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LOT SIZING METHOD

– Calculating the ordering costs for Wärtsilä Global Logistics Services

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BACHELOR'S THESIS | ABSTRACT

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LOT SIZING METHOD

- Calculating the ordering costs for Wärtsilä Global Logistics Services

The aim of this thesis is to calculate ordering costs for Wärtsilä global logistics services as well as to review the lot sizing methods used. The results of the thesis will be used to optimize the lot sizing by calculating new ordering costs and by reviewing the methods used when determining the lot sizes. Thesis can also be used as a guide to lot sizing.

Thesis consists three parts. First theorical review of lot sizing and parameters used in lot sizing calculation, ordering costs, and holding costs. Second part will focus on working ways in WGLS, the lot sizing methods used, ordering process, and ordering cost, and holding costs. In the third part of the thesis we will compare theory of lot sizing to lot sizing used in WGLS and calculate the ordering costs for WGLS.

The results of the thesis were that WGLS has a good mix of lot sizing methods, but these methods are not fully utilized since they are mostly using only one lot sizing method. Ordering costs were calculated and new value was determined.

KEYWORDS:

Spare parts management, Lot sizing, Ordering cost

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Verner Riissanen

LOT SIZING METHOD

- Calculating the ordering costs for Wärtsilä Global Logistics Services

Opinnäytetyön tavoite on laskea ostoerään perustuvat tilauskustannukset Wärtsilä global logistics services:lle ja tutkia ja vertailla eräkoon laskentaan käytettäviä menetelmiä. Opinnäytetyön tuloksia voidaan käyttää eräkokojen optimointiin. Opinnäytetyötä voidaan myös käyttää yleisenä oppaana eräkoon laskentaan.

Opinnäytetyö koostuu kolmesta osasta. Ensimmäisessä osassa käsitellään eräkoon ja siihen liittyvien parametrien teoriaa. Toisessa osassa tutkitaan eräkoon laskentaa käytettäviä metodeja WGLS:ssä ja tilauskustannuksia ja varastointikustannuksia. Kolmannessa osassa verrataan teoriaa WGLS:än työskentelytapaan ja lasketaan tilauskustannukset.

Opinnäytetyön tuloksena huomattiin, että WGLS:än käyttämät eräkoon laskentamenetelmät ovat hyvät, mutta niitä voisi hyödyntää paremmin. Tilauskustannukset laskettiin ja uusi tilauskustannus saatiin määritettyä.

ASIASANAT:

Vara-osien hallinta, eräkoko, tilauskustannukset

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LIST OF ABBREVIATIONS (OR) SYMBOLS

EOQ	Economic order quantity. Lot sizing method that determines the best lot size that minimizes ordering costs and the holding costs. (Malakooti 2014, 273–4)
EPP	Economic part-period. Calculated to find the quantity of an item, if carried in inventory for one period, which would result that carrying costs are equal to ordering costs. (Hong-Mo Yeh 2003, 7-19)
OEM	Original equipment manufacturer. Company that makes parts for other companies that are selling them under their own name. (Swamidass 2000b)
POQ	Period order quantity. Lot sizing method that uses the same theory as the EOQ method. POQ uses the EOQ method to calculate an economic time between orders. (Chapman etc. 2017, 266)
WGLS	Wärtsilä global logistics services. Is managing the entire logistic chain, from order intake to customer delivery, of Wärtsilä OEM parts. (Wärtsilä internal, 1.11.2020)

1. INTRODUCTION

For service or manufacturing organisation it is critical to maintain the production capability of production and operations. Therefore, maintaining of plant, building, machinery, material handling equipment and other fixed assets is important. Maintaining these assets makes it crucial to keep inventory of spare parts, so that needed maintenance and repairs can be done as soon as possible, without the need to wait for procuring the spare parts and operating supplies. (Bhat 2008, 181)

The globalisation and emergence of the extended enterprise of independent organisations has kick started a steady increase in the outsourcing of parts and services. Because of this firms are giving more importance to the purchasing functions and decisions associated with it. (Aissaoui, Haouari & Hassini 2007, 3516)

Intense competitive environment, defined by small profit margins, high consumer expectations for quality and short lead times, forces companies to take advantage of any opportunity to optimize their business processes. To remain competitive, companies must work with their supply chain partners to improve the chains total performance. Purchasing is taking increasing importance being one of the main process in the chain and having effect to all areas of an organisation. (Aissaoui et. 2007, 3516)

Objectives of inventory management are to provide the required level of customer service and to reduce the sum of all cost involved (Chapman etc. 2017, 257). At the item level there must be rules defined about inventory items so that inventory control will be effective. These rules include how much should be ordered at one time, when to order, which individual inventory items are most important (which are kept in stock) and how individual items are to be controlled. (Chapman etc. 2017, 233). This thesis will focus on the two first, how much should be ordered and when, these are main questions of lot sizing. Lot sizing has affects to ordering, setup and carrying costs. Thus, an important area of inventory management. Lot sizing has also an affect in overall levels of inventory (Viale and Carrigan 1996, 40).

This thesis will introduce most commonly used lot sizing methods and compare the lot sizing methods used in Wärtsilä global logistics services to theory. Also reviewing the lot sizing parameters (ordering costs) used in WGLS. This thesis however will not review holding costs for WGLS since the information needed to review is not currently available. Ordering costs often generate from the performance of the purchasing transaction. (Leppänen 2018, 36)

Ordering costs are one factor when determining the order quantities. Aim of this thesis is to calculate and optimize the ordering costs according to current situation in WGLS and compare new results to the figures that are currently used. This thesis will benefit WGLS to optimize their lot sizes by calculating more accurate figures with the formulas used when calculating lot sizes, and this way save in costs.

In the first chapters this thesis will focus on the theory of spare parts management, lot sizing and inventory cost related to economic order quantity formula. After the theorical review thesis will focus on WGLS ways of working regarding purchasing process and lot sizing. In the final chapter's thesis will concentrate calculating the ordering cost for WGLS.

The research chapters of this thesis (6-9) are no published because of the request of the commissioner.

2. THE COMMISSIONER OF THE THESIS (WÄRTSILÄ)

Wärtsilä is providing complete lifecycle solutions and smart technologies for the marine and energy markets. Wärtsilä maximizes its customers vessels and power plants environmental and economic performance by highlighting sustainable innovation, total efficiency, and data analytics. Wärtsilä has operations in over 80 countries and more than 200 locations around the world. Wärtsilä employs approximately 19,000 employees and net sales totaled 5,2 billion euros in 2019. The company is listed on Nasdaq Helsinki. (Wärtsilä, 2020a)

The company consists of two businesses: marine and energy business. In January 2019 Wärtsilä services business was incorporated to marine and energy businesses. Wärtsilä marine employees approximately 13 500 people and Wärtsilä energy approximately 5 500 people. Of Wärtsilä employees 20% are located in Finland and 42% elsewhere in Europe. In Asia Wärtsilä employees 23% of its total personnel and in Americas 11%. (Wärtsilä, 2020a)

2.1 Wärtsilä marine business

Wärtsilä is an industry leader in marine technology. Wärtsilä has an extensive portfolio of products and solutions which delivers efficiency, flexibility, reliability, and environmental sustainability to enhance the business of Wärtsilä's customers. Wärtsilä brings value and optimisation to all marine applications by using high levels of connectivity and digitalisation. By doing so Wärtsilä is leading the industry towards smart marine ecosystem. (Wärtsilä, 2020c)

Wärtsilä offering covers:

- Engines, propulsion, exhaust gas cleaning systems, electrical solutions, seals, and bearings
- Water and waste treatment
- Gas solutions
- Automation, navigation, and communication systems
- Fleet operations solutions and ship traffic control
- Simulators and training

- Lifecycle solutions
  (Wärtsilä, 2020a)

Wärtsilä marine businesses customer segments are cruise ships, ferries, fishing vessels, merchant, navy, offshore, ship design, special vessels, and yachts. (Wärtsilä, 2020c)

2.2 Wärtsilä energy business

Wärtsilä energy solutions are used for a wide selection of functions. For example, baseload generation, capacity for grid stability, peaking and load-following generation, and optimisation of high renewable content power systems. Wärtsilä provides comprehensive understanding of energy systems to their customers. These include fully integrated assets and advanced software, complete with lifecycle services. (Wärtsilä, 2020a)

Wärtsilä offers to its customers advanced gas and dual-fuel engine technology, optimised modular power plants, first-rate project management capabilities, and the global service support throughout the lifecycle of installations. This has led to a leading position in the gas and liquid fuel combustion engine power plant markets. (Wärtsilä, 2020a)

Wärtsilä energy solutions offering contains flexible power plant, energy management systems and storage, as well as lifecycle services that provide increased efficiency and guaranteed performance. Wärtsilä has delivered power plants in 180 countries around the world with 72 GW of total power plant capacity. (Wärtsilä, 2020b)

3. SPARE PARTS MANAGEMENT

Spare parts management is different from managing the inventory of raw material, component parts and subassemblies because these all are dependent demand items and can be managed based on consumption which can be forecasted easier. Spare parts cannot be managed in the same way since the breakdown of plant and equipment cannot be anticipated with certainty. Spare parts management can only be based on probability of breakdown. (Bhat 2008, 182.) Since the demand for spare parts can be very sporadic it is difficult to forecast. The planning of the logistics of spare parts has higher service requirements since the effects of the stockouts may be financially remarkable for customer and the prices of individual parts may be very high. Also, material and time buffers are decreasing in production systems and supply chains. These aspects are setting stress for streamlining the logistics systems of spare parts. (Huiskonen 2001, 125)

There are many different factors which make systematic spare part management necessary. Different factors are unpredictable failures of machines and equipment's, long lead times for acquisition of spare parts from vendors, non-availability of special materials which makes manufacturing difficult, high trend of obsolescence of machines and equipment, not economical to manufacture if requirements are small, in some cases stock-out cost of spare part are higher than total cost of carrying a spare part or even its procurement cost, maintenance personnel may be playing it safe and ordering all sorts of spare parts which may not be needed and bank interest on borrowed capital for procurement of spare parts. (Bhat 2008, 182)

Because of high requirements of material flow it is natural that spare parts management is an important area of inventory research. (Huiskonen 2001, 125)

The next chapter of this paper will focus on one of the main questions of inventory management, which is lot sizing.

4. LOT SIZING

Lot size is the quantity in which the item will be purchased from supplier or produced internally to meet the demand (Viale & Carrigan 1996, 40). The technique that is used to determine the order quantities for stock item is called lot sizing (ROY 2005, 135). Sollish & Semanik (2012, 313) are calling this as an inventory ordering strategy which they define “method for determining the quantity of materials to be ordered and the timing for delivery of that order”.

To reduce ordering, setup and carrying costs it is important to select an appropriate mix of lot sizing methods. Selecting the lot size method has also an affect in overall levels of work-in-progress inventory. (Viale and Carrigan 1996, 40).

There are several common methods of lot sizing. Viale and Carrigan (1996, 40) divide these methods to two main categories and nine major types of methods. These methods are:

- Demand based methods (static methods). Order quantities are constant.
  - Fixed order quantity: min/max
  - EOQ (economic order quantity). EOQ is calculated periodically and used as fixed lot
- Discrete methods (dynamic). Order quantities differ.
  - Period order quantity
  - Lot-for-lot
  - Periods of supply
  - Least unit cost
  - Least total cost
  - Part-period-balancing
  - Wagner-Whitin algorithm

According to Sollish and Semanik (2012, 314) and Chapman etc. (2017, 257–8) the most common methods of lot sizing are:

- Fixed order quantity
- Periodic order quantity
- Lot-for-lot
- EOQ (Economic order quantity)

4.1 Demand based methods

Demand based methods also called static methods are methods that have constant order quantities, meaning that they are not changing. (Viale and Carrigan 1996, 40)

In this part of the chapter we will go through some of the most common demand-based lot sizing methods.

Fixed order quantity

In fixed order quantity method specifies that the number of items ordered is a predetermined fixed quantity. The size of the lot could be based on the EOQ calculation, the size of the container or the size of a package the material comes in. The advantage in fixed order quantity is that it is easily understood, and the downside is that it is not minimizing the costs involved. (Chapman etc. 2017, 257)

Table 1. Example of the fixed order quantity method (Viale & Carrigan 1996, 41)

Safety stock = 40 Order quantity = 300 Lead time = 2		**Periods**					
		1	**2**	**3**	**4**	**5**	**6**
Forecast demand		380	320	300	200	230	320
Scheduled receipts							
Projected available	800	420	100	100	200	270	250
Net requirements				-200	-100	-30	-50
Planned order receipts				300	300	300	300
Planned order releases		300	300	300	300		

In table 1 there is an example of fixed order quantity method, where the safety stock is 40, order quantity is 300 and lead time is two periods.

Economic order quantity

The other type of static formula is the economic order quantity (Viale & Carrigan 1996, 42). EOQ method determines the best lot size that minimizes ordering costs and the holding costs assuming a constant rate of demand per period. Average demand rate can be calculated from past demands or from the given net requirements. (Malakooti 2014, 273–4)

The basic formula for EOQ:

$$\text{Units: EOQ} = \sqrt{\frac{2US}{IC}}$$

where U = Annual usage in units
S = Setup or ordering costs
I = Inventory carrying cost
C = Unit Cost

Equation 1. EOQ formula (Viale & Carrigan 1996, 42)

Table 2. Example of EOQ method (Viale & Carrigan 1996, 43)

Annual usage = 3480 Order quantity = 500 Lead time = 2		**Periods**					
		1	2	3	4	5	6
Forecast demand		380	320	300	200	220	320
Scheduled receipts							
Projected available	800	520	200	400	200	480	160
Net requirements				-100		-20	
Planned order receipts				500		500	
Planned order releases		500		500			

$$A = 290 \times 12 = 3480 \quad \text{EOQ} =$$
$$\sqrt{\frac{2US}{CI}} = \sqrt{\frac{2 \times 3480 \times 20}{2.50 \times .22}} = \sqrt{253,091} = 503 \text{ (rounded to 500)}$$

In the example table 2 the EOQ is 500 and the order quantity is fixed to that.

Economic order quantity method is based on following assumes demand rate and lead time is known and constant, entire lot sizes are added to inventory at the same time, stockouts are not permitted, holding and order costs are fixed despite of lot size and quantity discounts does not exists. (Wee 2011, 31)

Because of these assumptions the use of EOQ formula is limited. Especially in the case of spare part business where demand is constantly changing and hard to forecast.

4.2 Discrete methods

Discrete methods also called dynamic methods are methods in which order sizes vary. (Viale and Carrigan 1996, 40)

In discrete lot sizing different methods are used to calculate/determine best lot size based on the situation. In this part of the chapter we will examine most common discrete methods.

Period order quantity

Period order quantity (POQ) method uses the same theory as the EOQ method. POQ uses the EOQ method to calculate an economic time between orders. The POQ method does not calculate the quantity of the order, but actually the number of periods to be covered. POQ formula produces the time interval in which orders are placed. Instead of placing orders of same quantity, as in the EOQ model, in the POQ model the orders are made to fill the requirements for the calculated time period. The number of order quantity will vary each time when order is made. (Chapman etc. 2017, 266)

$$\text{POQ} = \frac{\text{EOQ}}{\text{Average Period Usage}}$$

Equation 2. POQ formula (Viale & Carrigan 1996, 44)

Table 3. POQ vs EOQ (Chapman etc. 2017, 267)

EOQ = 250 units

Week	1	2	3	4	5	6	7	8	9	10	Total
Net requirements	100	50	150		75	200	55	80	150	30	890
Planned order receipt	250		250			250			250		
Ending Inventory	150	100	200	200	125	175	120	40	140	110	1360

Period order quantity:

Weekly average demand = 890 / 10 = 89

POQ = 250 / 89 = 2,81 -> 3 weeks

Week	1	2	3	4	5	6	7	8	9	10	Total
Net requirements	100	50	150		75	200	55	80	150	30	890
Planned order receipt	300				330			260			
Ending Inventory	200	150	0	0	255	55	0	180	30	0	870

The difference between EQO and POQ methods can be seen in the table 3. For example, the total inventory in 10-week period is reduced when using POQ method. (Chapman etc. 2017, 267)

Lot for lot

In the lot for lot -method the ordered amount is always exactly the needed quantity for a given period. In this method the ordered amount is exactly enough to avoid a stock disruption while ordering as little as possible. (Sollish & Semanik 2012, 314)

Table 4. Example of lot for lot method (Sollish & Semanik 2012, 315)

Week #	1	2	3	4	5	6	7	8
Demand	150	0	70	0	175	0	90	60
Net Balance	110	110	40	40	(135)	0	(90)	60
Planned Receipts	0	0	0	0	135	0	150	0
On Hand End of Week	110	110	40	40	0	0	60	0
Quantity to Order	0	0	135	0	90	60	?	0

As we can see from table 4 the orders are made in time to avoid stock outage, to cover the requirements of certain period.

Periods of supply

Periods of supply method defines an order quantity that will cover a predetermined period. The only difference between periods of supply and POQ method is that this method does not use the EOQ formula to calculate. Primarily the periods of supply, is determined by using experience. (Viale & Carrigan 1996, 46)

Least unit cost

Least unit cost is a dynamic lot sizing method that aims to minimize the average cost per unit. In this method ordering and inventory carrying costs are added for each trial lot size and divided by the number of units in each lot size. The lot size with the lowest unit cost will be chosen. The advantage of this method is that it is a complete analysis that will also consider ordering costs that might change as the order size changes. (Samak-Kulkarni & Rajhans 2013, 806)

Table 5. Determining the lot size with least unit cost

Inventory carrying cost per part per period =
holding cost*(unit cost/52) ->
0,007212/unit/week
*Carrying cost = Inventory at the end of period*0,007212*Hold time

Future requirement	Period	Cumulative order qty	Inventory at the end of period	Hold time	Order cost	Carrying cost (*)	Total carrying cost	Total cost	Unit cost
120	3	120	0	0	10	0	0	10	0,0833
260	4	380	260	1	10	1,88	1,88	11,88	0,031
150	5	530	150	2	10	2,16	4,04	14,04	0,026
140	6	670	140	3	10	3,03	7,07	17,07	0,025
185	7	855	185	4	10	5,34	12,40	22,40	0,026
115	8	970	115	5	10	4,15	16,55	26,55	0,027

Table 6. Least unit cost example

Least unit cost = 670
Safety stock = 80
Lead time = 2 periods

		Period							
		1	2	3	4	5	6	7	8
Gross requirements		130	160	120	260	150	140	185	115
Scheduled receipts									
Projected available	370	240	80	630	370	220	80	?	?
Planned receipts				670					
Planned order releases		670							

In the table 6 the lot size covering the gross requirements from period 3 to period 6 is the one with the lowest unit cost as shown in the table 5. Tables are based on Hong-Mo Yeh´s (2003, 7-16 – 7) book Operations planning and control in ERP.

Least total cost

Least total cost method calculates the order quantity by comparing the ordering cost and the carrying cost for different lot sizes and chooses the lot in which these are most nearly equal. Ordering costs are reduced when lot size is increasing but the inventory carrying cost increases, and when lot size is smaller the carrying costs are smaller and ordering costs higher. Least total cost model tries to find the lot size where ordering cost and carrying cost are nearly the same. (Samak-Kulkarni & Rajhans 2013, 806 – 7)

Table 7. Least total cost example

Least total cost = 855
Safety stock = 80
Lead time = 2 periods

	Period							
	1	2	3	4	5	6	7	8
Gross requirements	130	160	120	260	150	140	185	115
Scheduled receipts								
Projected available 370	240	80	815	555	405	265	80	?
Planned receipts			855					
Planned order releases	855							

One can use the table 5 to find out the least total cost lot size, which is the lot size covering gross requirements from period 3 to period 7 where the total carrying costs are nearest to ordering costs. Example can be seen in the table 7.

Part period balancing

Part period balancing technique is similar to the least total cost method. This method however uses the look ahead/look back -procedure. In this procedure a lot quantity is calculated, and before firmed, the next or prior to the current period, periods are reviewed if it would be economical to include those in the current lot. (Viale & Carrigan 1996, 47)

"*The part period balancing procedure uses more information in the requirements schedule than other procedures*". In this procedure both lot size and time between orders can vary. For example, to reduce the inventory costs longer time intervals between orders can be used when demand is low. (Swamidass 2000a)

Part-period of an item means the number of units of inventory held for a period. One part-period means that one unit of item is carried in inventory for one period. Economic part-period (EPP) is calculated to find the quantity of an item, if carried in inventory for one period, which would result that carrying costs are equal to ordering costs. Requirements are added period by period until the generated part periods are approximately the value of EPP. (Hong-Mo Yeh 2003, 7-19)

$$\text{EPP} = \frac{\text{Carrying cost}}{\text{Unit carrying cost}}$$

Equation 3. Economic part-period (EPP)

Wagner-Whitin algorithm

Wagner-Whitin algorithm is a complex method that calculates all the different possibilities to cover the requirements of the planning horizon. (Viale 1996, 47)

Algorithm is an accurate method for determining optimal lot size for a product with dynamic demand. One of the key implications of the Wagner-Whitin algorithm is the zero-inventory property. This means that production/procurement takes place only when the store is empty. (Samak-Kulkarni & Rajhans 2013, 807)

5. INVENTORY COSTS

This chapter will discuss about the cost associated with inventory, more detailed about ordering costs and holding costs.

Roy (2005, 104) divides inventory costs associated with inventory management to three:

- holding or inventory carrying cost
- ordering cost
- shortage cost

Viale and Carrigan (1996, 38-39) on the other hand divide these costs to five different categories:

- Ordering cost
- Carrying cost
- Storage costs
- Stockout cost
- Transportation costs

Main difference between these two theories is that Roy (2005, 34) includes transportation costs to ordering cost when Viale and Carrigan (1996, 38-39) have these in separate categories.

5.1 Ordering costs

Ordering costs often generate from the performance of the purchasing transaction. (Leppänen 2018, 36)

Costs of ordering and receiving the inventory are determined as ordering costs. These costs are usually defined as a fixed amount per order, regardless of order size. Ordering costs include determining the needed amount, preparing invoices, shipping costs, quality inspections upon arrival and moving the items to temporary storage. (Roy 2005, 104)

Transportation costs could be extremely difficult to find out and therefore Piasecki (2020) is suggesting that the transportation costs are taken to account if they have significant effect on order.

Viale and Carrigan (1996, 38) include following work to ordering costs:

- Office work of preparing, issuing, following, and receiving orders
- Physical handling of the goods
- Inspections

The amount of purchases will increase ordering costs. Ordering cost can be calculated on a per item, per order basis, since the internal effort to determine amount, which supplier, price, terms etc. is same despite the item and amount. (Muller 2011, 98)

Table 8. Example of calculating ordering costs per item, per order (Muller 2011, 99)

Annual cost of purchasing department labor	$220,000
Annual cost of purchasing department overhead (rent, utilities, equipment allocation, etc.)	$179,000
Annual cost of expediting stock items	$25,000
Total annual costs	$424,000
Number of purchase orders created per year for stock (assume):	10,000
Average number of different stock items per order (assume):	× 8
Total number of times stock items were ordered:	80,000

$$\frac{\text{Total Annual Costs}}{\text{Total Times Stock Items Were Ordered}} = \underset{\longrightarrow}{\text{R Factor}} = \frac{\$424{,}000}{80{,}000} = \boxed{\$5.30 = \text{R Factor}}$$

In the example R Factor is the cost per line per purchase order. This means that if there are one million pcs of one item bought at one time ordering costs will be 5,30. If items are bought at 250 000 at a time then ordering costs would be four times 5,30 (four PO with one item each). (Muller 2011, 99)

Determining the ordering costs might be relatively hard since these costs are mainly related to utilization of recourses during transactional activities. (Leppänen 2018, 27)

5.2 Holding costs

Holding or carrying costs are costs that generate from having items in the stock. Holding costs include cost due interest, insurance, taxes, depreciation, obsolescence, downfall, misappropriation, deterioration, breakage, and warehousing costs. Equipment and personnel needed to run the stock are also included. Also, opportunity costs of funds, that are tied up in the inventory, which could be used elsewhere, are included. (Roy 2005, 104)

Viale and Carrigan (1996, 38) defines holding/carrying costs as following:

- Obsolescence
- Deterioration
- Taxes
- Insurance
- Storage
- Capital

Usually holding costs are stated as percent of a value per unit per one year (Viale and Carrigan 1996, 38). Holding costs can be stated also as value per unit. Typical holding costs range from 20 percent to 40 percent of the value of a unit. (Roy 2005, 104)

6. LOT SIZING AT WGLS

This chapter will examine lot sizing at WGLS, by listing the lot sizing procedures used in WGLS and comparing them to the theory in chapter four.

Not published by the request of the commissioner.

7. ORDERING PROCESS AT WGLS

In order to calculate the ordering cost, we need to map the ordering process, to understand the ways of working.

This chapter will examine the whole process, from receiving the order to shipment of the order.

Not published by the request of the commissioner.

8. CALCULATING ORDERING COSTS FOR WGLS

To calculate the ordering cost, all the cost related to purchasing of the parts need to be taken account. In this thesis we are going to take account only the expenses related to personnel, excluding costs such as rent, utilities and equipment etc. This could lead to lower ordering cost as in reality which will be mentioned in the result.

Not published by the request of the commissioner.

9. DISCUSSION

This chapter will discuss about the results and conclusions of the thesis as well as possible future development ideas.

Not published by the request of the commissioner.

10. CONCLUSION

The aim of this thesis was to carry out a review of the lot sizing methods used in WGLS as well as calculate the ordering costs by using most recent values.

This was done by reviewing the theory of lot sizing, listing different methods, and reviewing theory of lot sizing parameters, holding costs, and ordering costs. Then the lot sizing methods used in WGLS were listed and studied and compared to theory. Based on theoretical calculation methods of ordering costs, the ordering costs in WGLS were calculated.

Holding costs were excluded from this study but could be good to investigate in the future also.

The results of this thesis can be used to further develop the lot sizing in WGLS by investigating how to utilize more of the existing methods. Ordering costs calculated in this thesis can be tested, to show how the newly calculated value effects to lot sizing and inventory value.

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