Framework for developing product strategy for Configure-To-Order products

Myrodia, Anna; Hvam, Lars

Published in:
Proceedings of 6th International Conference on Mass Customization and Personalization in Central Europe (MCP-CE 2014)

Publication date:
2014

FRAMEWORK FOR DEVELOPING PRODUCT STRATEGY FOR CONFIGURE-TO-ORDER PRODUCTS

Anna Myrodia, Lars Hvam
Technical University of Denmark, Department of Engineering Management, Copenhagen, Denmark

Abstract: *Companies producing customized products tend to increase the variety of their product portfolio, in order to fulfill the demand of their customers and align with the competitors. Nevertheless the profitability of the product families may vary greatly. The purpose of this paper is to analyze profitability of Configure-To-Order (CTO) products. The framework consists of a 4-step model: Analysis of product assortment, Profitability analysis on configured products, Market and Competitors analysis, Scenarios for future product assortment. The suggested framework is tested on a company. The results in terms of product delimitation and experiences gained from the case study are further discussed.*

Key Words: ***CTO products, product variety, profitability analysis***

1. INTRODUCTION

The latest tendency of manufacturing companies is to increase the number of different products they offer to their customers, in order to satisfy their requirements and target new customer segments. Sustaining a competitive advantage is also a "key" driver for companies so as to widen their product portfolio. Mass customisation concept is highly embedded to the offering variety of products [1] [2].

Alptekinoglu [3] compares two companies, operating under the concepts of mass production and mass customisation. The research results in a need of the mass producing company to reduce its offering variety in order to sustain a competitive price to the mass customising company, which offers a larger variety of end-products.

The increasing variety of the product assortment is interrelated to the increase of complexity, both in products and processes. Complexity is considered to be a controversial term, as it usually connected to unnecessary activities and costs. However, the trend of a wider range of products provided to the end-customer is highly embedded to the Configure-To-Order (CTO) operating manufacturers [4].

When producing CTO products, the desired level of product differentiation can be achieved, as many of the variable parameters can be configured in order to fulfil specific customer requirements. Several researchers have been working on identifying the value adding product attributes that when differentiated, they offer the required variants [5] [6] [7].

To this end, the need of managing the product variety has become imperative and several approaches have been applied [8] [9] [10]. The purpose of this research is to create a detailed approach on how CTO manufactures should deal with product assortment issues. For this reason, several drivers have to be taken into consideration, such as product profitability, customer preferences, and competitive products to the market.

The rest of the paper is structured as follows: Section 2. The literature review identifies and discusses the existing approaches to profitability analysis studies, and management of product assortment. In section 3, the research methodology is argued. In section 4, the suggested approach is presented and, then in section 5, it is tested on a study case. Finally, in section 6, conclusions and issues for further investigation are discussed.

2. LITERATURE REVIEW

The literature review is focused on two main research areas, product management and profitability analysis. Nevertheless, it is even from the beginning realised that these two fields are highly interconnected. In order to gain a deeper understanding and be able to perform a critical literature review, the approaches for profitability analysis are presented first, and then the different suggestions for management of product portfolio.

2.1 Profitability analysis

Wheeldon [11] discusses the different aspects that have to be taken into consideration when identifying a product policy. The market where the company operates, international markets of current or future operation, technological status of own products, and, technological status of products offered by competitors are subjected to further analysis. This will provide the company with a valid perspective of its position in the market. Wheeldon [11] also suggests that short-term solutions, when defining the new product range, should be oriented towards the existing customers.

Wearden [12] lists the main factors that have to be included in a performance analysis. Turnover, profit and ratios, sales record, capital utilisation and overheads are among them.

Hansen et al. [13] perform an ABC analysis of product profitability by calculating the contribution margin and net revenue of each variant, and then making the ABC classification by using the Pareto Law [14].

Muneer and Sharma [15] point out the need of diversity inputs when developing a product strategy. Production planning, product development, and sales are these aspects.

Helo et al. [16] proposes a decision support tool, connecting product family design to cost analysis. The product structure information is related to volume and cost, so as the cost of managing the product portfolio could be estimated. Activities included in this approach are adding new variants into a product and substitution of a specialised component with a standard one.

2.2 Portfolio Management

By performing a critical literature review, it is realised that portfolio management is highly related to the profitability analysis.

Flapper et al. [17] discusses two strategies regarding product assortment. The first one investigates the contribution of each product to the total net profit, while the second strategy has the same approach but for customers. Two mathematical models are developed for determining the optimal product and customer based assortment.

Mathematical modelling and heuristics have been used by several researchers regarding product profitability. Dobson and Kalish [18] create mathematical program to quantify profit of a company taking into account products' desirability, fixed and variable costs. Additionally, the suggested methodology can also include, apart from own products, similar competitive products. A more customer-oriented ABC analysis is introduced by Liiv [19] [20], using demand association in order to improve the products classification.

A framework for evaluation of the product line design is introduced by Li and Azarm [21]. The framework includes factors that affect the evaluation, such as commonality of variants, customer's preferences, competitors and business goals.

The identification of the optimal set of products for a company, so as to maximise its value, is also discussed by Gonzalez et al. [22]. Value is realised as the sum of benefits of a set of products minus all costs created throughout the products' lifecycle activities.

De Reyck et al. [23] assess the relation between portfolio management and information technology projects, and identify that portfolio performance is one of the objectives. The suggested methodology for the financial analysis includes calculation of return on investment (ROI), internal rate of return (IRR), net present value (NPV) and economical value added (EVA). Similar approaches have been suggested by Beroch [24] and Mc Grath and Macmillan [25].

A framework for examining the decisions regarding a company's variety is presented by Kamalini [2]. The number of products, the targeting markets, and the time for each product to be introduced are identified as the key drivers of variety creation. Its implementation is related to the company's resources and capabilities.

3. RESEARCH METHOD

The previously discussed literature is identified from researching online libraries by the use of keywords, such as "product assortment", "profitability analysis", "product management" and "product planning". Additionally, the list of references of each article is used to identify related bibliography, as well as the names of the researchers in the recognised research groups within this field. As the content of this research lies also upon complexity management, the research group has used sources from an extended literature study performed in this field. The critical literature review is not only used for deeper understanding of the so far developed approaches, but it is also part of the interpretative philosophical position in the chosen methodology [26]. In order to test the suggested methodology, a study case is performed.

The suggested methodology is initiated from both the existing literature and by experiences from practitioners. In details, the approaches in the field of product management, product planning, and product's profitability have been the starting point of developing the suggested method. The method is also based on experiences from the industry, not only of the members of the research team, but also from experts.

The procedure is created by researchers with background in mass customisation, complexity management, mechanical engineering, and applied experience in the field of operations management.

Internal validity is achieved, as the research team has fully access to detailed data from the company. In order to gather accurate quantitative data, un- and semi- structured interviews are performed with the "key" informants.

The main limitation to this research project is its generalizability. As there are results only from one case study, external validity can be challenged [27]. However, this case is considered to be an exploratory study, in order to have an initial result from the application of the suggested methodology. Additionally, the under examination company is considered to be highly representative of the CTO manufacturing sector. Further information about the company is discussed in section 5.

The main scope of this study case is to test the suggested methodology and receive feedback from the managers in the company. The applicability of the data set is also tested and evaluated by the company. Another crucial reason for performing this study case is the discussions with the managers through the whole period, for the analysis performed and their reflections on the results. Feedback received is valuable for the verification of the methodology and for further improvements.

4. FRAMEWORK FOR DEVELOPING PRODUCT STRATEGY

Based on the literature review, a method for developing a concrete strategy for product assortment in CTO companies. The suggested framework is built upon the related research fields and attempts to include all aspects that should be taken into consideration in order to develop such as strategy.

It consists of four main phases, which have been suggested by product planning literature. The first step is scoping and defining the focus of the products to include in the analysis. The second step is an internal analysis, which is mainly inspired by literature on profitability analysis [13] [34]. The third step is an external analysis, as suggested from the product planning literature. The core idea suggests an analysis of the competitors' and their products in order to place the under investigation company to its market position. The final step is the synthesis. Based on the results from the internal and external analysis, suggestions are made for future development. The 4 steps of the method are briefly presented in the following figure and further described in the following sections.

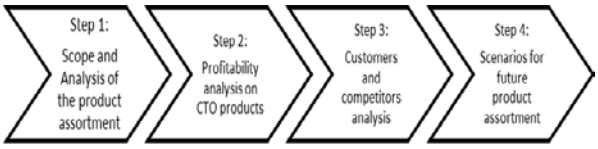

Figure 1. *Framework for developing product strategy*

4.1 Scope and analysis of the product assortment

The suggested method has as its starting point the definition of scoping within the project. Firstly, it has to be clarified which products or/and product families are to be included in the analysis. Based on experience and literature review on case studies within this area, the main indications for a product to be included in the analysis are low profitability and decrease in sales volume. These two factors usually signal the need of action and initiate further examination.

Additionally, since the focus is on CTO products, an overview of the technical characteristics of the products is performed. This overview enables better understanding of the product range in terms of structures, components, dimensions, but also applications, sales price, cost prices etc. The PVM technique is used at this stage to analyse the product structure, including component features, assemblies, and main attributes [1]. An in-depth PVM model gathers almost all data required for the following steps of the discussed framework. Data for this step are to be collected from the designs of the products and the company's internal database, such as Product Lifecycle Management (PLM) and Enterprise Resource Planning (ERP). Un- and semi- structured interviews with persons involved in each project, are performed to supplement the accuracy of the findings.

4.2 Profitability analysis on CTO products

Once the analysis of the product assortment is performed, the next step refers to the analysis of its profitability. Data collection includes sales numbers, cost price, sales price, which are provided by the company's database [23]. It is of great importance to ensure how cost price is calculated. The most common approach describes that cost price includes material cost and production cost. Additional factors that might add up to the production cost are, as identified from the existing literature, engineering, labour, machinery, and inventory costs [28].

Contribution margin is the sales price minus the production cost. As it is mentioned above, production cost includes the material and direct labour costs. In some case it is relevant to include the indirect production costs, which could be tools, machines, rent of the warehouse, and white collar wages.

Furthermore, an aspect that has to be taken into consideration while performing the product profitability analysis is whether the product is sold as individual or as a sub-assembly. Spare parts are also to be examined separately.

The next task of the second step is to calculate the gross margins of the product assortment. Gross margin is the difference between the sales price and the cost price of each product. Then, contribution ratio is calculated as the percentage of contribution margin of revenue. This calculation has to be made on product- and on product family- level. The results from this analysis reveal dependencies among the different aspects of the product assortment and are to indicate the most profitable products, and separate those that contribute on a lower level to the benefits.

4.3 Customers and competitors analysis

Step 3 is the analysis of customers and competitors, in order to understand the placement of the products in the market. To perform the customers' analysis, the information can be gathered on several levels, such as specific companies, industrial sectors, or countries. Data related to customers include sales number, discount policies, and the exact variants that each customer purchases. The last one is used to define the possible linked revenue of each product. The outcome of this analysis is the classification of the customers and the identification of the interdependencies among the customers and the product assortment. [29]

The second phase of step 3 continues with the analysis of the competitors [30]. At first, the competing companies have to be identified and the products they are offering have to be described in a similar way, as the under examination products, so as to enable comparison on valid terms. The PVM technique is also suggested at this phase for the competitive products. The level of detail required is not high, as the prior interest is to make a comparison among the characteristics that have been identified as main "strengths" or/ and "weaknesses" of the own product assortment. It is realised that due to confidentiality and competitive issues, it is not possible to gather the same amount of information for the competitive products. Sales prices and technical characteristics that can be obtained from sales catalogues are of main interest.

An overall conclusion can be drawn by calculating the relative market share for the competitors and the own company.

4.4 Scenarios for future product assortment

The final step of the suggested methodology refers to the development of scenarios for a future optimised product assortment [31] [32]. Scenario creation is based upon the outcomes and conclusions of the previous three steps of the analysis.

The scenarios may vary from case to case, however they are developed based on three main concepts, as it has been identified from the literature review.

The first scenario refers to decreasing the number of variants. One way that this solution is implemented is by eliminating the less profitable variants, which have been identified from the second step, the analysis of the profitability of product assortment. Linked revenue and product substitution have to be taken into consideration at the analysis of this scenario. Moreover, re-designing of specific components, or even products, is another option, which decreases product complexity and manages to keep the existing variety offered to the customers. Re-engineering costs have to be calculated, as well as the effect of the redesigned product, in terms of materials, dimensions, and production process, has to be measured on the related aspects, such as freight, inventory, and production costs.

The second scenario includes changes in the production flow. Investment in new machinery, new production sequence or application of LEAN principles are the most common suggestions. All the related costs have to be estimated, as well as the depreciation period of any investment.

The final scenario that is examined is the complete elimination of the product assortment. This scenario is considered as a drastic solution, as it suggests the complete stop of the production, in cases where the previous two scenarios do not offer enough benefits to invert the situation of the poor performing products. Substitution of the obsolete products and the linked revenue has to be scrutinised.

The final step is completed by an evaluation of the suggested scenarios and the final decision is taken after the comparison of the assessed scenarios, and points out the optimum solution for the development of the future strategy for product assortment.

The suggested methodology discussed in this section is applied on a case study. The description of the case and the results are further discussed in the following section.

5. CASE STUDY

For the case study a CTO company in the heating and ventilation industry is chosen. The company has operated approximately 45 years within a global network of more than 40 countries; however its products are designed and produced in Denmark. It employees around 550 persons, and it has an annual turnover of 750 million Danish crones. During the last years, the company has been facing decreasing number of sales in the main product family of its portfolio, along with declining revenue.

All data used for the analysis and calculations were acquired from the electronic database of the company.

5.1 Analysis of product assortment

The examined product family has been characterised by declining number of sales through the last years. At this point, the company is considering whether there is profit on maintaining the production or discard the whole family out of the product portfolio.

The product family consists of 3 products, A, B, and C. Product A has the largest size of all and it is the second most beneficial in terms of net revenue. The market for A is mainly food industry. Product B contributes the most in the net revenue, it has the smallest size, and its market is within the industrial sector. Product C is the newest addition to the product portfolio of the company, which has medium size and low contribution to the net revenue. Due to the difference of the material of product C in comparison to A and B, the marine sector is its main market.

The PVM technique is used to gain technical overview of the product structures and their components.

5.2 Profitability analysis on configured products

The first step at the analysis of the profitability of the 3 products is the annual sales numbers. Data are acquired from the EPR system of the company referring to the last six years. 4.434 orders have been placed for the product family, which resulted in 7.090 units sold. In details, for product A 714 units have been sold, for B 4.912 and C 1.464.

From the following sales figures, variants that are used as parts of other solutions are excluded; that is due to the fact that the sales price is not registered for each part used, but only for the final solution.

The variants taken into account had to meet three criteria; every order has to have an active Expected Cost Price, Actual Cost Price and Sales Price, in order to have coherency among the data analysed.

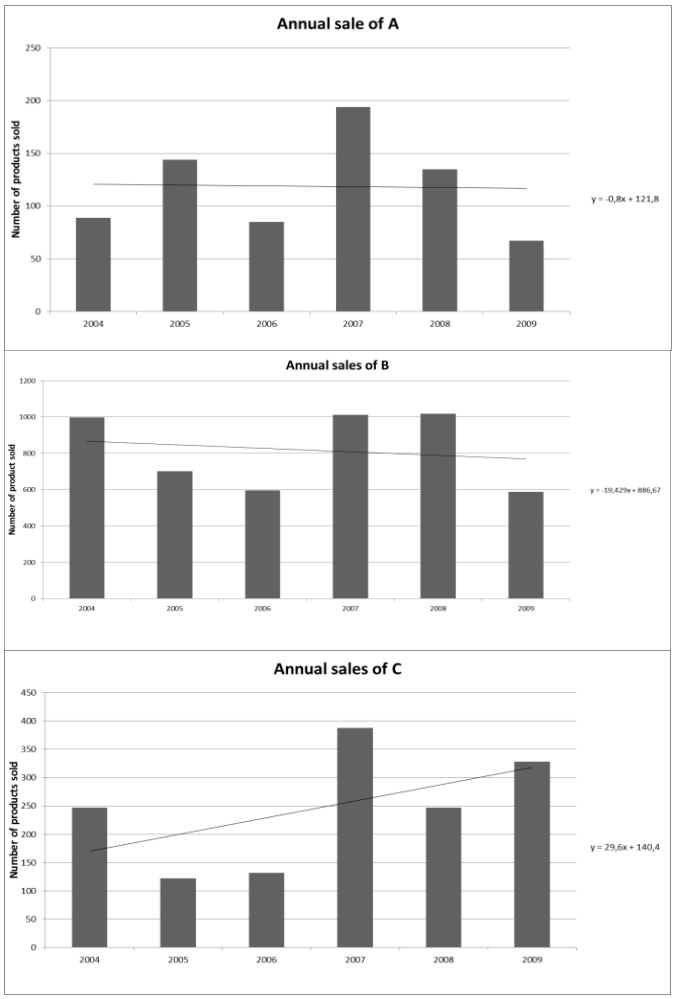

Figure 2. *Annual sales of products A,B,C*

Data provided by the company include the transaction date of sale provided in the format month/year, project number, Sales price, number of units sold, Actual Cost price, Expected Cost Price, description of sale, type that indicates if the transaction is a single piece sale or part of other solutions and country where the sale is carried out. Spare parts are also excluded from the analysis, as there is lack of information about their exact size and the sales country. The analysis is made for each product. The difference between the sales price and the cost price provided the basic gross margin.

The expected cost price originates from the company's product configurator, and is based on bills of material calculation and the cost of labour in the production. The actual cost price comes from the post-calculation at the end of production and includes the same parameters that are used in the previous calculation. The ratio between those two figures gives an indication if the configurator is miscalculating a given order or that there has been some kind of problem in the production.

By performing Grubb test for the outliers, it is concluded that orders within the range of 65 % and 135 % of the expected cost price are acceptable. The Grubb test detects the outliers and then it expunges them from the dataset. This allows a valid statistical analysis [33].

5.2.1 Gross margin calculation

Gross margin is calculated as the difference between the sales price and the cost price of each product. Then, the gross margin is allocated on every different variant. The analysis is made on a product family level, but also on A, B, C product and variant level.

The results indicate that the average gross ratio for product A is 38,6%. The revenue of the product A accounts for 48,1% of the total revenue of the product family and 44,7% of the total gross margin. The analysis also reveals that 88,3% of the total revenue comes from 50% of the product range. This raises questions regarding a reduction of the number of variants offered.

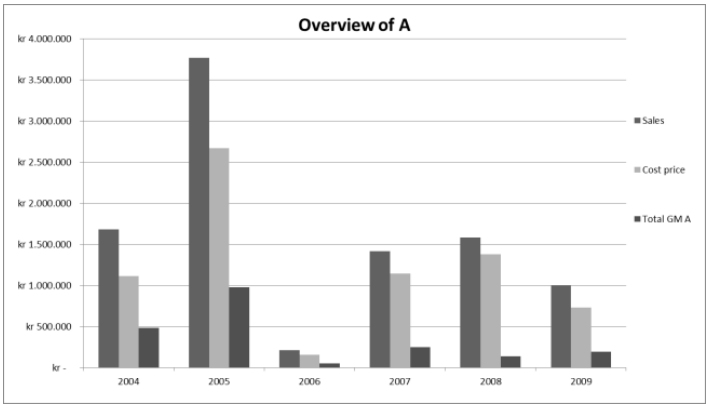

Figure 3. *Product A overview*

Product B is the most profitable product within the family, with gross ratio 48%. It also counts for 35% of the total revenue, 66% of the units sales and 38,5% of the gross margin. The analysis, furthermore, reveals that one variant counts for 25% of the gross ratio and number of sales.

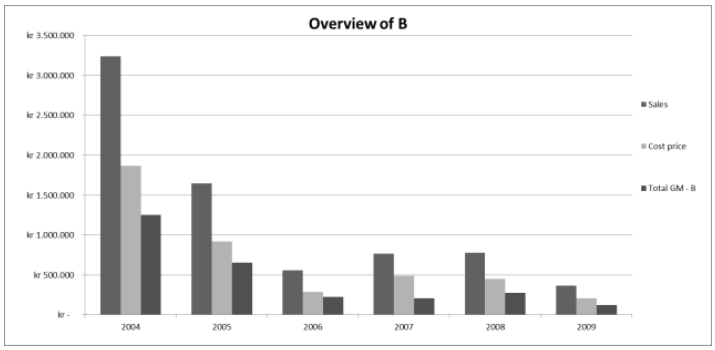

Figure 4. *Product B overview*

The gross ratio for product C is 37%, which counts for 18,7% of the total revenue for the product family and only contributes 16,7% of the total gross margin for the product family. Four variants are responsible for 82% of the revenue. Moreover, the newly introduced C product is not performing according to what it was expected from the company, in spite of the fact that it applies the latest technology in product development and strong marketing techniques, which are expected to lead to a significant market share.

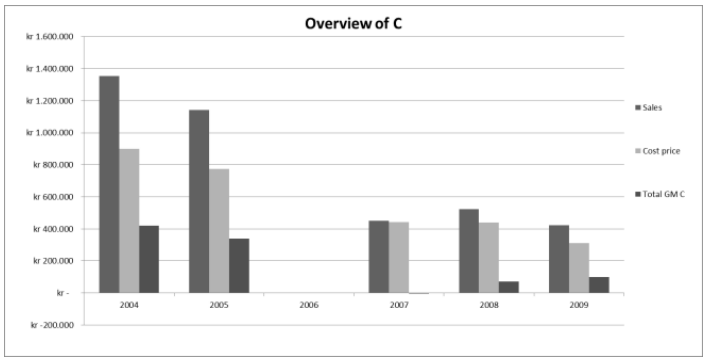

Figure 5. *Product C overview*

The gross margin is calculated based on the production costs. Based on the individual sales analysis of each product, the comparison reveals that the most profitable variant clearly identified, is product B.

5.2.2 Engineering Cost

When engineering hours are used it directly affects the gross margin because the customer is not charged directly for engineering hours used on a project. The overall cost of engineering during 2004 – 2009 is 851.877 DKK for known sales. Because sales vary through the years the total cost of engineering between years does not give the right picture of the development for the product family. Therefore it is more relevant to take a look at the total value of engineering resources used for the product family per year and divide that number with the total sale per year. The result is the average cost of engineering per sold unit and is displayed in the following figure.

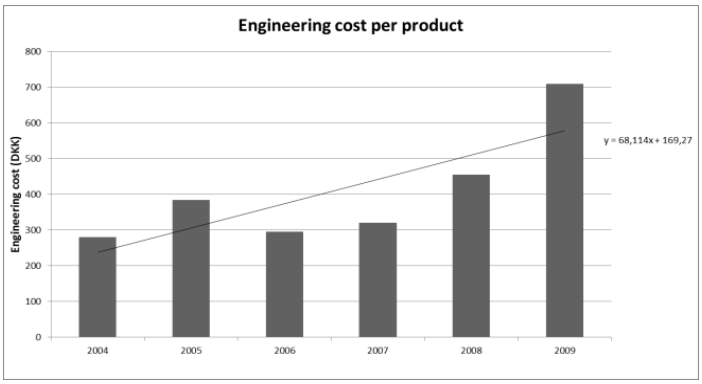

Figure 6. *Engineering cost per piece*

From the results is it released that engineering cost is increasing, and consequently gross margin is declining. This indicates that the demand in specialised products is increasing through years.

5.2.3 Sensitivity Analysis

The sensitivity analysis is used to investigate the impact of different parameters. In this case study an important parameter to examine is the subsidiary mark-up. The sensitivity analysis explored how much it would mean for the Company group in the course of five years if the subsidiary mark-up would be 4%, zero point, 25 % and finally 35 %. The results are presented in the following table.

Table 1. Subsidiary mark-up

Year	2009	2008	2007	2006	2005
Sale	983	1400	1594	812	968
4,00%	-85	-895	-448	1306	673
4,51%	-36	-845	-374	1349	741
25,00 %	598	-208	555	1920	1619
35,00 %	922	118	1020	2223	2068

The subsidiary mark-up of 25% is the mark-up claimed by the head of the Netherlands subsidiary, backed up by sales personnel at the company.

5.3 Analysis of Customers and Competitors

In this section the results from the competitors and customers analysis, respectively, are presented.

5.3.1 Competitors Analysis

Three main competitors have been identified and analysed, companies X, Y and Z. The comparison is made based on the characteristics of the competitive products resulting from the PVM attributes, such as product efficiency and weight, technical characteristics, delivery time and sales price. A part of the analysis is presented in the following table.

Table 2. Competitors' analysis

Comparison of efficiency and weight between company, X, Y, and Z					
	Static pressure [Pa]	Air flow [m3/s]	Efficiency [%]	Weight without motor [Kg]	Total list-price [Dkk]
A1	2700	10	81	604	105462
Similar product from X	2916	10	79	367	60950
	1808	8	81	461	66292
A2	1880	8	82	578	74773
A3	1880	8	82	718	103494
Similar product from X	1939	8	84	468	62010
Similar product from X	1916	8	82	320	44238
A4	778	21	68	1686	222924
Similar product from X	854	21	72	720	84387
A5	1693	21	74	1154	182811
Similar product from X	1854	21	83	720	102311
C1	516	10	54	187	34012
Similar product from X	369	10	51	320	37067
Similar product from X	467	10	86	720	70696
C2	2879	5	80	187	34012
Similar product from X	2847	5	81	*	29017
C3	3875	1	70	40	10420
Similar product from Y	4000	1	80	*	*
B1	1275	1	71	35	4399
B2	1275	1	75	40	8754
B3	1575	1	75	40	9215
Similar product from X	1430	1	81	27,5	5740
Similar product from X	1693	1	79	27,5	7966
Similar product from Y	1400	1	68	*	*
Similar product from Y	1700	1	52	*	*
C4	1691	8	80	187	34326
Similar product from X	1493	8	80	*	55513
C5	552	1	77	59	10314
C6	570	1	76	102	19751
Similar product from X	609	1	82	41	6823
Similar product from X	577	1	78	50	8951
B4	1421	2	69	98	13305
B5	1421	2	69	102	16238
B6	1421	2	78	121	24134
B7	1308	2	75	59	12329
Similar product from X	1424	2	75,5	34,2	6845
Similar product from X	1443	2	80,9	61	11457
C7	1691	8	80	187	34326
Similar product from X	1716	8	82	320	44238
Similar product from X	1649	8	78	*	35234
B8	921	2	72	89	9580
B9	921	2	72	98	12781
C8	921	2	80	84	14548
C9	880	2	77	102	20811
Similar product from Z	965	2	82,7	67,4	10374
Similar product from Z	967	2	81,4	91	13403
Similar product from Z	962	2	79,6	59	13759
B10	605	8	71	359	37667
B11	605	8	71	394	44713
Similar product from X	579	8	85,1	720	70696
Similar product from X	546	8	75	367	40368
Similar product from X	576	8	85,2	580	48918

The competitors' analysis shows that company X is the largest player in the market and has a wide variety of products. Company Y has a smaller turnover compared to the studied company, but the products Y mainly focuses on, are the ones that are competitive to A, B and C. Efficiency and weight are parameters that the under examination product family lacks, as well as delivery time. The analysis results in pointing out the main advantage of the company, which is flexibility and service, even to the extent to fulfil customer´s needs although they do not fit its standard product range.

5.3.2 Customer Analysis

The customer analysed in made on country level and is presented in the following figures for A, B, and C products.

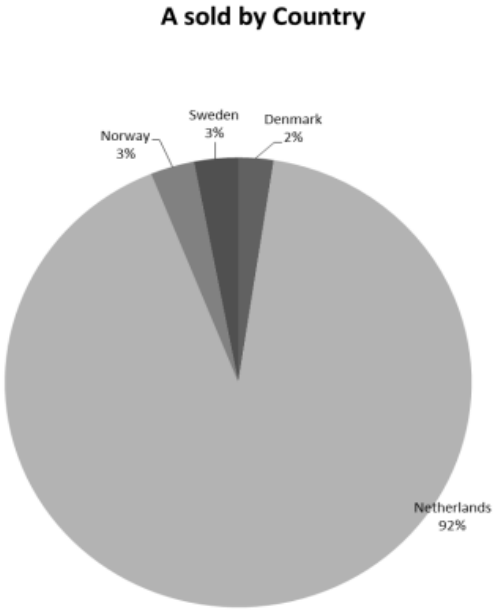

Figure 7. *A products sold by country*

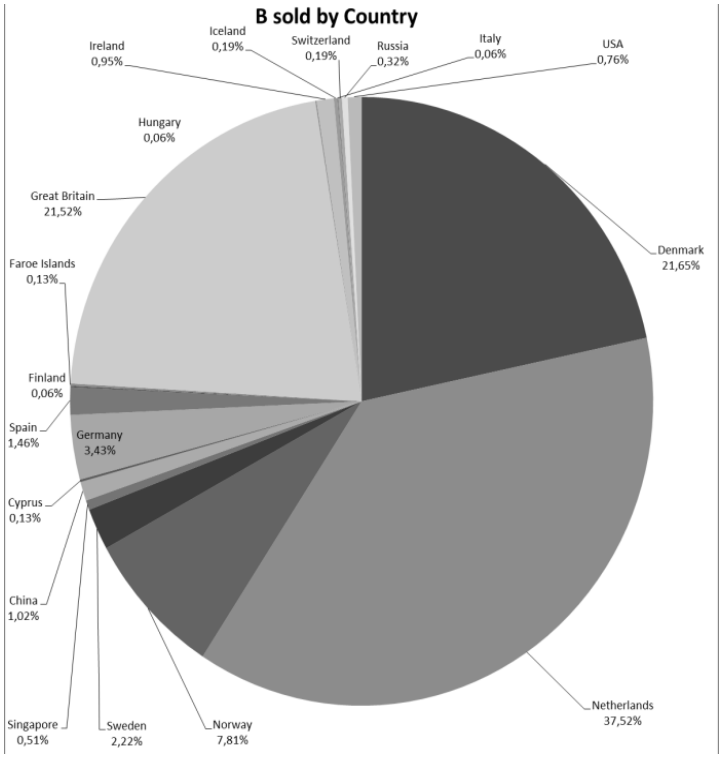

Figure 8. *B products sold per country*

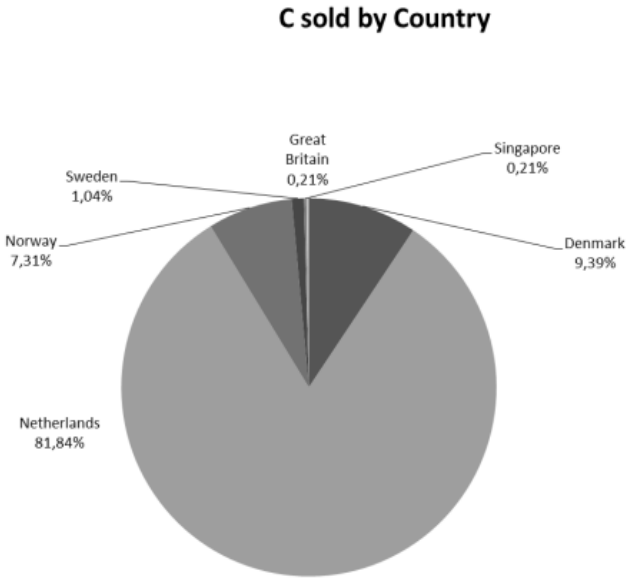

Figure 9. *C products sold per country*

Finally, the average estimated market share of the company and its competitors is calculated, which concludes in a relatively low market share (1.5%) for the company in the heating and ventilation products.

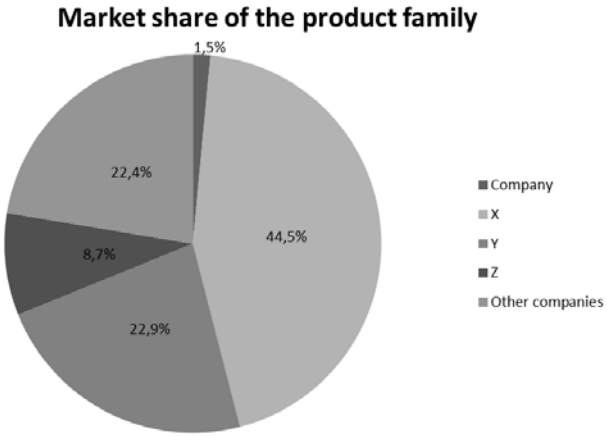

Figure 10. *Market share*

5.4 Scenarios for future product assortment

Although the product family has gone through the process of mass customization and standardization, there is a need for re-evaluation and further examination of the production set-up. After discussing with the company's chief engineer some suggestions can be made. One possibility according to the chief engineer is to decrease the material use for parts of product A. Another would be standardizing components and decreasing the number of variants.

5.4.1 Decreasing number of variants

From the PVM it is identified that the fan is produced in four different positions, 0°, 90°, 180° and 270°. Each position has its own centre height for each fan size. It can be seen from the information on the PVM that the centre height for positions 90°and 180° are similar positions 0°and 270° are closest to each other. Therefore it is possible to have the same centre heights for positions 90°and 180° and 0°and 270°. This means that the components connecting the fan house to the fan base can be decreased from 4 to 2, which results in decreasing complexity, both production- and assembly-wise.

5.4.2 Investment in a new machine

The plates for the variants produced at the company are cut in a laser cutter. After this operation, the remaining work required is welding for the under investigation product family is performed manually.

An investment in a robot welder is the second suggested scenario. However, such an investment of approximately 2.5 million DKK, is too big. As a result the suggestion includes the robot welder to be used for all the product families produced by the company.

By calculating the total number of welding hours spent on manual work and the number of hours that will be saved by using the robot. The estimated annual cost reduction of the implementation of the robot welder is presented in the following table.

Table 3. *Cost reduction by implementing the investment scenario*

Investment in a new robot	
Initial investment (DKK)	2.500.000
Product Family part	16,31%
Estimated cost reduction (DKK)	1.200.000
Investment ratio Prod Fam (DKK)	407.769
Cost reduction (DKK)	
A	51.917
B	31.563
C	37.532
Total cost reduction (DKK)	109.370

Based on the calculations the robot will be occupied by 16,31% of its time by the product family, while the rest of the time will be used for the welding process of the other product families of the company.

5.4.3 Stop the production

This scenario examines the benefits of stopping the production of the product family. There are two different options for the Company in that case; either to sell the customer base, or source similar products from competitors.

For the first option is required to estimate the future sales and sales value in order to calculate if this is a attractive solution for the possible buyers. This results in 1,25 million DKK earnings in the time horizon of 5 years for the potential customer. The following table summarises the estimated earnings for the Company when implementing the scenario of base selling.

Table 4. *Company's side of NPV with sale with calculation rate 11%*

Year	0	1	2	3	4	5
Income (DKK)		521.543	578.913	642.593	713.278	791.739
Sales (DKK)	4.741.300					
	4.741.300	521.543	578.913	642.593	713.278	791.739
NPV (DKK)	**7.090.594**					

In order to explore and evaluate the second option, of outsourcing the product family, a comparison is made between the total cost of producing the products in-house, and the selling price for the competitors' products. Outsourcing is 19,2 % more costly for the Company than producing its own products. The total costs are presented in the following table.

Table 5. *Cost comparison*

Outsourcing	In—house
73.301.165 DKK	61.479.904 DKK

5.5 Conclusions

The scope in the study case is to assist the decision making process regarding the future product assortment. In order to do that, the suggested methodology is implemented. Firstly, the product family is analysed, in terms of technical characteristics and profitability. Then, an analysis of the customers and the competitors is performed, in order to place the Company on its market position. Finally, based on the results of the previous steps, three scenarios are created. The benefits and the costs of each scenario are quantified; they are presented to the company as recommendations for the future product assortment strategy.

Based on the results of the scenarios and the feedback received, after the scenarios have been presented to a workshop in the company, the most feasible solution is to stop the production. If the company decides on outsourcing the variants from the competitors, it would only increase the gross margin if the company can get a discount on the products they purchase from competitors at least 16%, based on the cost calculations. As a result, the optimal solution would be to sell the customers' base, which will increase company's income directly.

6. DISCUSSION AND FUTURE RESEARCH

The purpose of this paper is to build and test the suggested methodology for developing product assortment strategy. Firstly, the relevant theories are used to build the conceptual framework of this research. The 4 step framework attempts to guide a systematic approach of product scoping, profitability analysis for CTO products, customers' and competitors' analysis, and scenario creation for future product assortment. It is a tool for assisting and co-ordinating the decision-making process of the product strategy in a company.

The application of the methodology to the case study reveals several options for the company's future, but also valuable feedback for further research and extension of the research method. The applicability of both the method and the required data is tested and verified. Moreover, the challenges in data gathering have been identified. However, since the methodology has been tested to only one study case, more cases have to be added. This will enable the research team not only to identify the limitations of the methodology, but also to improve and strengthen the structured approach.

7. REFERENCES

[1] L. Hvam, N. H. Mortensen and J. Riis, Product customization, 1 ed., Berlin: Springer-Verlag, 2008.

[2] R. Kamalini, “Managing product variety: An integrative review and research directions,” *Production and Operations Management,* vol. 12, no. 1, pp. 79-101, 2003.

[3] A. Alptekinoglu and C. J. Corbett, “Mass Customization vs. Mass Production: Variety and Price Competition,” *Manufacturing & Service Operations Management,* vol. 10, no. 2, pp. 204-217, 2008.

[4] L. Hvam, “Mass Customization in the electronics industry - based on modular products and product configuration,” *International Journal of Mass Customisation,* vol. 1, no. 4, pp. 410-426, 2006.

[5] R. Ramaswamy and K. Ulrich, “Augmenting the house of quality with engineering models,” *Research in Engineering Design,* vol. 5, no. 2, pp. 70-79, 1993.

[6] K. Ishii, C. Juengel and C. Eubanks., “Design for product variety: Key to product line structuring.,” Boston, MA, 1995.

[7] V. Krishnan and K. T. Ulrich, “Product Development Decisions: A Review of the Literature,” *Management Science,* vol. 47, no. 1, pp. 1-21, 2001.

[8] H. ElMaraghy, G. Schuh, W. ElMaraghy, F. Piller, P. Schonsleben, M. Tseng and A. Bernard, “Product variety management,” *CIRP Annals - Manufacturing Technology,* pp. 629-652, 2013.

[9] X. Wan, P. Evers and M. Dresner, “Too Much of a Good Thing: The Impact Of Product Variety on Operations and Sales Performance,” *Journal of Operations Management,* vol. 30, no. 4, p. 316–324, 2012.

[10] Y. Li, L. Li, Y. Liu and L. Wang, “Linking management control system with product development and process decisions to cope with environment complexity,” *International Journal of Production,* vol. 43, no. 12, pp. 2577-2591, 2007.

[11] A. Wheeldon, “Identifying a product strategy,” *IEE PROCEEDINGS,* vol. 133, no. 9, pp. 1-7, 1986.

[12] T. Wearden, “Dynamic product strategy,” *Electronics & Power,* pp. 813-815, 1981.

[13] C. L. Hansen, N. H. Mortensen and L. Hvam, “Calculation of Complexity Costs – An Approach for Rationalizing a Product Program,” in *Proceedings of NordDesign Conference 2012. Aalborg University, Center for Industrial Production*, Aalborg, Denmark, 2012.

[14] Pareto V., Kelley A.M. , Manual of Political Economy, English Translation, New York, 1971.

[15] S. Muneera and C. Sharmab, “Enterprise mobile product strategy using scenario planning,” *Information Knowledge Systems Management,* vol. 7, pp. 211-224, 2008.

[16] P. Helo, Q. Xu, Y. Kristianto and R. J. Jiao, “Decision support system for product variety mangement,” *Journal of Engineering and Technology Management*, pp. 1-17, 2013.

[17] S. D. P. Flapper, J. L. Gonzalez–Velarde, N. R. Smith and L. J. Escobar-Saldıvar, “On the optimal product assortment: Comparing product and customer based strategies,” *International Journal of Production Economics,* vol. 125, pp. 167-172, 2010.

[18] Dobson and Kalish, “Heuristics for Pricing and Positioning a Product-Line Using Conjoint and Cost Data,” *Management Science*, vol. 39, no. 2, pp. 160-175, 1993.

[19] I. Liiv, “Inventory classification enhancement with demand associations,” *IEEE International Conference on Service Operations and Logistics, and Informatics,* pp. 18-22, 2007a.

[20] I. Liiv, “Visualization and data mining method for inventory classification,” *IEEE,* pp. 1-6, 2007b.

[21] H. Li and S. Azarm, “An Approach for Product Line Design Selection Under Uncertainty and Competition,” *Journal of Mechanical Design,* vol. 124, pp. 385-392, 2002.

[22] J. P. Gonzalez-Zugasti, K. N. Otto and J. D. Baker, “Assessing value in platformed product family design,” *Research Engineering Design,* vol. 13, pp. 30-41, 2001.

[23] B. De Reyck, Y. Grushka-Cockayne, M. Lockett, S. R. Calderini, M. Moura and A. Sloper, “The impact of project portfolio management on information technology projects,” *International Journal of Project Management,* vol. 23, pp. 524-237, 2005.

[24] M. Benaroch, “Managing information technology investment risk: a real options perspective.,” *Journal of Management Information Systems ,* vol. 19, no. 2, pp. 43-84, 2002.

[25] G. McGrath and I. Macmillan, “Assessing technology projects using real options reasoning,” *Research Technology Management,* pp. 35-49, 2000.

[26] J. Meredith, “Alternative research paradigms in operations,” *Journal of Operations Management,* vol. 8, no. 4, pp. 297-326, 1989.

[27] Yin, R. K., Case study research: design and methods,, ed., : Sage Publications, Thousand Oaks, 2003.

[28] M. Zhang and M. M. Tseng, “A Product and Process Modeling Based Approach to Study Cost Implications of Product Variety in Mass Customization,” *IEEE Transactions on Engineering Management*, vol. 54, no. 1, pp. 130-144, 2007.

[29] D. R. Lehmann and R. S. Winer, Product management, New York: Mc Graw - Hill, 2005.

[30] S. Haines, The Product Manager's Desk Reference, New York: Mc Graw - Hill, 2009.

[31] S. M. Millett, “The future of scenarios: challenges and opportunities,” *Strategy & Leadership*, vol. 31, no. 2, pp. 16-24, 2003.

[32] P. J. Schoemaker, “Scenario planning: a tool for strategic thinking,” *Sloan management review*, vol. 36, no. 2, pp. 25-40, 1995.

[33] A. o. m. a. r. International Organisation for Standardization, *Basic method for the determination of repeatability and reproducibility of a standard measurement method*, International Organisation for Standardization, Accuracy of methods and results, 1994.

[34] Wilson Stephen A., Perumal Andrei, Waging war on complexity costs, Mc Graw Hill, 2009.

CORRESPODANCE

Anna Myrodia, PhD student
Technical University of Denmark
Management Engineering,
Produktionstorvet, Build. 424
2800 Kgs. Lyngby, Denmark
annamyr@dtu.dk

Lars Hvam, Professor
Technical University of Denmark
Management Engineering,
Produktionstorvet, Build. 424
2800 Kgs. Lyngby, Denmark
lahv@dtu.dk