42452 Complexity Management

Garden A/S

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Student contributions:
All members in the group agree that the workload was shared evenly. Also, proofreading and editing was done by the group in equal proportions.

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1 Introduction

The case study is designed in the course Complexity Management to investigate the Garden A/S case. The analysis is held according to the five-stage model, where the data for analysis were provided in the course material, for the analysis of complexity costs.

Garden A/S is the leading lawnmower corporation in the Scandinavian region. Its value-added goods and its customer-oriented business character are well recognized in the market. The business has captured a wide consumer niche in the EU, the UK, and the USA. Today, it is split into two business operations, respectively production and distribution. The company is a multinational retailer with manufacturing facilities in Denmark and China. Garden A/S values ongoing improvement of the quality and affordable price of the product for their customers. Over the last seven years, the company has seen a downfall in their growth rate. This development is not aligned with the company's goal – to climb to the top of the lawn-mower industry, particularly in the Northern European market.

We aim to perform and illustrate an analysis based on provided data of the cost allocation in production, storage, distribution, and sales for Garden A/S towards future growth. Further, this report will showcase analysis and quantification of complexity costs and moreover identify effective initiatives to fight Garden A/S's complexity and the connected costs. Conclusively, an evaluation is conducted to determine and prioritize the initiatives to provide recommendations and possible action plans.

2 Scope of Project

2.1 Product variants

The company has categorized its products into 11 product platforms, all included in the following complexity management analysis. The different platforms are shown in Figure 2.

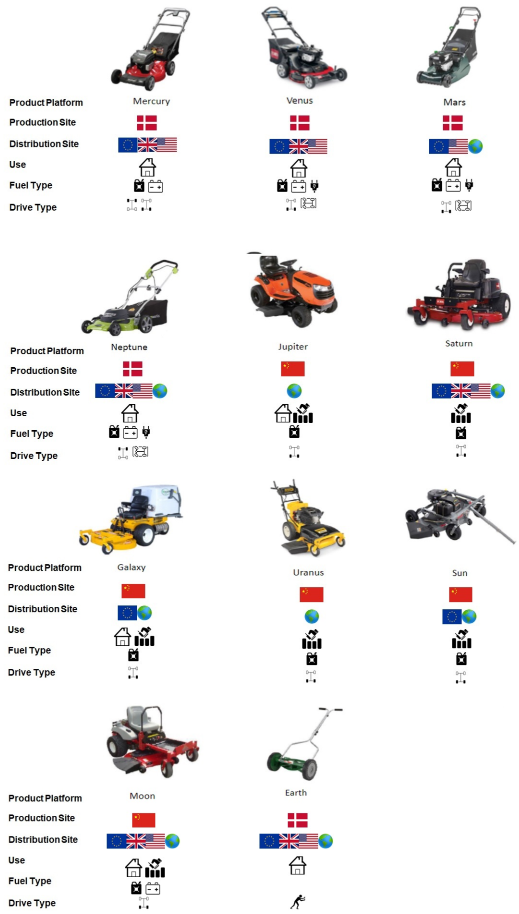


Figure 2: Overview of A/S Garden 11 product platforms

Figure 3 illustrated significant product statistics calculated from the files given. From Figure 2 one can see that the company produces almost the equal amount of products in **China** and **Denmark**, however, Denmark's production exceeds China's by a small proportion. Moreover, most of the products are sold in all three markets: **EU, USA, UK** with a percentage of **30.7%**. Furthermore, two-thirds of the products are used in the residential sector, that being **70.7%.** Finally, in Figure 3 is shown that most of the products use Gasoline as their fuel type **57.9%**.

Figure 5 illustrates the cost break down of Garden A/S. Direct production cost represents almost half the company's cost **45.6%**. Fixed production cost and distribution cost are **12.5%** and **9.4%** respectively. Furthermore, in Figure 5 can be argued that Freight and FGI costs combined result in the highest cost proportion of the company's complexity cost at **77.2%**.

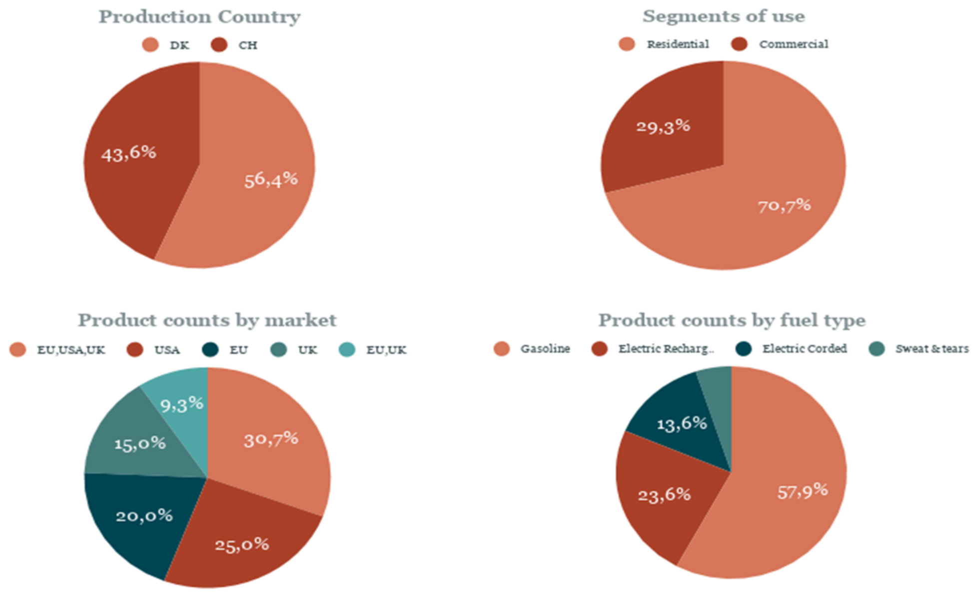


Figure 3: Product statistics of Garden A/S

In Figure 4, the total revenue and unit sales per product of the company can be seen. From Figure 4 it is clear that **Neptune** holds around **22%** of the company's total revenue and **32%** of its unit sales. Moreover, **Venus** and **Moon** hold the company's next highest proportion as far as the total revenue is concerned. Finally, it is interesting to annotate the high **Saturn**'s net revenue compared to its units sold. This is due to the high price per unit of the product.

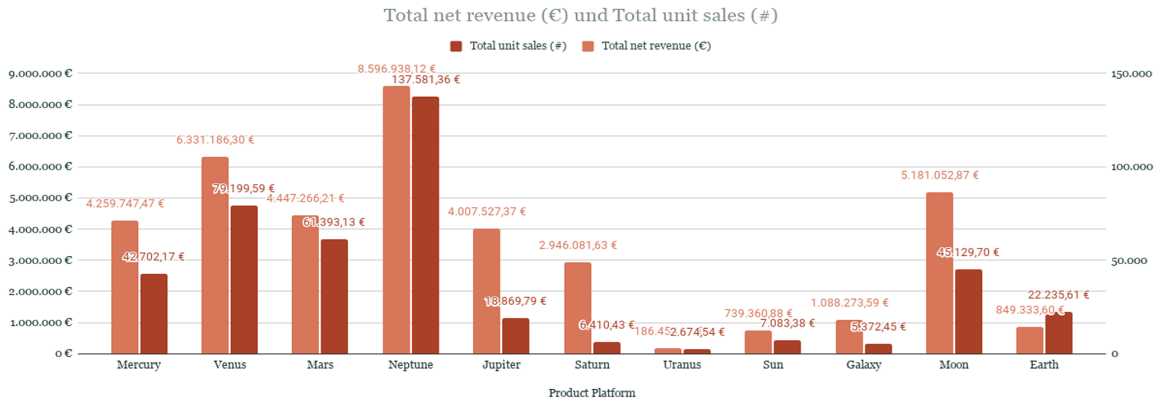


Figure 4: Total revenue & unit sales of Garden A/S

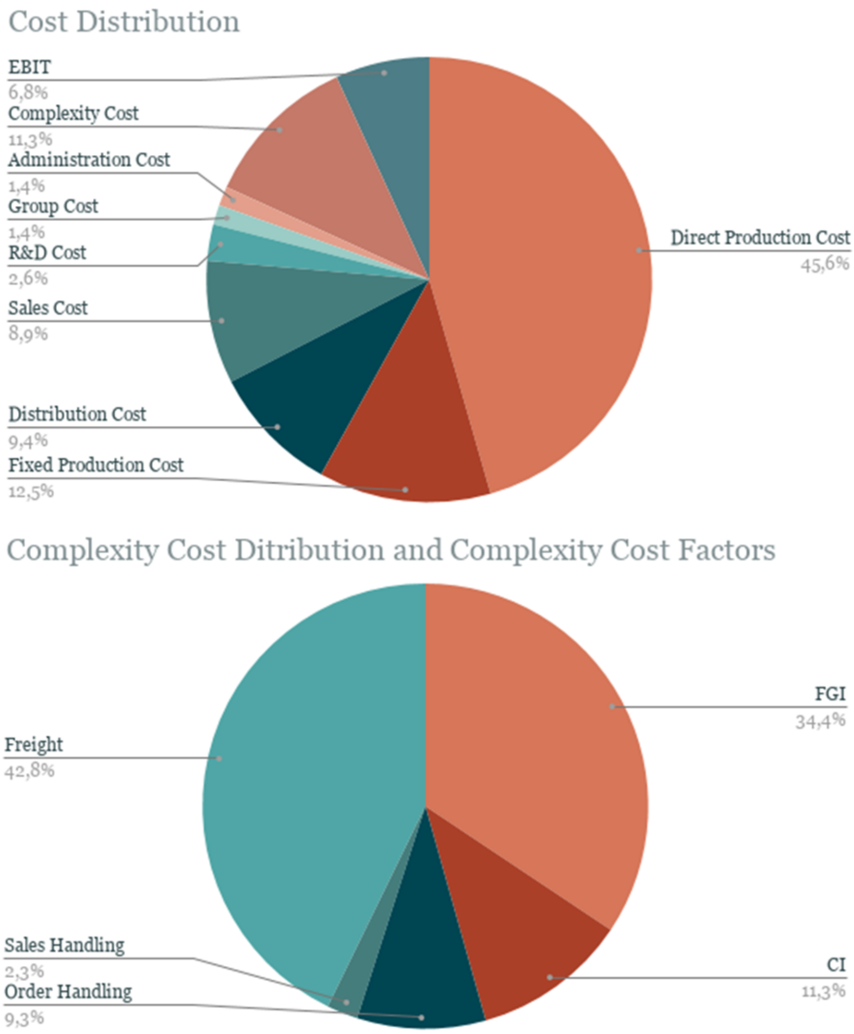


Figure 5: Cost distribution of Garden A/S

2.2 Process steps in the analysis

The process flow and the related costs are shown in Figure 6. A more detailed analysis of the complexity cost factors is given in the following chapters.

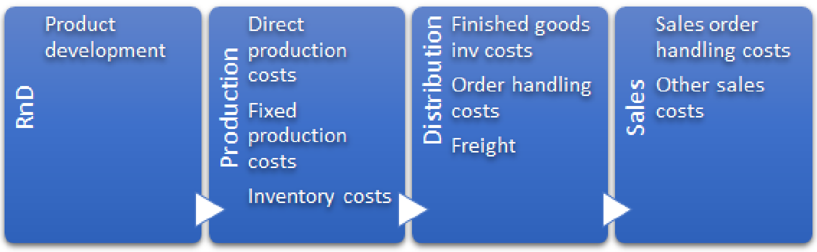


Figure 6: The process flow of Garden A/S with the related costs

3 ABC Analysis of Product Range

To start with a reliable base analysis, the further reasoning and initiatives will be based upon, an **A**ctivity **B**ased **C**ost analysis (ABC-analysis) was carried out. Both the procedure and the results will be outlined and discussed in the following chapters.

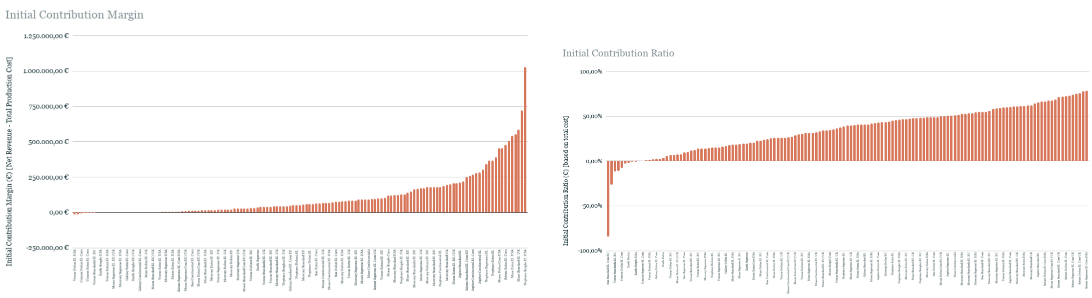
3.1 Contribution Margins

Before implementing the initial ABC-analysis, a detailed dissection of the current product portfolio based on the product's contribution margin II (CM II) and the corresponding contribution margin ratio (CMR) was performed. To arrive at each product variant's fix production cost, the overall fix production cost were distributed according to the overall direct cost share of the product variant. The exact determination of the figures mentioned above was executed according to the formulas below.

$$CM \quad II = Revenue - Direct \quad Cost - Fix \quad Production \quad Cost \tag{1}$$

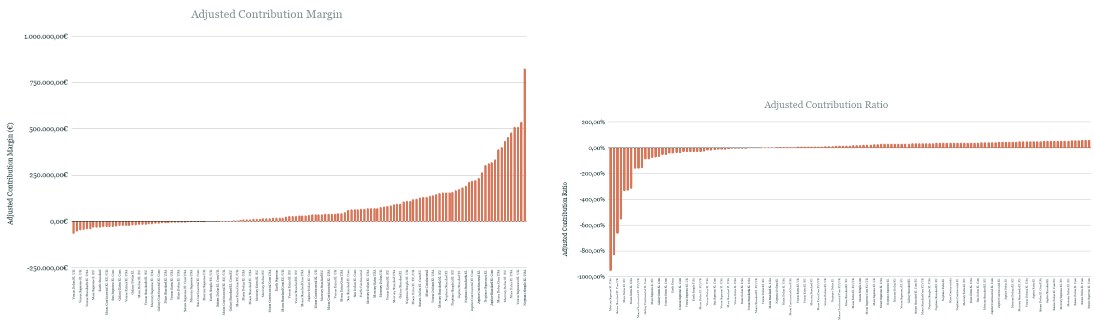
$$CMR = \frac{CM \quad II}{Revenue} \tag{2}$$

To acquire a more detailed understanding of the current portfolio profitability, the products were sorted concerning their CM II or CMR in ascending order before being displayed.



(a) Contribution Margin (b) Contribution Ratio

Figure 7: Initial Contribution values



(a) Contribution Margin (b) Contribution Ratio

Figure 8: Adjusted Contribution Values

Garden A/S exhibits negative amounts for both measures in 9 out of 139 products. In contrast to the rather exponential development of CM II towards the highly profitable products, the CMR shows a relatively linear course from 19 products with CM's below the EBIT-rate (6.85%) to 9 products displaying CMR's above **70%**. Overall, considering the volume of Garden A/S's product portfolio this might lead to the premature conclusion of a healthy and diverse product offering. Often, the pro-rata allocation of fixed cost onto different products leads to distorted CM II and CMR's values. By that procedure high-quantity selling products are usually overestimated compared to the low-quantity selling products, which commonly consume a substantially more significant share of the fixed cost. Hence, several complexity cost factors will be constructed to generate a better understanding of the hidden distribution of fix cost across the product portfolio. A comparison to the complexity cost adjusted CM II and CMR will be carried out in section 4.2. The process for the initial ABC-analysis will be outlined further.

3.2 Classification of ABC Products

Following the premise of classifying the existing models into three categories, a **double Pareto** analysis considers **Net Revenue (X-axis)** and **Contribution Margin (Y-axis)** as the variables to evaluate. The Pareto classification defines the product models by which one provides the variables mentioned above with the **top 80% (A products)**, **15% (B products)** and **lower 5% (C products)** [**larsHvam**].

3.3 Initial ABC Analysis

The initial analysis for the Net Revenue summarized a ratio of **54:36:49** (A:B:C) and for the Contribution Margin a ratio of **43:33:63**. A second classification was done for double selection of the Net Revenue and the Contribution Margin as in Fig 9.

Classification	A	B	C
A	A	B	C
B	B	B	C
C	C	C	C

Figure 9: ABC classification for double Pareto

The final ABC analysis gave the end ratio of **40:33:66**. This re-classification evaluates both classifications and leans towards the lowest one. Ex: A product get a classification of A Net Revenue and B for the Contribution Margin hence the new reclassification assigns the product to the B category. Calculation can be found in the tab **Final ABC** - of **Full ABC Analysis** file - under Appendix 9

4 Complexity Analysis

Subsequently to the initial ABC classification, revealing the cascading profitability distribution of Garden A/S's product portfolio, a complexity analysis aiming at identifying influential complexity cost factors will shed further light into the hidden fix cost distribution. After identifying the complexity cost factors, each factor will be explained in detail before quantifying their respective impact. Following an adjusted product portfolio ABC-analysis, the complexity cost factor's effects on the overall cost distribution will be summarized.

4.1 Identification of Complexity Factors

In this section, the complexity costs for each product is analyzed. Moreover, the calculations of the different complexity cost factors are described;

- Component Inventory
- Freight
- Finished Good Inventory (FGI)
- Sales Order Handling

4.1.1 Component Inventory Cost

The level of the product shall be tracked corresponding to the cost of inventory of the components. To determine component inventory cost, initially calculating the value of the individual product being relative to the total value of components kept in stock with a total value of components. Further, CI cost is relative to the local inventory rate and individual product value. Since the local inventory rate is different for both countries, the CI cost calculations were made separately for China and Denmark (appendix). The below Equation 3 is used in order to calculate the Component Inventory (CI) cost, Where the evaluation of total CI cost it **€493.529,19** .

$$CI \quad cost_n = Amount \quad of \quad CI \quad in \quad stock_n \quad * value \quad of \quad components_n * local \quad inventory \quad rate \tag{3}$$

4.1.2 Freight Cost

The calculation of the freight cost went through a different number of steps. Each product's dimensions, pallet, and container are given; thus, the number of pallets each product needs is calculated based on its dimensions and the pallet's size. Furthermore, having the container's dimensions, the number of pallets that fit in it has been found. *Equation 1* shows the formula used to calculate the products that fit in the container, whereas, *Equation 2* displays the calculation of the total number of containers needed.

$$Products \quad per \quad container_n = total \quad pallets \quad per \quad container_n * Pallets \quad to \quad be \quad used_n \tag{4}$$

$$Containers \quad needed_n \quad = \frac{Unit \quad sales_n}{products \quad per \quad container_n} \tag{5}$$

It is given that each container has the same type of product and that the prices of shipping a container are taken even if it is not 100% full. Further, the number of containers shipped in each market has been computed. Later, the freight cost is calculated based on the given prices to ship one container from the production country to the related market Equation 3. It is considered that for the products which are shipped to more than one market, an equal amount will be allocated in each one of them. *Equation 5* has been used to evaluate the freight cost for each product family which is shown in figure Figure 10. The freight calculations may be found in the "Freight"excel file.

$$Freight \quad cost_n \quad = Containers \quad needed_n * cost \quad per \quad container_n \tag{6}$$

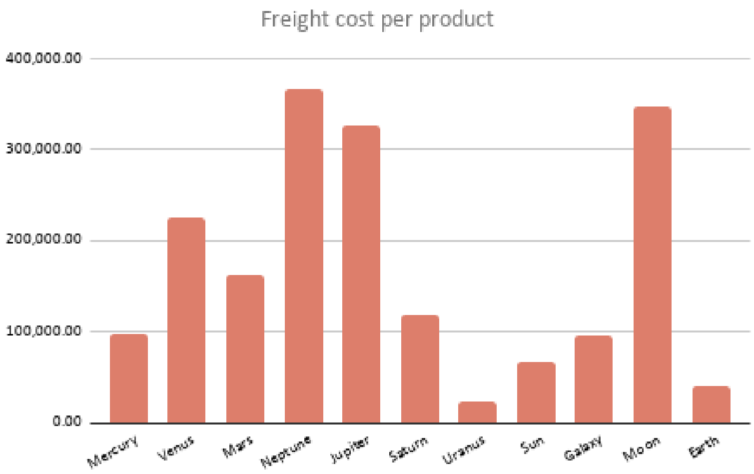


Figure 10: Freight cost per product family

4.1.3 Finished Goods Inventory Cost

In the warehouse stores of all finished goods, the inventory of finished goods is available in all three distribution centres (Denmark, USA, UK) since they all receive products from Danish and Chinese manufacturing sites.

While performing complexity analysis, several factors were considered to identify the complexity cost. As it is stated the cost for order handling in the warehouse differs for every product from the product family, warehouse handling cost is determined by calculating the order frequency of its products based on unit sales. The time for a particular order frequency depends on the unit sale (Appendix table 3).

Further, time per order was calculated using the below expression. A regular time of 10 seconds for each new product per order is applied to the time needed for the corresponding order frequency.

$$Time \quad per \quad order = Time \quad for \quad the \quad specific \quad order \quad frequency + (order \quad size – 1) * 10 sec \tag{7}$$

The total amount handling time of order for every hour is evaluated using the number of orders and time per order. Given that the handling cost is 100 €/hour, the Warehouse handling cost for each product is determined. As the total handling cost for all the products is **€408.098,221** . The below graph 11 showcase warehouse handling cost distribution among the product family.

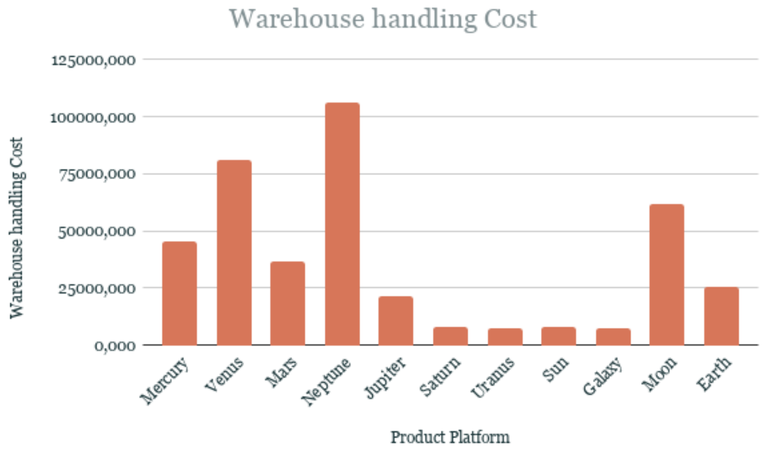


Figure 11: Warehouse Handling Cost

The FGI cost is measured for each type since the number of stock items varies for each model. In initial steps, the total production cost is calculated for each product, by using this the calculation made for the FGI by multiplying the amounts of finished products. Moreover, the inventory rate is also calculated for all three-distribution centre based on four different parameters (products 0,5%, scrap 0,7%, and bank interest 7,3%, rent), where the rent varies according to as suitable to change in location and the percentage of the inventory rate allocated to each product as shown in fig no 28 from section 9.

The aim is to investigate the complexity in FGI cost to outline the products that are less profitable for the organization. The new FGI is calculated in the assessment of complexity reduction initiative section 5.2, where the new FGI is investigated based on segregation by features, like market, fuel type, starting type, and drive type accept accessories. The products are then distributed in the groups presuming similarities, where the new FGI after reduction of complexity is determined. The below figure 12 depicts the difference between FGI cost and the cost after complexity reduction. As the illustration shows **57.56%** reduction in the cost after substitution.

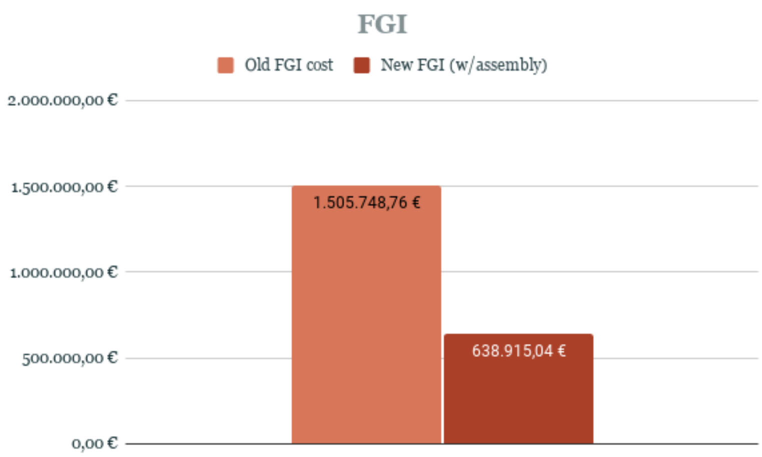


Figure 12: Finished good inventory cost

4.1.4 Sales Order Handling Cost

The order handling cost is proportional to the formulated value of *Unit sales*, *average size of order lines* and *average cost per order line*, which is considered as a constant i.e. **3,5€**/order line. This constant is then multiplied by *number of orders* to calculate the **sales order cost**. The number of orders can be formulated as Unit sales by Average size per order line described in the below equation.

$$Sales \quad order \quad handling_n = \frac{Unit \quad sales_n}{Average \quad Order \quad Line_n} * 3.5 \tag{8}$$

Total sales order cost per product family is depicted in the corresponding bar plot 13. Each bar plot signifies the total sales order cost evaluated of each product family ranging from Mercury, Venus, Mars until Earth considering all product platforms.

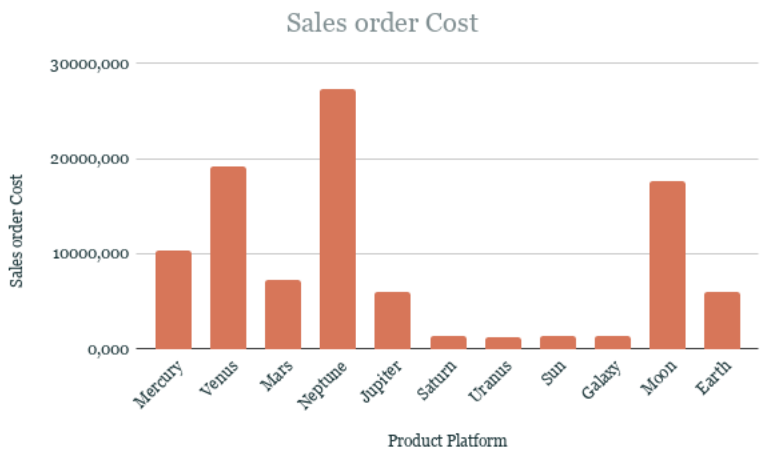


Figure 13: Sales order handling

4.2 Complexity Factors Overview

Overall it was possible to redistribute €4.38 million of fix cost to the specific complexity cost factors, which constitutes almost a quarter of the total fix cost **23.82%**. In turn, the newly distributed complexity cost will alter the product-specific cost structure; this furthermore influences the ABC-classification. Hence an adjusted ABC-analysis was carried out to incorporate the alternations and account for an adjusted decision making. With these insights, *Garden A/S* can obtain a more detailed understanding of the actual cost distribution among their product portfolio. As expected for an industrial production company, the FGI and freight complexity cost factors capture a substantial part of the overall complexity cost distribution, amounting to a combined value of **77.2%**. These findings suggest considerable saving opportunities if the process and organizational complexity concerning the freight and the customer order decoupling point can be substantially reduced. The final spread of cost among the respective complexity cost factors can be seen below.

4.3 Adjusted ABC Analysis

After performing the necessary calculations on the complexity costs, the ABC classification showed an increase in C products' volume, which followed the logic of having its contribution margin lowered by the complexity costs. This change can be seen in both the Original and Adjusted values graphs in Fig 12.

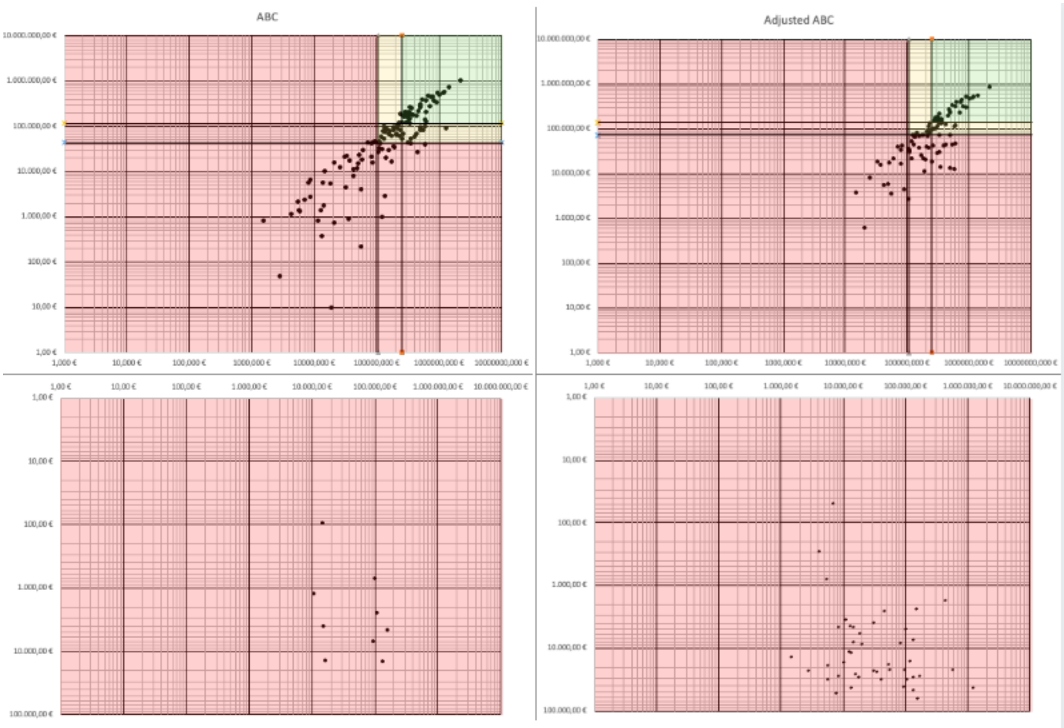


Figure 14: ABC chart vs Adjusted ABC chart

After performing a second classification to the adjusted Net Revenue and the Adjusted Contribution Margin, the final result was a ratio of **30:19:91** (A:B:C) where both the *A and B products suffer a significant reduction while the C product incremented proportionally.* The calculation can be found in Appendix 9.

4.4 Cost distributions

After the adjusted ABC-analysis, the cost distribution of *Garden A/S* will also be adapted according to the results. Previous to the complexity cost adjustment, by a direct cost share distribution of the production fix cost and a revenue share distribution of the remaining fix cost positions (distribution, sales, administration, product development and group cost), five product platforms generate a negative EBIT with a minimum EBIT margin of **-39.73 %** (*Uranus*). After the complexity cost adjustment, this picture changes slightly as it also pushes the product platform *Moon* to slight unprofitability. The new minimum EBIT margin results in **-64.07%** (*Uranus*), also diminishing the prior maximum of **38.23%** (*Saturn*) to **27.27%**. In conclusion, one can observe that the remaining six unprofitable product platforms devour the five profitable product families' partly high EBIT margins. These outcomes combined with the findings of the adjusted ABC-Analysis hint the potential savings that can be obtained by an optimization of

Garden A/S's product portfolio and the asymmetric cost distribution among the products' complexity cost. A comparison of the cost distribution before and after the complexity cost adjustment and the resulting product platform EBIT margins are displayed below.

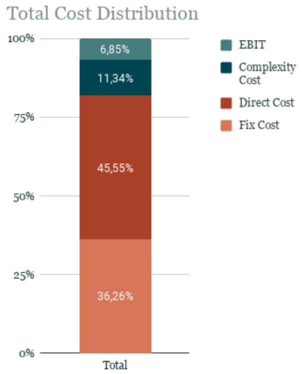


Figure 15: Total Cost Distribution

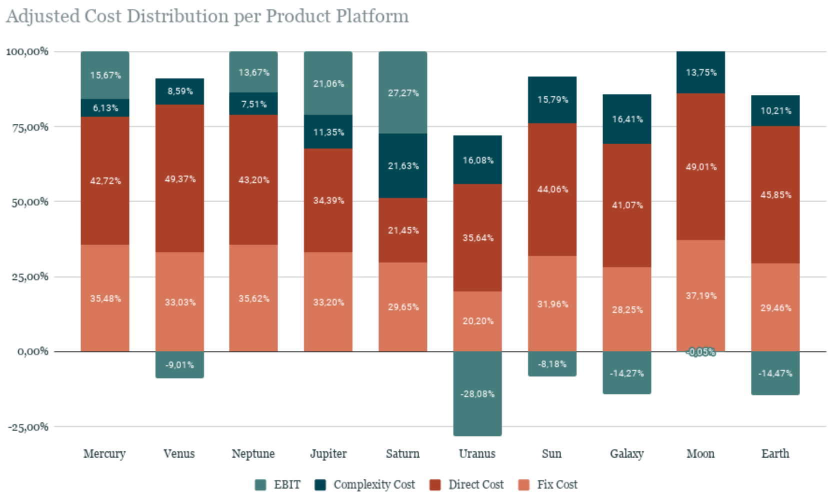


Figure 16: Adjusted Cost Distribution per Product Platform

5 Complexity Reduction Initiatives

In the previous chapters, the complexity cost factors have been shown, and we are now looking into various ways to achieve a cost reduction. One step would be to determine the products that can be substituted from others to reduce total costs. Later, assemble the products in the distribution centres (savings in FGI's) whereas different freight cost options are also described. Finally, achieving component sourcing is also considered.

5.1 Initiative 1 - Adjustment of the product assortment

As a first initiative, an adjustment of the product portfolio was taken into account. Interestingly, significant gains in EBIT (and EBIT margin) can already be generated by a well structured and meaningful modification of the offered product portfolio. As established by the adjusted ABC-analysis, the **Pareto-distribution** of the individual product profitability implies strong cost asymmetry amid the product portfolio, hence targeted actions such as the substitution merging of comparable products can extensively boost a company's earnings. In the case of Garden A/S's product assortment adjustment, the methodology was executed as follows. At first, the following standards were set: if a B or C categorized product fulfilled one of the following three criteria

Attribute	Criterion	Value	Fulfillment	Fulfillment = Yes	Fulfillment = No
Unit Sales	>80% Quantile	3.912,74	Yes/ No	Keep	Substitute/ Cancel
Revenue	>80% Quantile	€444.261,32	Yes/ No	Keep	Substitute/ Cancel
CMR	>2x EBIT Margin	13,70%	Yes/ No	Keep	Substitute/ Cancel

it was kept in the product portfolio, without a chance of being cancelled or substituted. To prepare a more realistic adjusted product assortment, products showing unit sales and revenue above the 80% quantile were kept in the portfolio as a proxy for potential linked revenue. Furthermore, both the high revenue and high unit sales indicate significant demand for these products; thus it is believed that customers either buy these products in combination with others from the product portfolio or are willing to pay the complexity of these products. Although there is no focus on the profitability of the products, it is assumed that nudging these products to profitability can either be obtained with a price rise or meaningful marketing efforts. The next step after the general complexity analysis will be to perform a product-specific complexity analysis to deliver the valued complexity at a lower cost for the B and C classified products that exhibit negative contribution margins but were still selected to be kept.

As a third decider, the value of the product's CMR was held against the doubled EBIT margin to underline the product assortment's ambitious intention. Products that were not maintained in the updated portfolio were evaluated for substitution across the two dimensions of technological substitutability and price substitutability, as seen below. The lower substitution value set the standard for the realistic scenario while accounting for an optimistic and pessimistic scenario, with the below-stated variation in substitute demand. In the case of no viable substitution alternatives, the product was dropped from the portfolio.

Technological Substitutability	Product Platform	Fuel	Market	Start Type	Drive Type	Use Type
Equal	100%	100%	100%	100%	100%	100%
Not Equal	70% or 0%	0%	0%	0%	0%	0%

Overall this approach was applied in order to proxy potential linked revenue, but also in order to achieve a more stable fix cost and revenue distribution across the modified product portfolio for the respective scenarios. Furthermore strategically it is believed, that nudging potential high-selling products into profitability can be fulfilled with numerous cost-effective reactions.

As a consequence of the methodology mentioned above, the adjusted product portfolio includes 86 of the initial 139 products. Interestingly this approach yields equal amounts in A (30) and B (19) products, but makes a substantial cut to the tail of C products, reducing the amount by 53 product variants from 90 to 37. 56 of the adjusted classified products variants were kept, while 37 were substituted and 17 were dropped entirely. The resulting product portfolio with its respective ABC-classifications is compared to the initial product offering below/ in figure 17.

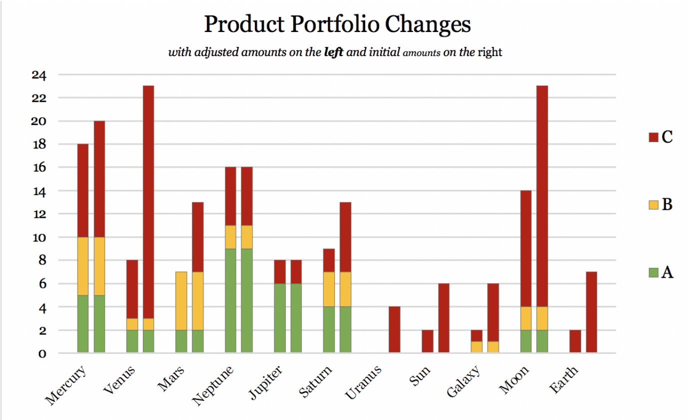


Figure 17: Product Portfolio Changes

By calculating the updated revenue of the remaining products stemming from the scenario adjusted unit sales and subtracting the adapted product-specific direct and complexity cost (based on adjusted unit sales), de novo distributed production fix cost (based on updated direct cost share) and remaining fix cost positions (according to updated revenue share), the overall effect of the adjusted product assortment on the company performance can be evaluated, as displayed below.

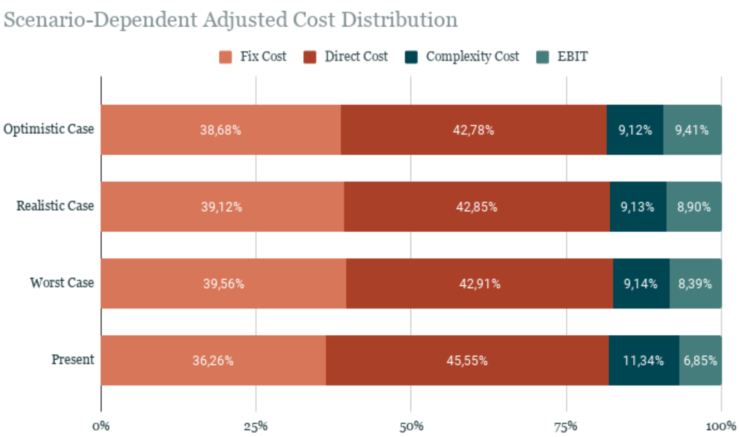


Figure 18: Scenario dependent Adjusted Cost Distribution

We are reducing the portfolio by almost 40%, based on the criteria mentioned above yields a substantial increase in EBIT and EBIT margin for every scenario. Hence the action to diminish the product variants offered to decrease the complexity and optimize the cost of delivered complexity is strongly suggested.

5.2 Initiative 2 - Changing Customer Ordering Decoupling Point

In this particular scenario, the idea was to exchange the primary machines' assembly order with its accessories. Initially, the primary machines were assembled at origin (Denmark, China). However, the new initiative proposes to cut complexity by grouping the primary machines that share the same specifications and assemble their accessories onsite at the distribution centres.

To aboard such a task, the first step is to assort the models by family, distribution centre, and technical specifications, regardless of their accessories. This grouping process reduced the existing variants, from **139** to **67** different models.

The next step is to calculate the Average Inventory level (AIL) to determine the number of stock products. This amount consisted of Q, the required amount of product required in 10 weeks, plus SS, the Safety stock, as shown in the following formula.

$$AIL = (\frac{Q}{2}) + SS$$

This amount draws information from the prior 12 months of sale units. For this process, it is essential to always keep in mind the time units, as the AIL runs in weeks, whereas the Unit sales are for one year(12 months/ 52 weeks).

From here on, the FGI is to be calculated next. However, an FGI is calculated for the primary machines sharing the same specs and another FGI for the accessories.

It is essential to mention that, although there are cost-savings by performing this product-accessories segregation, there are extra costs regarding the assembly on-site of those as mentioned earlier.

This leads to the next set of evaluation which is the freight implications. It is assumed that the original products do not change their initial dimensions, but still shipped by groups of similarity. The accessories are shipped separately also, making this a new source of costs to consider. Despite this, Machine freight incurred in a total of €1.252.475 and €21.238 for the accessories freight. It is important to note that the same type shipped the accessories and no mix of them was attempted.

As mentioned earlier, the new assortment of machines vs accessories has the added cost of on-site mounting. This cost is further diversified by the location where the mounting takes place which adds to an extra cost of €24.919.

There is a reduction in the freight costs and FGI as the grouping of similar products conducts a lower inventory allocation and containers shipped as seen previously in Fig. 10 and next in Fig 13.

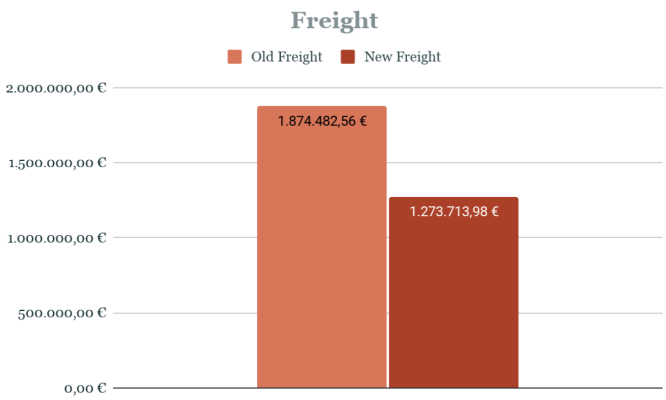


Figure 19: Original vs Decoupled freight costs

The end result was a total gain of **55,42% in the EBIT** and an overall reduction in complexity of **48,2%** which results in an increment of €1.8 million for the EBIT ass seen in Fig 14.

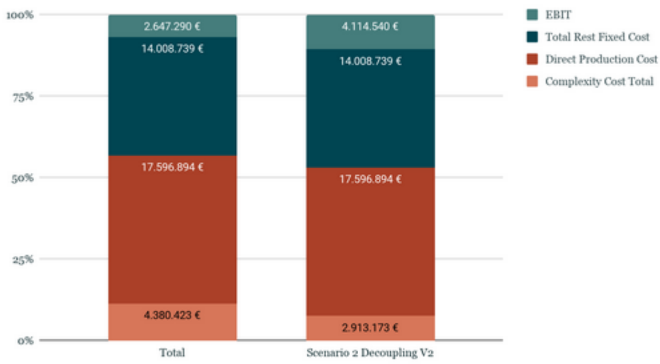


Figure 20: Original vs Decoupled Distribution

All calculations are shown in the tab **Decoupling**, and **Freight ACC** in the document **Complexity Management complete** as well as in the document **Freight Machines no ACC**.

5.3 Initiative 3 - Freight

As shown in Figure 10, the freight cost is quite substantial for all product families. In the initial case, where products are only shipped based on the product family they belong, result in a higher cost due to the unused space per container. The amount of unused space in each container has been calculated and is shown in Figure 21 for each product family. It can be observed that in average **25%** of each container is not used while shipped, resulting in a high freight cost. For the calculation of the unused space in each container Equation 9 has been used in order initially to find the percentage of fill containers. Then, to obtain the idle volume per container, each value taken from Equation 9 is subtracted from the container's size **88.128m**^{3}.

$$Percentage\quad of\quad fill\quad containers = \frac{(Pallet\quad Height\quad +\quad Product\quad Height) * Pallet_w\quad * Pallet_L}{1000000\quad * total\quad pallets\quad per\quad container} \tag{9}$$

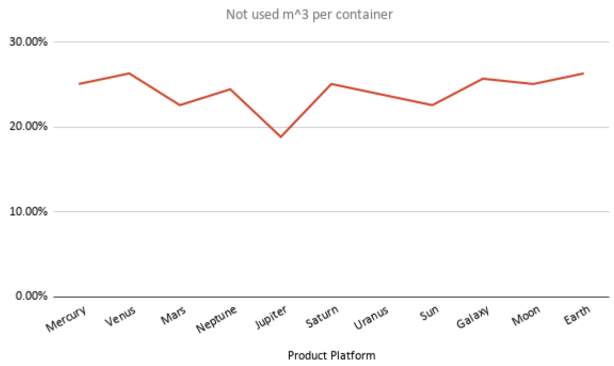


Figure 21: Not used volume (m^3) per container for each product family

Various scenarios have been studied in order to decrease the high freight cost. All three scenarios are briefly described in Table 1.

Scenarios	**Descriptions**	**Freight method**
Product	Calculate cost per product	Product-Family-Location
Family-Location	Same family/container. Ship from one production facility to one market.	Family - Location
Location	Products in one container are produced in the same facility and have the same market.	Location

Table 1: Freight scenarios

The first scenario represents the freight cost as calculated in sub-section 4.1.2. In the second scenario each container contains only one family and can be shipped from one production facility to one type of market.

For the calculations stage the maximum cost per container is computed as shown in Equation 10 which is then multiplied with the containers needed in order to obtain the new freight cost of the 2^{nd} scenario Equation 11. In the final scenario products in one container are produced in the same production facility and then shipped to the same market location.

$$Max \quad cost = \frac{Freight \quad cost}{ContainerstoEU \quad + ContainerstoUK \quad + ContainerstoUSA} \tag{10}$$

$$Freight \quad cost_2 = max \quad cost * containers \quad needed \tag{11}$$

Figure 22 illustrates the comparison of the freight costs of the two first scenarios per product family. It can be seen that is some product families (e.g. Neptune, Jupiter) the freight cost has been reduced in the 2^{nd} scenario.

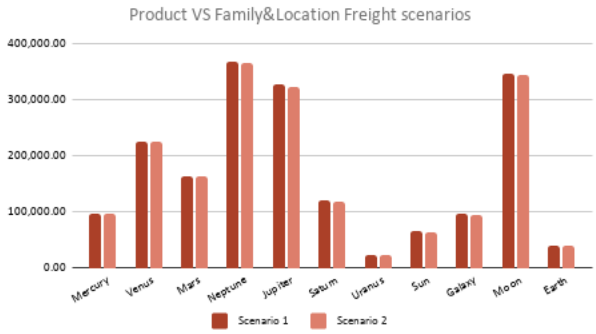


Figure 22: Freight costs of the two scenarios

Finally, Figure 23 shows the total freight costs in million euros of each scenario; in both scenario 2 and 3 the cost has been reduced.

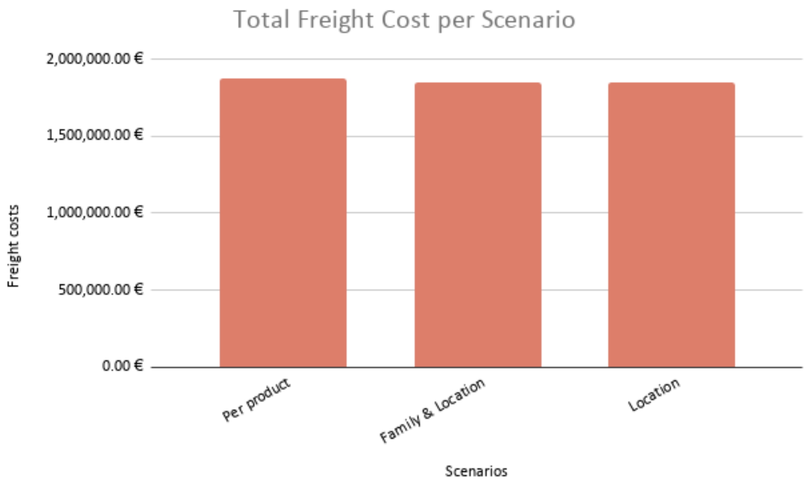


Figure 23: Total freight cost per scenario in euros

In Table 2 the freight cost reduction in euros for each scenario is shown. Both scenarios 2 and 3 have almost the same proportion reduction being €20000 approximately. This amount corresponds to **1%** freight cost reduction.

It should be argued that the freight cost has not decreased significantly. This is likely due to the required number of containers, which is computed by the volume each product family takes up. For example, a large amount of container volume is wasted by Saturn due to its big dimensions, resulting to a high transportation cost. The freight calculations may be found in the ”Freight”excel file.

https://www.overleaf.com/project/5ff9e58f57997a2a68f8e1ef

Table 2: Freight costs and savings in each scenario

Scenarios	Freight costs	Savings	%Savings
Per product	€1,874,482.56		
Family & Location	€1,854,142.18	€20,340.38	1.09%
Location	€1,854,250.18	€20,232.38	1.08%

5.4 Initiative 4 - Component Sourcing

Reducing the cost of purchasing materials could probably Garden A/S might consider to be focused with. Therefore, components which are shared with the product range, might have limited range of components. This can result in an increased amount of such components. As shown in the table 4, Garden A/S can reduce the cost of purchasing for the components. The table as in section 9 illustrates the relationship between increase in price and decrease in volume.

Component sourcing was calculated considering unit sales in place of original CI per component family. From the available company data, it was evident to first consider to replace the unit sales for each product variant. Later, we managed to merge the components on product family level. The merging of components for products was based on eliminating the product variant and reducing complexity cost, however, we managed to reduce the number of components just not aiming the highest possible gains.

The number of components were managed to be reduced are **90** from the total of **140** products which can be seen illustrated in the figure 24, after rough calculations based on the methodology of merging the least amount of components to the greater amount of components. This calculation of **90** removed variants constitutes to **64.29%** of the total volume.

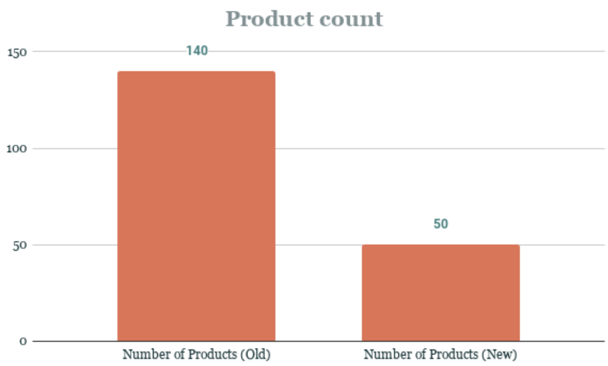


Figure 24: Difference between product variants

Figure 25 depicts the outcome from the calculations done using table 4 and formulates the final count from the range of 5% until 24% by also considering the count of unchanged product - components dynamics. Considering the reduction in price, updated values were evaluated for total product value and total savings on CI which could be seen in the Appendix under filename with folder . A bar chart with difference between old and new product value of components per product family can be seen in figure 29 under section 9 for the reference. The total difference between the old product cost and updated cost could be found around **€455.278,82** which constitutes to **10.87%** in savings.

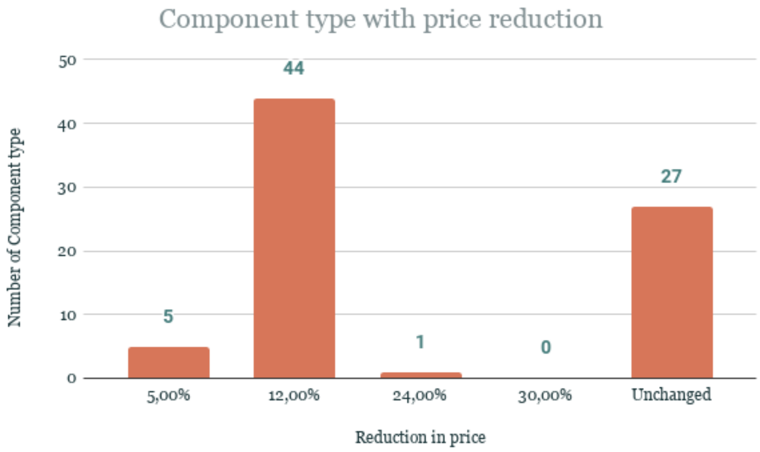


Figure 25: Count of products considering price reduction

6 Evaluation and Prioritisation of Initiatives

The respective section implies a reflection on combined evaluation encountered in concluding the analysis. This section can guide reader to identify the prioritization of the scenarios as explored in the previous chapters.

6.1 Combined Effect of Scenarios

The logical next step was to combine the different scenarios and detect the viability and possible reductions in the company's overall complexity. Although many permutations could occur in various ways and iterations, it was decided to associate those scenarios that had the shortest leap in areas that were optimized and those that had the least interference, so that the studies that were done before the merger were not lost. This lead to the decision to test the combined effect of Product Assortment with Component Assortment and Product Decoupling with Freight.

6.1.1 Product Assortment with Component Assortment

In order to combine the updated product assortment, a second component sourcing scenario for the adjusted product portfolio has been carried out. Interestingly, the overall number of used components dropped from **140** to **125**, while adjusting the component list for the remaining product variants. The merging of components was based on product family and the overall component utilization across all product platforms. Accordingly, the overall component utilization was based on the unit sales derived from the estimation of the realistic scenario of the product assortment adaptation. Hence, if different products of a product family incorporated different component types of the same component,these were merged into the component type displaying the highest application amount across the overall portfolio. In some cases this guideline was overruled. If a merging opportunity would present itself with the possibility of reducing the overall amount of component types used by the portfolio products, this opportunity was seized, even though the overall unit sales initially demanded differently.

Subsequently to the updated overall component list the discounts arising from the volume increase for the remaining component types were determined. These price adjustments were utilized to update both the overall component inventory value, based on the adjusted unit sales, and the component inventory complexity cost. Surprisingly the total component inventory value only decreased by **0.11%**, and furthermore also reduced the component inventory complexity cost, from originally **493,529€** to **275,491€**. One explanation for this behaviour might be that the merging of component types, was based on ineffective rules resulting in poor component value discounts and/ or sub-optimal merging of originally cheaper component types. It seems as if the savings from the discount in component value is cannibalised by the increase in unit sales, resulting in almost equal values for the overall component inventory. Following a similar logic, the steep decrease of component inventory complexity cost is most likely due to the reduced amount of component types, both variant-wise and in the overall utilization in the updated product portfolio.

Following this tactic will lead to slightly decreased EBIT values and margins in comparison to the standalone Product Assortment Adjustment. Unfortunately the adjusted component sourcing for the updated product assortment does not lead to the desirable reduction in fix cost but rather to a slight increase. This development swallows small parts of the EBIT and induces reduced values for both the overall EBIT and its margin. Although the combined scenario still shows impressive gains to be made, a standalone product portfolio reduction seems to yield similar if not preferable results, with unchanged rules and procedure. Furthermore the complexity of implementation, when applying both procedures increases, hence a combined approach without procedure changes is not advised.

6.1.2 Product Decoupling with Freight

Combining the Decoupling point and the freight optimisation made perfect sense as the decoupling already considered freight costs and reorganised the products according to several factors that significantly reduced complexity. A benefit from the freight optimisation that could dramatically improve the decoupling point was rearranging the containers with different family products.

In order to proceed with the merger of scenarios, the products were arranged primarily in groups that shared the same origin and destination. This gave six groups with the origins of Denmark and China and the three destinations to each of the EU, UK and USA.

Next was to arrange the product by the similarity of box dimensioning. Later on, this would facilitate visualising priority and disposition for locating the correct mix of products onto the pallet and subsequently in the container. This was the core notion for maximising occupancy and reducing idle space.

Various mix combinations of products were attempted, but the variability in amounts and the possible combinations were quite large. Having up to 5 different box sizes from Europe and 3 from China already suggested 126 options. In order to overcome this technical difficulty, we used a 2D combinatory algorithm provided at Planetcalc.com **(member, 2021)**. Initially, the idea was to run with a 3D combinatory, but we assumed the container could hold two layers, being both identical. This desition reduces the number of combinations and iterations to perform, resulting in superior mix combinations. An example of this optimization can be seen in Fig 20.

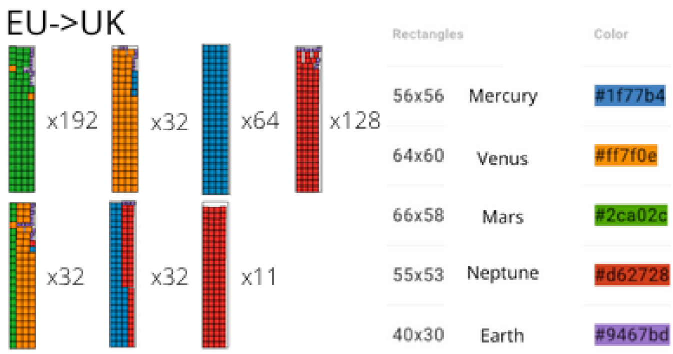


Figure 26: Example of box assortment for shipping from EU to UK

The result was a reduction both in the Freight complexity, its volume, its cost, the FGI cost and consequently an growth of 65,57% fort the EBIT. The results can be seen in the tab **Cost distribution**, in the file **Complexity Management complete** and the full assortment of containers in the file **Freight combined scenario Group 28** as well as a full graphic depiction in the Appendix in Fig 22.

6.2 Recommendation

There is clear untapped potential in what respects to assortment and modularity. After performing the permutation and morph of two scenarios within each other, we can see immediate gains in resources and an impactful reduction of complexity by merely rearranging the products by their common denominators and treating their discrepancies as separate products. This was seen both in the Decoupling scenario as well as in the product assortment. Besides, there is an even more intermediate expansion of capabilities by optimizing the freight service.

The below graph gives an overview of possible cost reduction initiative, it showcases four initiatives having Total Cost and EBIT gain. It comparison will be effective to make more sustainable decision in order to thrive in the market.

Scenario Comaprison	Product Assortment			Decoupling	Freight	Component Sourcing
	Optimistic	Realistic	Pessimistic			
Total Revenue	36.213.755 €	35.808.741 €	35.408.391 €	38.633.346 €	38.633.346 €	38.633.346 €
Total Cost	32.804.878 €	32.621.321 €	32.439.346 €	34.518.807 €	35.986.056 €	35.530.778 €
EBIT [€]	3.408.877 €	3.187.420 €	2.969.045 €	4.114.540 €	2.647.290 €	3.102.569 €
EBIT [%]	9,41%	8,90%	8,39%	10,65%	6,85%	8,03%

Figure 27: Combine Initiatives

As an immediate recommendation, we suggest that with the increase of EBIT gained from such optimizations, there should be some investment in R&D for modularity and DFMA. This would ensure the development of more streamlined products that resonate more with some DFMA practices. It will reduce the variability of products and components and provide flexibility towards new markets and state from the beginning the existence of base models with appendices, instead of different models with similarities.

Another point of further expansion should be the exploitation of combinatory algorithms for shipping and logistics. This should be a natural step to follow as the new assortment of products and Decoupling can provide new ways of combining shipping more efficiently.

We can for see that with this improvements, the company could adapt to new client demands in a shorter period and even expand its current client portfolio, as it would be easier to adapt to the requirements and costs of insertion of new market.

6.3 Action plan

From a pragmatical point of view, we highly suggest embarking on both scenarios within a different period. For this, we propose a short and long term plan of action. For the short term scenario, we suggest the consideration of the Decoupling and freight hybrid method. As indicated in the recommendations section, this would create a fast source of saving in an almost immediate way while keeping the products' technical intricacies intact.

For the long term scenario, Product and Component assortment is a natural choice to follow.

Although it did not have the expected impact, both scenarios by themselves showed great potential, and further rearrangements in product specs and modularity could pave the way for smarter and flexible design. In turn, this could expand the availability and presence of the brand in different markets regardless of their needs or requirements from current markets.

Of course, this last leg of the plan of action requires heavy investment. However, as mentioned earlier, such financing could come from the increased EBIT of the first plan of action regarding decoupling and Freight optimizations. After all, complexity management is about growth and not about cutting costs.

7 Conclusion

Throughout this project, we have delved into the company GARDEN A / S's processes and catalogue, whose areas of study were, broadly speaking, those of product and logistics. From the first meeting with the company's portfolio, a significant complexity level can be seen in its products and clients' catalogue. The measures taken to make the product flow from point A to B are cumbersome at best, and its product permutation does not allow for this to improve.

After conducting an ABC study and quantifying its complexity costs, it was clear that the company suffered from a large park of products that generated more costs than profits. Now the real challenge lies in defining whether to identify and curtail these points of loss or correct them with innovative assortment in neighbouring areas for improvement.

After performing various scenarios where different areas are optimized and then exchanging their qualities, we can conclude that immediate practices can correct the complexities inherited from an old corporate product catalogue model and look into more root-level improvements for a long term effect.

A fast-profit status with low investment cost could generate the necessary resources to improve the catalogue costs. This could be achieved by optimizing immediate areas of decoupling and freight. This, in turn, could generate the necessary means for improving its catalogue for a more responsive and smart one.

All these suggested improvements could position the brand and its products at the forefront of the market against the other players and make it visible to a more significant extent market with minimal insertion costs due to fast adaptability.

8 Reference

@articlelarsHvam, author = Lars Hvam Christian Lindschou Hansen Cipriano Forza Niels Henrik Mortensen Anders Haug, year = 2019, title = The reduction of product and process complexity based on the quantification of product complexity costs, URL = https://doi.org/10.1080/00207543.2019.1587188,

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9 Appendix

This report is based on provided data set from the course, further calculation are made in order to perform complexity analysis and providing possible recommendation.

From the submitted Excel file can be found here (Group28*Submision*), the **"Complexity Management Complete group28"** consist of major calculations and have all the graphs. Separate Excel **"Full ABC analysis, ABC analysis Group 28, Freight Group28, Freight machines no ACC Group 28, Freight combined scenario Group 28"** has been created to calculate ABC analysis, Decoupling, and Fright cost in this case study.

Below figures and table are part of appendix

Inventory rate for DC (DK)	
Rent	19,00%
Insurance	0,50%
Scrap	0,70%
Bank Interest	7,30%
Inventory Rate	27,50%

Inventory rate for DC (UK)	
Rent	17,00%
Insurance	0,50%
Scrap	0,70%
Bank Interest	7,30%
Inventory Rate	25,50%

Inventory rate for DC (USA)	
Rent	16,00%
Insurance	0,50%
Scrap	0,70%
Bank Interest	7,30%
Inventory Rate	24,50%

Figure 28: Inventory Rate

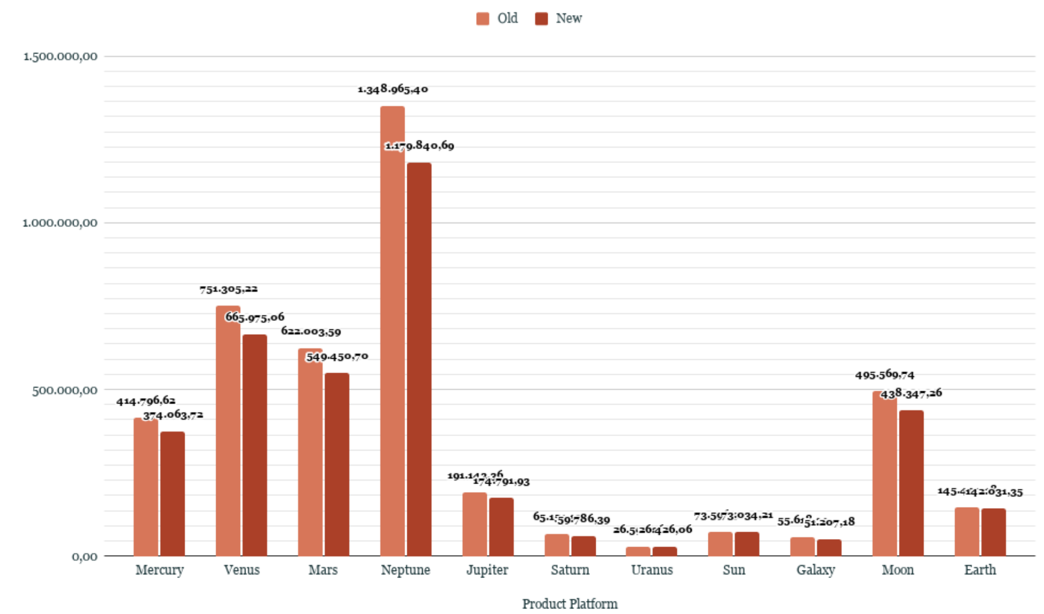

Figure 29: Product value of components per product family

Order Frequency	Min	Sec	Units Sale
High	5	300	>5000
Medium	7	420	1500-5000
Low	12	720	<1500

Table 3: Order frequency per unit sale

Increase in price	**Reduction in volume**
20% - 50%	5%
50% - 100%	12%
101% - 200%	24%
>200%	30%

Table 4: relation between price & volume

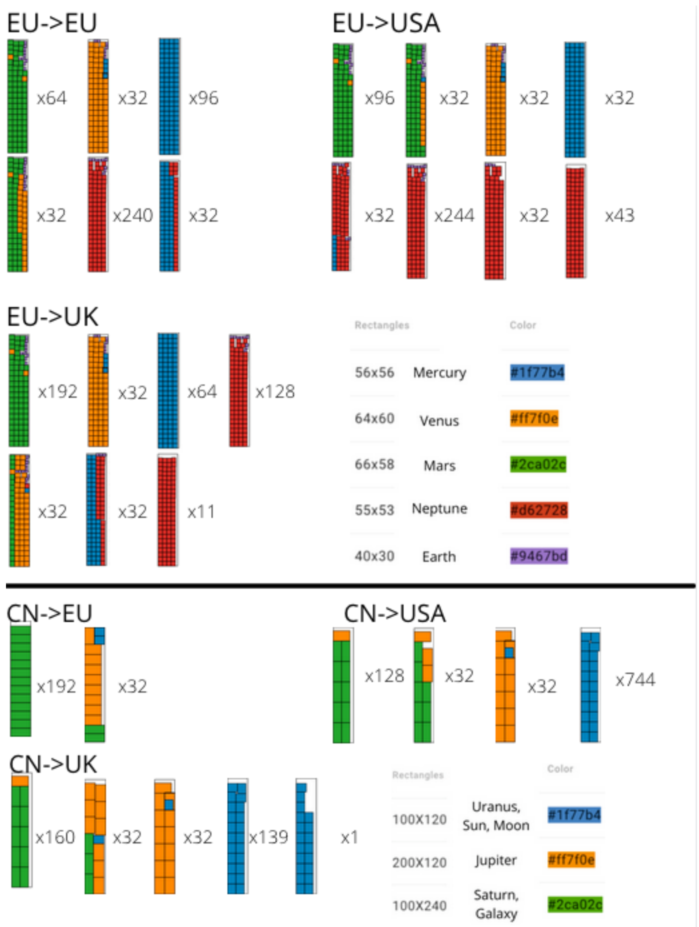

Figure 30: Full palette assortment by Origin, destination and amounts