9PPL1091	15549715	211	1,8	112	5	7	€ 1.032	€ 1.444
63	T9PPL1091	15549715	211	1,8	112	5	7	€ 1.032	€ 1.444

64	T9HAB0275	33112346	265	2,3	89	5	7	€ 1.025	€ 1.435
65	T9HAB0206	15518861	213	1,9	97	5	7	€ 902	€ 1.263
66	T9HAB0350	15548468	254	2,2	81	5	7	€ 892	€ 1.249
67	T9HAB0350	15548468	254	2,2	81	5	7	€ 892	€ 1.249
68	T9PPL1082	15549706	132	1,1	140	5	7	€ 802	€ 1.122
69	T9PPL1082	15549706	132	1,1	140	5	7	€ 802	€ 1.122
70	T9PPL0815	15518958	118	1,0	133	5	7	€ 682	€ 954
71	T9HAB0451	15548505	187	1,6	80	5	7	€ 650	€ 910
72	T9HAB0451	15548505	187	1,6	80	5	7	€ 650	€ 910
73	T9PPL1099	15549723	90	0,8	150	5	7	€ 586	€ 821
74	T9PPL1099	15549723	90	0,8	150	5	7	€ 586	€ 821
75	T9HAB0277	33112348	172	1,5	78	5	7	€ 585	€ 819
76	T9PPL1067	15549690	79	0,7	150	5	7	€ 514	€ 719
77	T9PPL1067	15549690	79	0,7	150	5	7	€ 514	€ 719
78	T9HAB0219	15518874	126	1,1	90	5	7	€ 491	€ 687
79	T9PPL1007	15549626	109	0,9	103	5	7	€ 486	€ 680
80	T9PPL1007	15549626	109	0,9	103	5	7	€	€

								486	680
81	T9HAB0229	15518884	113	1,0	93	5	7	€ 456	€ 638
82	T9HAB0362	15548492	95	0,8	91	5	7	€ 375	€ 525
83	T9HAB0362	15548492	95	0,8	91	5	7	€ 375	€ 525
84	T9PPL1100	15549724	82	0,7	104	5	7	€ 371	€ 520
85	T9PPL1100	15549724	82	0,7	104	5	7	€ 371	€ 520
86	T9PPL1071	15549694	57	0,5	147	5	7	€ 365	€ 511
87	T9PPL1071	15549694	57	0,5	147	5	7	€ 365	€ 511
88	T9PPL0831	15518974	65	0,6	127	5	7	€ 358	€ 501
89	T9HAB0452	15548506	90	0,8	79	5	7	€ 309	€ 433
90	T9HAB0367	15548497	60	0,5	99	5	7	€ 258	€ 361
91	T9HAB0367	15548497	60	0,5	99	5	7	€ 258	€ 361
92	T9HAB0401	15548499	65	0,6	80	5	7	€ 225	€ 315
93	T9HAB0401	15548499	65	0,6	80	5	7	€ 225	€ 315
94	T9HAB0228	15518883	57	0,5	90	5	7	€ 224	€ 314
95	T9HAB0221	15518876	56	0,5	90	5	7	€ 218	€ 306
96	T9HAB0450	15548504	63	0,5	75	5	7	€ 206	€ 289

97	T9HAB0450	15548504	63	0,5	75	5	7	€ 206	€ 289
98	T9HAB0368	15548515	56	0,5	82	5	7	€ 200	€ 279
99	T9HAB0368	15548515	56	0,5	82	5	7	€ 200	€ 279
100	T9PPL1069	15549692	31	0,3	144	5	7	€ 194	€ 271
101	T9HAB0207	15518862	32	0,3	105	5	7	€ 145	€ 204
102	T9PPL1096	15549720	23	0,2	142	5	7	€ 142	€ 199
103	T9PPL0955	15543451	30	0,3	94	5	7	€ 123	€ 172
104	T9HAB0314	15548486	28	0,2	97	5	7	€ 118	€ 165
105	T9HAB0314	15548486	28	0,2	97	5	7	€ 118	€ 165
106	T9PPL1098	15549722	18	0,2	145	5	7	€ 114	€ 159
107	T9PPL1015	15549634	25	0,2	99	5	7	€ 108	€ 151
108	T9PPL1015	15549634	25	0,2	99	5	7	€ 108	€ 151
109	T9HAB0317	15548489	24	0,2	99	5	7	€ 104	€ 145
110	T9HAB0317	15548489	24	0,2	99	5	7	€ 104	€ 145
111	T9HAB0200	15518855	26	0,2	87	5	7	€ 98	€ 137
112	T9HAB0356	15548478	27	0,2	83	5	7	€ 97	€ 136
113	T9HAB0351	15548469	22	0,2	88	5	7	€	€

								84	118
114	T9HAB0351	15548469	22	0,2	88	5	7	€ 84	€ 118
115	T9HAB0300	15548462	23	0,2	81	5	7	€ 81	€ 114
116	T9HAB0300	15548462	23	0,2	81	5	7	€ 81	€ 114
117	T9PPL1070	15549693	13	0,1	143	5	7	€ 81	€ 113
118	T9PPL1080	15549704	13	0,1	136	5	7	€ 77	€ 108
119	T9HAB0303	15548465	17	0,1	94	5	7	€ 69	€ 97
120	T9HAB0303	15548465	17	0,1	94	5	7	€ 69	€ 97
121	T9HAB0311	15548483	19	0,2	84	5	7	€ 69	€ 97
122	T9HAB0311	15548483	19	0,2	84	5	7	€ 69	€ 97
123	T9HAB0364	15548494	16	0,1	96	5	7	€ 67	€ 94
124	T9HAB0364	15548494	16	0,1	96	5	7	€ 67	€ 94
125	T9PPL1063	15549686	11	0,1	138	5	7	€ 66	€ 93
126	T9HAB0301	15548463	17	0,1	89	5	7	€ 65	€ 92
127	T9HAB0301	15548463	17	0,1	89	5	7	€ 65	€ 92
128	T9HAB0402	15548500	18	0,2	79	5	7	€ 62	€ 86
129	T9HAB0402	15548500	18	0,2	79	5	7	€ 62	€ 86

130	T9PPL1001	15549620	10	0,1	131	5	7	€ 57	€ 80
131	T9PPL1001	15549620	10	0,1	131	5	7	€ 57	€ 80
132	T9PPL1065	15549688	8	0,1	146	5	7	€ 51	€ 71
133	T9PPL1065	15549688	8	0,1	146	5	7	€ 51	€ 71
134	T9HAB0400	15548498	14	0,1	75	5	7	€ 46	€ 64
135	T9HAB0400	15548498	14	0,1	75	5	7	€ 46	€ 64
136	T9PPL1009	15549628	8	0,1	128	5	7	€ 44	€ 62
137	T9PPL1068	15549691	6	0,1	139	5	7	€ 36	€ 51
138	T9PPL1002	15549621	6	0,1	134	5	7	€ 35	€ 49
139	T9PPL1002	15549621	6	0,1	134	5	7	€ 35	€ 49
140	T9HAB0353	15548471	8	0,1	94	5	7	€ 33	€ 46
141	T9HAB0353	15548471	8	0,1	94	5	7	€ 33	€ 46
142	T9PPL1088	15549712	5	0,0	139	5	7	€ 30	€ 42
143	T9PPL1088	15549712	5	0,0	139	5	7	€ 30	€ 42
144	T9HAB0312	15548484	7	0,1	91	5	7	€ 28	€ 39
145	T9HAB0312	15548484	7	0,1	91	5	7	€ 28	€ 39
146	T9HAB0307	15548475	7	0,1	91	5	7	€	€

								28	39
147	T9PPL1066	15549689	4	0,0	145	5	7	€ 25	€ 35
148	T9HAB0360	15548490	7	0,1	80	5	7	€ 24	€ 34
149	T9HAB0360	15548490	7	0,1	80	5	7	€ 24	€ 34
150	T9HAB0453	15548507	7	0,1	78	5	7	€ 24	€ 33
151	T9HAB0363	15548493	6	0,1	89	5	7	€ 23	€ 32
152	T9HAB0302	15548464	6	0,1	86	5	7	€ 23	€ 32
153	T9HAB0302	15548464	6	0,1	86	5	7	€ 23	€ 32
154	T9HAB0361	15548491	6	0,1	83	5	7	€ 22	€ 30
155	T9HAB0310	15548482	6	0,1	80	5	7	€ 21	€ 29
156	T9HAB0310	15548482	6	0,1	80	5	7	€ 21	€ 29
157	T9HAB0357	15548479	5	0,0	90	5	7	€ 20	€ 27
158	T9HAB0357	15548479	5	0,0	90	5	7	€ 20	€ 27
159	T9HAB0318	15548510	5	0,0	83	5	7	€ 18	€ 25
160	T9PPL1013	15549632	3	0,0	136	5	7	€ 18	€ 25
161	T9HAB0355	15548473	4	0,0	96	5	7	€ 17	€ 23
162	T9PPL1014	15549633	4	0,0	95	5	7	€ 16	€ 23

163	T9HAB0370	15548517	4	0,0	93	5	7	€ 16	€ 23
164	T9HAB0319	15548511	4	0,0	86	5	7	€ 15	€ 21
165	T9PPL1101	15549725	3	0,0	109	5	7	€ 14	€ 20
166	T9HAB0322	15548514	3	0,0	99	5	7	€ 13	€ 18
167	T9PPL1006	15549625	3	0,0	98	5	7	€ 13	€ 18
168	T9PPL1083	15549707	2	0,0	144	5	7	€ 13	€ 18
169	T9PPL1083	15549707	2	0,0	144	5	7	€ 13	€ 18
170	T9PPL1089	15549713	2	0,0	144	5	7	€ 13	€ 18
171	T9PPL1089	15549713	2	0,0	144	5	7	€ 13	€ 18
172	T9PPL0880	15519023	2	0,0	142	5	7	€ 12	€ 17
173	T9PPL1017	15549636	3	0,0	91	5	7	€ 12	€ 17
174	T9PPL1023	15549642	3	0,0	90	5	7	€ 12	€ 16
175	T9PPL0909	15519062	2	0,0	133	5	7	€ 12	€ 16
176	T9PPL1021	15549640	2	0,0	129	5	7	€ 11	€ 16
177	T9PPL1022	15549641	2	0,0	125	5	7	€ 11	€ 15
178	T9PPL1022	15549641	2	0,0	125	5	7	€ 11	€ 15
179	T9HAB0320	15548512	2	0,0	93	5	7	€	€

								8	11
180	T9HAB0366	15548496	2	0,0	92	5	7	€ 8	€ 11
181	T9HAB0354	15548472	2	0,0	89	5	7	€ 8	€ 11
182	T9HAB0352	15548470	2	0,0	86	5	7	€ 7	€ 10
183	T9HAB0352	15548470	2	0,0	86	5	7	€ 7	€ 10
184	T9PPL0881	15519024	1	0,0	146	5	7	€ 6	€ 9
185	T9PPL1109	33108865	1	0,0	143	5	7	€ 6	€ 9
186	T9PPL1064	15549687	1	0,0	142	5	7	€ 6	€ 9
187	T9PPL1054	15549676	1	0,0	135	5	7	€ 6	€ 8
188	T9HAB0232	15518887	1	0,0	105	5	7	€ 5	€ 6
189	T9PPL1104	15549728	1	0,0	103	5	7	€ 4	€ 6
190	T9HAB0324	15548521	1	0,0	102	5	7	€ 4	€ 6
191	T9HAB0323	15548520	1	0,0	100	5	7	€ 4	€ 6
192	T9HAB0305	15548467	1	0,0	97	5	7	€ 4	€ 6
193	T9HAB0305	15548467	1	0,0	97	5	7	€ 4	€ 6
194	T9HAB0359	15548481	1	0,0	96	5	7	€ 4	€ 6
195	T9HAB0313	15548485	1	0,0	89	5	7	€ 4	€ 5

196	T9HAB0306	15548474	1	0,0	83	5	7	€ 4	€ 5
								€ 695.410	€ 628.831