Outsourcing in the Danish Fashion Industry

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Abstract

Purpose Improve the competitive performance of Danish fashion companies with tools for profit analysis, cost estimates, and supplier comparisons. Suggest management decision support tools for outsourcing through scenario analyses.

Design/methodology/approach Use of statistical analysis, operations research methodologies, and reviews of trends in global sourcing patterns.

Findings We see a trend towards increased Freight-On-Board production rather than Cut-Make-Trim. Macro-economic qualitative measures can be quantified to better support outsourcing decisions. Operations research have relevance to the fashion industry; it provides more profitable suggestions for decision-making companies of all sizes.

Research limitations/implications Access to more data than available for this report could lead to an interesting analysis for matching competitive goals and supplier types. Confirmation lacks on the precision of quantifying macro-economic impacts on sourcing decisions, using the Business Environment Ranking (developed by the Economist Intelligence Unit). No comparison between model recommendations and the judgement of an experienced, sourcing professional.

Practical implications The simple tools put forward in this report are suggested for inclusion in daily business routines to support outsourcing and purchasing decisions. Fashion companies are advised to investigate new suppliers, under the consideration of macro costs, indirect costs, and direct costs in that order.

Originality/value This report examines global fashion business practices from a Danish perspective. Using the Economist Intelligence Unit's Business Environment Ranking, the impact of macro-economic perspectives are included in an outsourcing-decision evaluation. Methods are proposed for estimating costs of delays, errors, wrong deliveries, etc. Price quote structures in the fashion business leave great opportunities for cost savings.

Keywords Sourcing, outsourcing strategies, operations research, Danish fashion, master's thesis, engineering, linear programming, integer programming, sourcing, fashion, apparel, clothing, garment, Denmark, comparative analyses, economies of production, macro costs, indirect costs, supplier comparison, business environment ranking.

Paper type Engineering approach

Executive Summary

Abstract

This is an executive summary of the report based on the M. Sc. Thesis "Outsourcing in the Danish Fashion Industry", carried out at the Department of Informatics and Mathematical Modelling at the Technical University of Denmark.

This paper outlines the reason for the M.Sc. project and introduces a tool for supporting management decisions in outsourcing. The tool may be used in the fashion industry to support a more profitable business conduct.

Tests on data sets indicated that there are significant cost advantages to obtain using this tool, especially for small and mid-sized fashion companies, who are typical less cost efficient than their large-sized colleagues.

Introduction

The Danish fashion industry is dominated by three large fashion groups within a segment of very price-oriented consumers for whom design is also important. In the higher-priced segment, design and branding becomes increasingly important; price remains a factor, though not the primary one. A densely populated group of fashion players compete in this segment and they account for the majority of Danish fashion businesses. As these players mainly compete on the local market

but at the same time iconify the Danish self-perception as an international fashion nation, the ambition of the industry to turn Copenhagen into a fashion capital is faced with a dilemma. This is further highlighted by the fact that these companies struggle to even yield a profit.

Danish fashion companies all outsource their production, which therefore establishes their main costs. For this reason the report focuses on identifying sourcing models and analytical tools to increase company profits.

The development of such tools are inspired by fashion industry consultant, David Birnbaum who argues that additional costs are of vital importance when evaluating suppliers. It is important to include considerations of macro costs (macro economic factors, quota charges, and tariffs) and indirects costs (damaged garments, delays, wrong lot deliveries, and quantity minimums).

The main purpose for this paper is not to give a complete summary of the M.Sc. thesis, "Outsourcing in the Danish Fashion Industry", but rather to present the tool and methods developed during the project and show the relevance of the tool to the fashion industry.

Project achievements

A tool for supporting management decisions in outsourcing is developed. It is divided into three steps: strategy, tactics, and operations:

Strategy A method developed and proposed for evaluation on which supplier collaboration, Freight-on-Board (FOB) or Cut-Make-Trim (CMT), best matches a company's competitive profile. The method is versatile enough to include other collaboration types as well.

Tactics An method is developed for supplier comparison analyses, which includes estimates of macro costs, indirect costs, and supplier price quotations.Further methods were developed to perform the cost estimates, and the more interesting are mentioned below:

- **Estimating costs of business environment**an experimental methods is suggested for estimating the macro cost of business environment. The method is based on the Business Environment Ranking from the

Economist Business Intelligence Unit, but may work for any ranking system.

- **Estimating cost of delays** The method include considerations to delay time and the fashion company's tolerance towards delays.
- **Damaged garments** With steady error percentages, this percentage can then be automatically included in cost comparisons

Operations Methods are developed to increase a company's profitability buy weeding out low profit styles and include surplus lot ordering to attain cost advantages due to price quotation structures.

The components of the decision tool

In this section the three-step process of the decision tool is briefly sketched:

Strategy: FOB vs. CMT collaborations

With this method the cost of working CMT or FOB is mapped to support a decision voting in favour of the collaboration method, which best support the competitiveness of a company.

The general formula for checking if FOB collaborations cost may be less than CMT collaborations is given below. The method includes all company costs linked to production, from development to post-production activities. Costs are mixes of variable costs and fixed costs.

$$p^{allfob} - \hat{p}^{cmt} \leq \frac{C^{fob} + \hat{C}^{coo}_{cmt} - C^{coo}_{fob}}{D^{std}}$$

To compare costs across collection size and composition, seasons, and time, garments are weighted into a standard garment, D^{std}.

$$D^{std} \equiv \frac{\sum_s w_s \cdot D_s}{\sum_s w_s}$$

where

D^{std}	number of 'standard' garments
D_s	the quantity of garment style D_s, e.g. D_{AW146} is an order of 520 skirts of style #AW146.
w_s	weighted value w_s of one piece of garment style D_s, e.g. w_{AW146} is the added value €14 for each skirt of style #AW146

Tactics: Supplier comparison analysis

This section proposes a method for comparing suppliers based on their price quotes, geographic location, and quality standards (few errors, delivery on time).

For the sake of simplicity, an example comparision including macro costs, is conducted:

Macro costs for a shirt

	Vietnam	Lithuania
Price quote	€3.5	€6.8
BER rank	5.92	7.04
BER cost ($\alpha = 0.3$)	€1.48	€2.64
Quota	€0.5	-
Subtotal	**€5.48**	**€9.44**
Tariff rate	12%	-
Tariff costs	€0.66	-
Macro costs total	**€2.64**	**2.64**
Total	€6.14	€9.44

As stated earlier, this method for supplier comparison analyses includes the further development of methods for estimating macro costs and indirect costs. The table below lists the order in which costs are entered to the comparison and their formula for calculation, developed and proposed in this report, beside it.

Category	Value	Formula
Direct costs	Price quote	p^{quote}
Macro costs	BER costs	$p^{BER} = \alpha \cdot \left(1 + (1 - \frac{r_{BER}}{10})\right)$
	Quota charge	p^{quota}, listed in price quote
	Tariff costs	$p^{tariff} = p^{quote} \cdot x^{tariff}$
Indirect costs	Damages	$p^{errors} = p^{quote} \cdot \frac{\#\text{of damaged garments}}{\#\text{ ordered items, D}}$
	Delays	$p^{delays} = p^{quote} \cdot a^{s\Delta_t}$
	Underdelivery	$p^{delays} or p^{errors}$
	Overdelivery	$p^{overdelivery}$, a fixed charge
	Order minimums	$p^{minimums} = (D^{min} - D^{mto}) \frac{p^{quote}}{D^{mto}}$
Total		

mto = made-to-order
D = demand
min = minimum
BER = Business Environment Ranking

Operations: profitability maximization

This demonstrates how Operations Research techniques solve complex scenarios to identify cost advantages and increase collection profitability.

Profitability maximization, made-to-order lot

First step evaluates a data set for low profit garments, and will suggest a solution, which increases the profitability of collection order. The method requires specifications for the langrarian constraint λ and the minimum accept of gross margin percentage $g\hat{m}p$. The method includes the impact of surplus material and result in a mixed-integer programming problem:

Objective:

$$\text{maximize} \quad Z = \sum_{i \in S} \Big(gmp_i + \lambda (gmp_i - g\hat{m}p) \Big) x_i - \sum_{j \in F} p_j Q_j^{excess}$$

Decision variables:

$$\begin{aligned} x_i &\geq 0 \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned} x_i &\leq D_i \quad , \quad \forall i \\ Q_j^{excess} &\geq 0 \quad , \quad \forall j \\ Q_j^{excess} + \sum_{i \in S} q_{ij} \sum_{k=0} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) &\geq Q_j^{min} \quad , \quad \forall j \end{aligned}$$

Profitability maximization, surplus lot

Second step investigates opportunities for costs savings by ordering surplus stock, enabled by special price quotation structures of the fashion industry.

Objective:

$$\text{maximize} \quad Z = \sum_{i \in S} \sum_{k=0} (g_k^{new} y_k + a_k^{new} x_k) - \sum_{j \in F} p_j Q_j^{excess}$$

Decision variables:

$$\begin{aligned} x_k &\in [0, d_{k+1} - d_k] \\ y_k &\in \{0; 1\} \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned} \sum_{k=0} y_{(i,k)} &= 1 \quad , \quad \forall i \\ y_{(i,k)}(d_{(i,k+1)} - d_{(i,k)}) - x_{(i,k)} &\geq 0 \quad , \quad \forall k, \forall i \\ x_i &\geq D_i^{mto} \quad , \quad \forall i \\ x_i &\leq D_i^{mto} + D_i^{surplus} \quad , \quad \forall i \\ Q_j^{excess} + \sum_{j \in F} q_{ij} x_i &\geq Q_j^{min} \quad , \quad \forall j, \forall i \\ Q_j^{excess} &\geq 0 \quad , \quad \forall j \end{aligned}$$

and

$$
\begin{aligned}
x_i &= \sum_{k=0}^{n}(d_{(i,k)}y_{(i,k)} + x_{(i,k)}) \\
gmp_{g_k} &= \left(\frac{r - \frac{g_k}{d_k}}{r}\right) \\
gmp_{a_k} &= \frac{r - a_k}{r} \\
g_k^{new} &= d_k * (gmp_{g_k} + \lambda(gmp_{g_k} - g\hat{m}p)) \\
a_k^{new} &= (gmp_{a_k} + \lambda(gmp_{a_k} - g\hat{m}p))
\end{aligned}
$$

Demonstration

The methods for profitability increase and possibilities for cost advantages by ordering surplus stock is demonstrated on a data set:

Style S				min. 200pcs
Quantity ranges (pcs)	0-199	200-499	500-999	1000 $\leq$
Price per item (LDP)	€21.6	€18	€15.3	€10.8
Surplus charge/Discount	20%	-	-15%	- 40%

Fabric F			min. 200m
Quantity ranges (meters)	200-999	1000-4999	5000 $\geq$
Price per meter	€6	€5.4	€4.5
Discount	-	-10%	-25%

The analysis yields a decrease in production costs and an increase in profits, by reducing order.

CMT F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**		**Original costs**			**€22,670.00**
New profit		**€33040.00**		**Original profit**			**€32,282.00**

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Part I

Project outline

Chapter 1

Preface

Motivation

While working with the fashion industry in Denmark I began searching for information to understand the strategic challenges of setting up a fashion company in an already overflowed market. I came across the books of David Birnbaum, a fashion professional, who after working in the fashion industry for years, has now become a strategic consultant for countries anxious to build a stable fashion industry or large companies who wish to improve their competitiveness by working more profitably.

In a world with quota restrictions, declines in the work force of countries with well-developed fashion industries and frequent pessimistic forecasts for fashion businesses make the outlook for fashion businesses in the western world may seem pretty gloomy.

I was intrigued by Birnbaum's optimistic forecasts for companies willing to embrace challenges and changes. His refreshingly positive analysis of the dynamics of the global fashion industry certainly leaves the impression that there is work to be done. His arguments have inspired me to investigate his ideas in a Danish fashion industry context.

A Danish perspective

In Denmark there is a strong conception of having a particular fashion identity. However, this notion is not echoed internationally, and political initiatives to support the industry's ambition for recognition are virtually non-existent. The densely populated market of small creative fashion companies plays a significant role in the Danish fashion epos, but in reality profits are low and the number of names making an international breakthrough continue to be modest. The fashion industry's economic contribution to Denmark is mainly provided by three fashion companies, BTX group, Bestseller, and IC Company's, all of them run sound professional businesses. If the rest of the Danish fashion world wish to rise to this level, they need more than a good story and creative designs: they need capital and management.

The authors background

I have studied software engineering at the Technical University of Denmark since August 2000. My academic focus set off in computer graphics with special emphasis on garment simulation and virtually tailored garments. This interest was spurred on by studying automatic pattern-making for the garment industry at the Hong Kong University of Science and Technology for two semesters in 2002 and 2005, respectively, in the mechanics department under Prof. Matthew Yuen. My bachelor's thesis used optimization techniques from Operations Research, to aid the development of large tree structures by using a 3D graphical representation. Courses at Copenhagen Business School in the Fall of 2005 provided me with insights to luxury industries, as well as global and local branding strategies.

Since August 2005, running parallel with my studies, I have worked as a production agent and sales agent for minor Danish fashion companies. As a sales agent I have established sales channels and direct sales on the Danish, English and Swedish markets. Through responsibilities in outsourcing entire collections to East-Europe and Asia, I developed easy tools to support good outsourcing decisions. My pre-university education as a garment pattern-developer was useful during this period.

Quantitative methods

In this report, I suggest the use of certain analytical tools to enhance support measures for outsourcing decisions in fashion companies. Techniques from operations research are applied to develop profit optimization and cost minimization models. Statistics and accounting methods are used for comparing costs of sourcing collaborations, and basic math is used in cost estimates.

Acknowledgements

I would like to thank my supervisor professor Jens Clausen of the Technical University of Denmark for his guidance on this report and help issues within operations research. Thanks are also due to Thomas Ernfeldt from IC Company's for contributing valuable insights into the fashion industry, John Eskebaek for information on practices in the food industry, as well as Jan Fabritius for input to financial codes of conduct, and intensive help with structuring the analysis in chapter 6. I am very grateful to Jeanny Fabritius for extensively proofreading my English.

Chapter 2

Introduction

2.1 Outline and limitations

This report seeks to develop methods to support outsourcing decisions in the Danish fashion industry on both strategic, tactical, and operational levels. Three methods must be developed to use as one tool:

Strategy Create method to investigate which supplier type, Cut-Make-Trim or Freight-on-Board, enhances the competitiveness of a fashion company.

Tactic Present method to compare suppliers including direct costs, indirect costs, and macro costs. Develop methods for estimates none exist already.

Operation Construct method to support purchasing decisions at to increasing profits or profitability, making the most of the fashion industry's price structures.

The first two methods are developed from the basis of author, David Birnbaum who's views and recommendations are investigated in a Danish context.

2.2 Target audience

The aim of this report is two-fold. As an engineering masters thesis, this report will demonstrate my analytical skills in approaching a subject - in this case the fashion industry. The setting for my application of academic ideas has been determined by my intention to brief the non-fashion professional reader about the nature of the fashion industry, and its characteristics in Denmark in particular.

For fashion professionals with a more usage-oriented approach, I attempt to demonstrate the usefulness of available analytical and mathematical tools, which could benefit profits and support sourcing decisions.

2.3 Benefits

Fashion professionals will learn about specific tools in order to gain better insights into sourcing scenarios and their outcome. They will be able to identify opportunities for cost savings within the costs structures of their industry. Furthermore, they will obtain tools to quantify qualitative measures so as to make a better choice when evaluating sourcing opportunities. Other readers stand to gain interesting insights into learnings from the fashion industry. Applications of mathematical tools and logical analysis may inspire readers from other industries, especially in terms of best practices and recommendations for outsourcing analyses.

2.4 The content of the report

Outcome:

- A tool for supporting outsourcing decisions on strategic, tactical, operational levels.
- A method for analysing and comparing the costs of two main supplier collaboration types, Freight-On-Board and Cut-Make-Trim.
- A method for estimating macro costs using a country ranking system which includes weights on political climate, educational level, and trade barriers, etc. Macro costs also include quota restrictions and import tariffs.

- A method for calculating indirect costs in of delays, damaged goods, and wrong deliveries.
- A method for comparing suppliers based on price quotations, quantity minimum's, macro costs, and indirect costs.
- A method for profit maximization in purchasing decisions, by discarding low-profit products and purchasing surplus stock to gain quantity discounts. Profits were increased on a test data set with 5%.
- Investigation of David Birnbaum's views in a Danish context

Given the mixed target audience of this thesis, I will begin by introducing the reader to the main characteristics of the Danish fashion industry, some features of which will be shared with fashion businesses worldwide. The reader will learn about the relative size and competitive landscape of Denmark as opposed to other markets, as well as Denmark's frequently stated vision of becoming the world's fifth fashion capital; a title fiercely challenged by other aspiring cities worldwide, e.g. Antwerp, Tokyo, and Los Angeles. The highly competitive environment of Denmark leaves too little a profit to the take on heavy branding and marketing resources needed to funnel an international breakthrough for a fashion company. Denmark would need quite a few of these breakthroughs to be able to successfully claim the title as a, generally acknowledged, fashion capital.

In the interest of identifying qualified management tools to increase the profit margin of Danish fashion companies, I wanted to compile the existing literature on the subject. Sources turned out to be quite scarce. However, for the purpose of Chapter 4 the works of D. Birnbaum claim a prominent position and his tools and ideas are presented in a summarized form to the reader. Birnbaum suggests how companies may sort their costs into three categories (macro costs, indirect costs and direct costs) to obtain a better understanding of which decisions will provide the most profitable outcome. Birnbaum's suggested methodology for making costs comparisons between different suppliers is accounted for, and critique is given to his less than direct-deployable model. Subsequently, his claims and views are evaluated in the light of additional literature on the fashion industry and trends.

The next chapter discuss methods and techniques of improving profitability in outsourcing decisions. General best practises for management conduct are valid in all industries. No additional learnings are found in industries that share characteristics with the fashion industry.

With knowledge acquired from previous chapters, a method is proposed to evaluating which outsourcing method is the more profitable to a fashion company.

Due to limited data access the chapter is mainly based on theory while suggesting a method to challenge the claim that Freight-On-Board sourcing is more profitable than Cut-Make-Trim sourcing.

Following Birnbaum's suggestion to compare suppliers and thus finding the least expensive, work is conducted to measure macro costs and indirect costs. To account for macro costs I develop a macro cost factor, in chapter 7 using a widely acknowledged ranking system. Suggestions are put forward on how to adjust the macro cost factor to suit fashion industry specifics. It is also concretized how to include tariff and quota costs in comparative analyses, as well as how to identify, quantify, and include indirect costs. A small data set is produced in an attempt to demonstrate how to perform full-scale analyses.

Chapter 8 presents a method for further increase in profitability, using techniques from the operations research (OR). The simplified model of cost minimizations serve to illustrate the concept and deployment of OR methods. A method is given to identify cost saving opportunities by ordering surplus stock, taking advantage of price quote structures on materials and production, as well as quantity minimums. The model is extended into a profit maximization model, to suggest letting go of low-profit products and to advance qualified recommendations for purchasing surplus stock. A demonstration is provided using realistic data extended and the models tested for stability and strength.

Chapter 9 combines the tree methods of the previous chapters into one tool for supporting manager's sourcing decisions. Perspectives and evaluations of this report alert the reader to new trends in competitive factors, which may be better facilitated with Cut-Make-Trim production.

In conclusion the report lists the primary findings of the work presented.

Part II

Background Knowledge

In this part..

This part contains three chapters with background knowledge for to understand the settings for the work presented in this report.

First chapter provides a sketch of the fashion industry and it's outline in Denmark especially. Logic and premises of the fashion industry are introduced including definitions of industry terms to be used interchangeably throughout the rest of the report.

The second chapter deals with the tools and ideas of David Birnbaum, who inspired this thesis. Birnbaum's claims and ideas are summarized and then challenged using related literature. The relevance of his recommendations in a Danish context is confirmed.

Finally, focus on management methods and guidelines in general. The chapter investigates methods for cost and profit analyses. Based on a report from The Confederation of Danish Industries, recommendations for good outsourcing practices are given. Furthermore, a brief introduction on operations research (OR) techniques is given as OR can help companies in decision analysis.

Chapter 3

The Danish fashion industry

The chapter aims at giving the reader background knowledge of the fashion industry in general and in Denmark particularly, with information on main characteristics, key figures, and competitive factors. Key terms will be explained and important structures in business logic introduced as well as information on business conduct and decision processes will be described. The Danish vision to proclaim Copenhagen a fashion capital and the prerequisites to do so, is discussed.

This chapter main basis in interviews with case companies, as well as sources [15], [29], [24], [11], [22]

3.1 Characteristics

The Danish fashion industry is populated by small and medium-sized businesses. Each season fashion products are gathered in new style collections, available in multiple colour variants (see figure 3.1. A small fashion company will develop 50-1,000 new styles a year, distributed over two to four seasons, and a medium-sized company may develop up to 5,000 new styles a year for as many as eight seasons. In Denmark most companies work with two primary seasons and occasionally

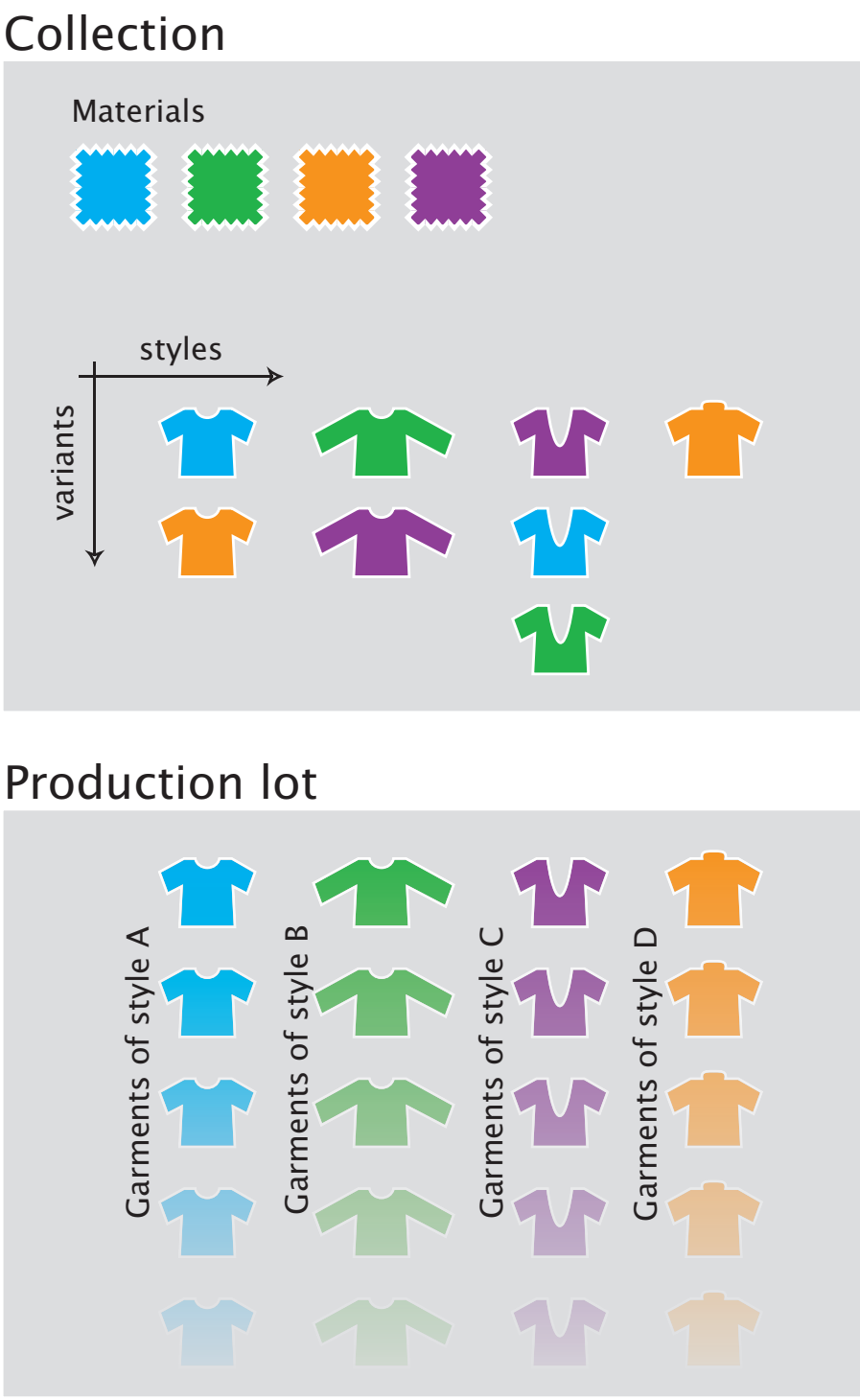

Figure 3.1: Collection, styles, variants, and production lot

2006	Textile	Country total
Total turnover, mDKK	21,512	590,697
Employment (DK)	10,224	
Total Export, mDKK	18,895	546,162
Share of Exports	88	

Table 3.1: The clothing industry, figures of 2006 [8][10]

mid-season collections. First sketches may be created one year ahead of the final product being delivered to the stores, but lead time as short as one month is becoming more frequent, though this is still rare in Denmark.

With low entry barriers to the market, there are many fashion companies, but only a few medium-sized companies dominate the Danish market (see next section). The majority of the medium-sized businesses have outsourced their garment production to subcontractors in Asia, India and the Middle East for productions of inexpensive or labour-intensive garments. High quality products are typically produced in East or Central Europe. Medium-sized companies will typically work in long-term relationships with manufacturers, and they will have well-developed IT systems to support their businesses.

Most of the small companies will have little or no production in Asia, and most garments will be manufactured in East and Central Europe, popular countries being: Poland, Lithuania, Italy, Spain, Romania, and Hungary. Small fashion importers typically lack an overview of skilled manufacturers, and will frequently shift manufacturer until they come across someone who meets their expectations as to quality, communication skills, and service. Many small companies have negative financial results the first couple of years during start-up, and they sometimes have IT systems, which may occasionally be integrated systems.

3.2 Key figures

Together the Danish fashion industry and the Danish textile industry constitute the fourth largest exporting industry in Denmark. 75% of the total turnover comes from Denmarks three largest companies, Bestseller, BTX Group, and IC Company's[11]. Key figures of the fashion clothing industry are stated in table 3.1.

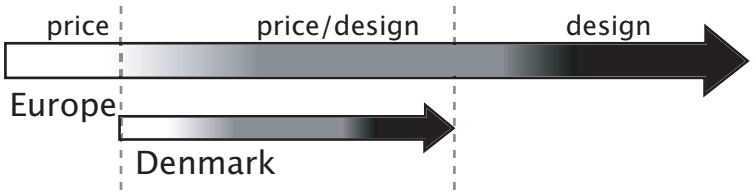

Figure 3.2: Competive factors, price and design

3.3 Competitive factors

In the fashion industry price and design are huge competitive factors. Other factors may be successful branding, availability, fit and sizes, etc. However, price and design are significant for consumer behaviour[1], and examples are given in figure 3.2 of how price and design diverse the market and its players. Figure 3.2 illustrates a way to divide the market into segments depending on the two big competitive factors, price and design. The market in Denmark differs, however, from the overall European market in terms of a much lower domestic price structure than their foreign equivalents. Thus, a high-ranking brand in Denmark may correspond to a lower mid-segment brand abroad.

Price (low) Price is a highly competitive factor in the fashion industry, and supermarket chains like Bilka and Kvickly have a well, established market for apparel. In fact, these retailers do compete slightly on design as well, as garments must balance with current fashion. The supermarkets are not involved in the design process, though. Rather, they buy garments wholesale from, mostly Asian, subcontractors.

Price/Design (mid) This segment can further be divided into two. One, in which price is very significant (InWear, H&M) and another where price is merely supplementary (Baum und Pferdgarten, Hugo Boss). In Denmark, this is the primary stage for fashion companies. The three large Danish fashion groups[2], along with H&M, have almost monopolized the lower part of this segment, while the numerous, and independent small fashion brands work in the high end of the Danish market. IC Companies are also present in the mid-segment to high-segment with brands like "by Malen Birger" og "Tiger of Sweden"

Design (high) In this segment, price is subordinate to importance of design and branding. Brands in this segment are often well established and famed

[1] [11], p. 25 col. 2, top
[2] Bestseller, BTX Group, and IC Company's

for their high quality luxury products. The only Danish example is Birger Christensen (fur apparel). Internationally, we find brands such as Hermés, Chanel, and Christian Dior in the high-end.

3.4 Business Conduct

Brief Product Development flow overview

Producing garments is a highly complex process, which in most cases require solid knowledge of sewing and knitting techniques, fibers and yarns, reliable language skills, the ability to communicate ideas and comprehend limitations, and good material suppliers. Keeping a deadline is crucial. The product development process can be concentrated into 5 primary steps in figure 3.3.

The process begins with outlining the collection: themes, colours, silhouettes, and materials. When a collection and its styles are designed, the sampling process begins. This step includes *pattern making*[3] and *gradations*[4], more industry terms in appendix D.

In this complex and highly time-critical process companies could keep their expenses low as one means to maintain a competitive edge.

Production methods

A variety of production methods exist within the fashion industry, the two general ones being Cut-Make-Trim (CMT) production and Freight-On-Board (FOB) production. Manufacturing companies will be inclined to apply one more extensively than the other.

CMT production CMT is a low-service approach, which leaves much of the controlling and logistics to the fashion company. CMT implies that the manufacturer will cut the fabric, make the garment, and provide the trimmings (buttons, hooks, zippers, thread, etc.). CMT production springs from the even more modest service of CM (Cut and Make) where the fashion company also had to deliver all trimmings. In CMT production

[3] specifying the pattern pieces, the shape of the garment subcomponents.
[4] scaling the patterns up and down in sizes.

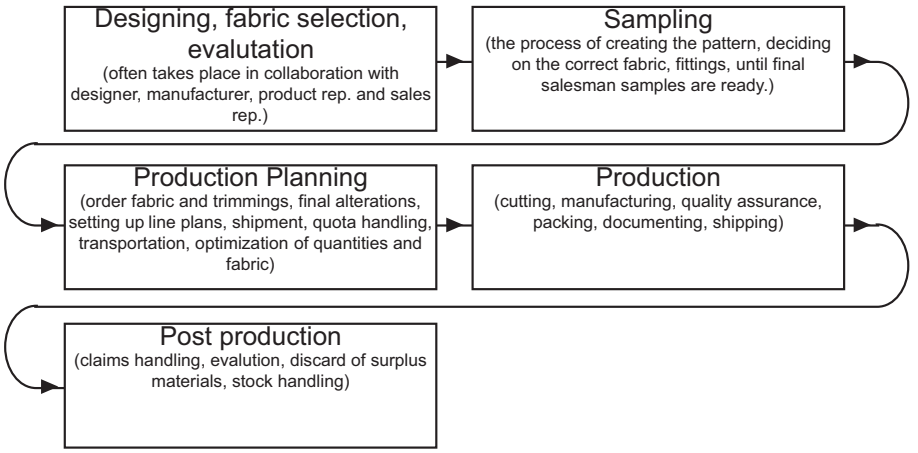

Figure 3.3: The development process in 5 steps

fashion companies, are responsible for selecting the fabric, logistics, negotiations with material suppliers, pattern making, prototype sampling etc.

CM(T) production collaborations were among the first production methods to be used when outsourcing was new. Today, many newly started companies collaborate with this type of production suppliers as it allows them to keep in control of the final design of a garment (fabric, fittings and pattern, buttons etc.), or because they lack the knowledge or network to choose other collaborational forms. Fashion companies relying heavily on technical textiles (e.g. GoreTex®) may also prefer CM(T) production.

FOB production FOB is a high-service approach, where manufacturers will supply not only CMT services, but also pattern making, prototype sampling, material sourcing etc. This relieves the fashion company of many of these cumbersome tasks, and even solves cash-flow issues related to disbursements for materials and others. The design of the garments is a collaborative effort between the fashion company and the manufacturer. The manufacturing company will handle all production and product development tasks until the order exits the factory.

Accounts of profitability

The fashion industry holds a unique status being among the first industries to outsource the greater part of their business activities. Production was moved

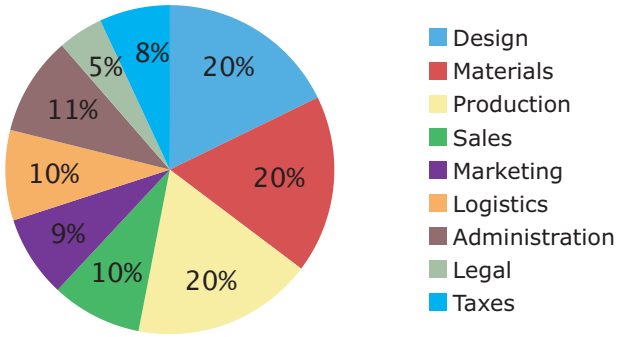

Figure 3.4: An example of estimated cost distributions in a Danish fashion company

abroad, as early as the 1950's, due to cost advantages offered by lower-wage countries. No other industries work with this extreme a combination of short product life-cycles, short time-to-market, and rate of new product development in such a densely populated market. In order to make profit, companies could focus on both increasing sales and cutting expenses. Earlier times' focus on the importance of low wages and material costs are yet perceived as a key factor to cost-effective garments. More recent observers of the fashion industry claim, however, that this one-sided view misleads fashion companies into focusing on less efficient cost-saving initiatives. The distribution of a company's expenses vary greatly with the size of the company, and the competitive strategy of the brand, see one example of a company's cost distribution in figure 3.4.

Outsourcing patterns

Suppliers are investigated and selected by the sourcing offices, whether by own staff or external agents. These suppliers are found through recommendations by associate, previous collaborations, unsolicited applications, or third party introductions. The process of selecting suppliers are not as extensive as the one suggested in this report. Among larger companies it is common practise to double-source[5] items on a regular basis, before supplier evaluations.

[5]the process of collecting price quotes and production/salesman samples from two or more suppliers.

Professional Management

Managers in the fashion industry have a wide variety of education, managerial training and experience. The presence of experienced management is more prominent in large companies and companies with professional investors. There are indications that where experienced management is present, more focus is given to cost and profitability analyses.

3.5 Vision: Copenhagen as a fashion capital

Danes often pride themselves of living in a fashion-famed culture. But the truth is that in the global market, Copenhagen is merely one of many cities worldwide hoping to be acknowledged as a fashion capital next after Paris, Milan, London and New York. Achieving this goal is, however, is by no means a simple task and will require a collaborative effort within the industry itself and backing from political quarters. Newly formed associations such as Modekonsortiet (MOKO) and Danish Fashion Institute (DAFI) work together to consolidate Denmark's position in the fashion landscape.

For Danish fashion companies struggling to succeed abroad, these are frequent challenges[6]:

1. Once established in a small and low-priced market as Denmark, companies do not have the resources to promote themselves abroad.

2. Finding financial backing from investors is challenging, because few investors are accustomed to investments in the fashion industry.

3. Lack professional management: Most Danish fashion companies are founded and controlled by people with a design background instead of a professional management team which may lead to focus on areas of interest rather than areas of need.

4. Old-fashioned production and product development methods: surprisingly many companies in Denmark still develop their products in a traditional way through CMT collaborations rather than testing opportunities in collaborating with FOB suppliers, as a more recent approach. This approach keep key competences on design and marketing in-house but oursource most of the traditional production development processes to the supplier.

[6] [11] p. 48, middle.

FOB production is standard in the three leading fashion groups in Denmark.

This report discusses some of the issues mentioned above, contributing observations and identifying tools for companies hoping to achieve a more profitable business conduct.

The next chapter is dedicated to literature on fashion industry management. As primary source of information, David Birnbaum's views will be summarized and challenged with related literature.

Chapter 4

Fashion business management

The previous chapter outlined the fashion industry characteristics with Denmark in focus. This chapter seeks out literature on business management in the fashion industry, with emphasis on analyses and tactics in processes for global outsourcing. The works of David Birnbaum is interesting and have served as inspiration to this report. Birnbaum's work is examined for concurrence with other authors and his relevance to a Danish setting concluded upon. The lack of additional, elaborate literature to support fashion business mangement, identify de facto standards of the industry, and recommended codes of conduct, leaves Birnbaum as the only author with this prominent a position on fashion business management.

4.1 An introduction to D. Birnbaum's ideas

David Birnbaum is a fashion professional, who after working in the fashion industry for years has now become a strategic consultant for countries, who whish to build a stable fashion industry or large fashion companies, who wish to improve their competitiveness by working more profitably.

The challenge of the fashion industry

Birnbaum argues that the fashion industry players are at war. He claims that the number of garment manufacturers, material suppliers, as well as fashion importers and designers, has increased steadily while we see a decrease in the amount of money consumers spend on clothing: the market is shrinking. Companies should improve their competitiveness or they will become extinct. He sees the primary parameters of competition as quality, delivery, and price. Furthermore, he believes that these factors will become even more important over time.

Tools and results from Birnbaum

One way for companies to improve competitiveness is to focus on their costs. Birnbaum claims that few fashion businesses know the actual costs of their activities and the financial impact of their sourcing decisions. According to him, many companies focus primarily on direct production costs, instead of minimizing their true burden: *indirect costs* so. In order to stay competitive, companies should know their costs so that they may reduce them, and focus on quality, delivery, and price of their products.

Based on a definition of three costs: *macro costs, indirect costs,* and *direct costs*, Birnbaum demonstrates his tool "Full Value Cost Analysis" which supposedly unveils the true costs of a company's production related activities.

Birnbaum opposes the conventional perception that low manufacturing costs are equal to the least expensive outsourcing. He also argues that quota restrictions damage fashion businesses everywhere. He suggests that factories upgrade their service as much as possible and recommends fashion importers to work with high-service factories, if possible. Consequently, both parties will gain from this approach.

Birnbaum's cost analysis

Through carefully planned strategic and tactic decision-making, companies can improve their profitability by including cost analysis, in comparative studies between suppliers worldwide. Too many companies focus only on direct costs when they make decisions about where to produce their garments, which contrasts Birnbaum's main arguments that indirect costs are more significant for a

company's profitability. His cost analysis yields three costs that should influence fashion importers sourcing decisions, in order of importance:

1. Macro costs - critically important. Macro costs should indicate where to produce. Macro costs imply:
   (a) Education (there must be sufficiently educated people managing factories)
   (b) Infrastructure (roads, electricity, communication must work well)
   (c) Government policy (work towards supporting their industries)
   (d) Human rights (proper working hours, no child-labour, rights to unions)
   (e) The politics of trade (import/export quotas, taxes/tariffs)
2. Indirect costs - very important. Indirect costs should indicate which manufacturer to work with. Indirect costs include:
   (a) Letter of credits, credit # of days
   (b) Quality Assurance, Communication skills,
   (c) Delivery, Reliability
   (d) Order minimums
3. Direct costs - least important:
   (a) CMT (Cut, Make, Trim)
   (b) Materials: fabric and trimmings
   (c) Time-to-market

Quantifying the macro costs

How Birnbaum intends to quantify qualitative macro costs is not demonstrated in his publications. However, it is possible to calculate macro costs based on company accounts for previous orders and their additional costs for legal aid, bribes, additional transportation costs, etc. Import tariffs and quotas[1] who are also part of the macro costs, may be obtained from communication with suppliers and customs authorities. Examples on tariff costs and quota charges are given in the following sections.

Table 4.1 illustrates how China, because of quota restrictions must produce at a lower price than their competitors in Hungary if they want to deliver to the EU. Table 4.2 illustrates the added costs (customs tariffs) imposed on garments imported from outside EU.

[1]See the dictionary in Appendix D, for a dictionary and acronym meanings.

Quota

Importer	Supplier options				China Disadvantage
	Country	FOB (ex. quota)	Quota	total FOB	
Italy Diesel	Hungary	€7.50	€0.00	€7.50	
Italy Diesel	China	€4.92	€2.58	€7.50	-34.40%

Table 4.1: Example of macro cost analysis: Quota restrictions [3]

Product	Import Tariff	
	inside EU or GSP[2]	outside EU
Apparel	0%	+12%

Table 4.2: Example of macro cost analysis: EU added costs [3]

Tariff cost example

Shirts (M&B) wool	FOB price	Country tariff category	Import tariff (1 shirt = 0,2kg)	Extra cost per shirt
Lithuania	€6.00	EU	€0.00	€0.00
Italy	€8.00	EU	€0.00	€0.00
Hong Kong	€4.00	EU	€614.77	€0.95
India	€2.00	EU	€341.77	€0.53
Turkey	€5.00	EU	€751.27	€1.16
Romania	€4.50	EU	€683.02	€1.05

Table 4.3: Example of macro cost analysis: Tariff costs

Shirt	FOB price	Quantity	Minimums	Costs
India	€2.08	1,200	2,500	€5,200
Hong Kong	€4.45	1,200	1,000	€5,340
Lithuania	€7.00	1,200	300	€8,400

Table 4.4: Minimum quantities reflects in the indirect costs

Shirts	Quantity	Minimums	Costs	Dispatch surplus stock (unit cost: €1.2)	Total
India	1,200	2,500	€5,200	€1560	€6760
Hong Kong	1,200	1,000	€5,340	€0	€5340
Lithuania	1,200	300	€8,400	€0	€8400

Table 4.5: Example of indirect cost analysis:

Indirect costs analysis

Manufacturers often have minimum quantities on each garment style. If a company is only able to sell 1200 styles of a garment, but must order 3000 items, they consequently must sell the surplus stock at a discount or dump it. This is reflected in table 4.4. The final mark-up illustrates that an Indian manufacturer is favourable to work with, if one considers direct production costs and minimums only. It is most likely, however, that other cost factors will reduce the advantage held by India according to this table.

If the company can only sell 1,200 items, then its is more profitable order the production in Hong Kong even though unit prices are lower in India. Table 4.5 illustrates how additional costs for dispatching surplus stock further decreases the competitiveness of the Indian manufacturer in the previous example. This is an example of indirect costs' impact on total costs.

Finally, an example on comparing bank costs (see example below). The conditions for payment set by the supplier also impact the final costs of an order, especially if a bank guarantee is supplied through a letter of credit, which freezes the money on the fashion company's account to ensure sufficient funding when production must be payed for.

Example: see table 4.6
A production batch should be ordered in early March for delivery in July, the costs of production are approximately €300,000. This expense must be financed

Name	Bidder 1	Bidder 2	Bidder 3
Price	€280,000	€290,000	€292,000
Bank guarantee	Mar. 1.	No	No
Cash advance	-	-	€58.400,00 (Jun. 1.)
Payment date	Aug. 1	Aug. 1	Oct. 1
Present value, Oct. 1.	**€299,220**	**€294,853**	**€293,472**
Index	**100**	**99**	**98**

Table 4.6: Example of cost comparison

with a bank loan at a 10% annual interest rate until the goods have been delivered to and paid for by clients. Three suppliers have bidden for the order, but their terms of payment are very different. Bidder 1 wants bank guarantee upon placing the order and money upon arrival. Bidder 2, only requires money upon arrival. Bidder 3 will give two months' credit but requires a cash advance of 20% one month before arrival. As we see from the results in table 4.6[3], though Bidder 1 has the lowest price quotation this is the most expensive supplier. The reason being that the supplier requires a bank gurantee. With this requirement money is frozen on the fashion company's account separated from cash-flow usage between ordering and payment. The evaluation of Bidder 2 against Bidder 3 is more complex, as Bidder 3 requires a cash advance but in return offers 2 months credit in return. In this example, Bidder 3 is the least expensive supplier of the three, but variations in cash advance or credit terms may yield a different outcome.

The FVCA

A Full Value Cost Analysis (FVCA) combines the macro costs, indirect costs, and direct costs. Table 4.7 gives a rough example of an FVCA, where the final costs, Landed-Duty-Paid (LPD) costs are indexed for comparison. The table is not complete and could be extended with some of the factors given in tables 4.1-4.5, but it does illustrate what sort of outcome an FVCA is expected to give. Once an LPD value is obtained, companies could perform other analyses to identify profit optimization opportunities. [4]

It is, however, important to keep in mind, that quantifiable data alone should not affect outsourcing decision. Other factors may be equally important though more difficult to price: human rights and image value of the production country.

[3] see appendix B for reference on how to project values to the same point in time.

[4] Tariff charges inside Denmark are listed at `http://tarif.toldskat.dk/`; obtain classification codes at `http://www.vita.toldskat.dk/`

Costs		Countries		
Type	Task	Lithuania	Hong Kong	India
Direct	**"FOB" quote**	**€8.00**	**€4.45**	**€2.05**
Macro	Tariffs	-	12%	12%
Macro	Quotas	-	€2.2	€2.3
	Subtotal	**€8.00**	**€5.00**	**€2.30**
	Quantity	900	900	900
Indirect	Minimums	200	1000	3000
	Subtotal	**€7,200.00**	**€4,984.00**	**€6,880.00**
Indirect	Pattern, gradation, sampling	-	-	€680
Indirect	QA, procurement	€110	€356	€250
	Total	**€7,310.00**	**€5,340.00**	**€7,818.00**
	Index	**100**	**73**	**78**

Table 4.7: FVCA analysis

4.2 Evaluating Birbaum

Birnbaum primarily makes suggestions and seeks to illustrates his views without going into details substantiating his claims. Unfortunately, he does not demonstrate a complete implementation of his recommendations. However, his views concur with the general picture drawn from interviews with case companies. In the following, Birnbaums statements will be verified or rejected using concurring and opposing literature.

The evaluation of Birnbaums claims and views, relies mainly on the sources of [8], [11], [12], [14], [15], [22], [24], [27], [29], and [32], supplemented by interviews with case companies (appendix C).

Claim: The market is shrinking

Though the claim is made that the apparel market is shrinking, this trend could not be supported or rejected by supplementary studies[5]. Though this claim might be confirmed from more extensive research, the outcome is of strategic relevance in the fashion industry, but mostly irrelevant to the focus of this report.

[5]sources listed in the beginning of the chapter

View: The challenge of the fashion industry

As Birnbaum's view on the challenge of the fashion industry is partly based on the claim that the market is shrinking his conclusions has not been sufficiently backed by literature used for evaluation. However, his views on quality, delivery, and price as important competitive factors concur with the the description of the fashion industry in chapter 3, which is based on sources [25], [11], and [24], as well as interviews with fashion companies. In a densely populated market, it is most likely that profitable businesses will outlast those yielding losses, though new start-up companies are in constant supply. Whether the many players of the fashion industry are cannibalizing on each other is a subject for further studies outside of this report.

Claim: Companies focus on direct production costs

The claim that companies focus on direct production costs is only partly supported by Gibbon and Thomsen [29]. However, case company interviews indicated some concurrence with Birnbaum's claim for *small* fashion companies. Once businesses have attained a certain size, with the experience following this position they will most likely have identified a business conduct, which is both profitable and adjusted according to main macro costs and indirect costs. Consequently, the attention given to direct costs is justifiable. The cost focus of mid-sized companies depends on management experiences and personalities.

Concurring literature

Gibbon and Thomsen somewhat confirms Birnbaum's claim, documenting that Scandinavian fashion companies find price of vital importance to their sourcing decisions. Countries like China, India and Bangladesh are preferred over Hong Kong and East-Europe in the price discussion. However, Scandinavian countries are at the same time, slow to investigate new and potentially less costly manufacturers. They maintain low expectations to their suppliers' potential for adding value to design and materials [29]. Conclusively, it would seem that Scandinavian fashion companies are more likely to focus on direct cost savings, rather than cost-savings in a greater perspective.

Opposing literature

In the UK Gibbon and Thomsen observed a different pattern amongst fashion companies. Whether it is a conscious decision or not to investigate cost-savings outside direct production costs, UK companies tend to demand higher-service suppliers because of their added value to their businesses.

View: The importance of macro costs, indirect costs, and direct costs, respectively

Whilst no other authors than Birnbaum's directly state *why* sound (and often market leading) companies choose, presumably, more expensive high-service suppliers, literature concludes that this is in fact the case.

Concurring literature

Most available literature supporting Birnbaum's view, focus on the business challenges of manufacturers rather than fashion companies. The conclusion is never the less crystal clear: supplier price is not the single most competitive factor, but also logistics, material sourcing, and qualified customer service have become vital.

Literature further concludes that many truly low-wage countries like e.g. many African nations, have little or no part in the global garment manufacture due to poor infrastructures and an unstable political climates ([15]). These same issues are addressed in Birnbaum's emphasis on the importance of macro costs. Furthermore, other authors point out that trade barriers or favoured nations agreements heavily affects the sourcing patterns of the EU and the USA. The natural competitiveness of countries and manufacturers are distorted by these political agreements, making room for less than competitive manufacturing environments in, e.g., Italy or Mauritius.

Opposing literature

No opposing literature was found which questions the reasoning behind evaluating macro-economic aspects before considering candidate countries for outsourcing. Whether focus on direct costs should be prioritized higher than indirect costs has not been articulated.

Claim: High-service manufacturers are more profitable to work with

Gibbon and Thomsen describes how many UK companies have high service expectations of their suppliers. UK fashion companies insist that their suppliers 'bring something to the table' whereas this was only the case for 50% of the Scandinavian fashion companies. Also Scandinavian countries meet their suppliers with lower expectations regarding the value they could bring to their company: design suggestions, material sourcing, etc.

Concurring literature

Much of the literature, recommends manufacturing companies to upgrade their service-level, and consequently increasing competitiveness. This increase in demand for high-service manufacturers indicates that customers experience better value.

Opposing literature

In the report by Gibbon and Thomsen some Danish companies claim that CMT allows them to order smaller production quantities, a prerequisite for their business existence. Whether this is the most profitable choice is not necessarily investigated, though.

The latest trend towards *fast fashion* may challenge Birnbaum's claims in the future[6]. They iconify the new world of lean retailing which likely will provide new opportunities and threads to the fashion industry [30],[31].

[6]Fast fashion is an industry term for meeting consumer demands instantly, yielding quick collection turnovers. Spanish fashion company and retail chain Zara have experienced a tremendous success with fast fashion. Zara currently serves as a model example for the fast fashion movement. Its organisation structure is a vertical platform, from yarn dying and spinning to retailing and customer feedback loops. Much of Zara's production is done in-house or linked closely to manufacturers working according to the CM concept. They produce in small production batches, waiting for the market to respond to their products. Based upon the market feedback they either discontinues a style, increase production or design new versions.

Job function	Annual salary	Days Worked per Year	Days to Make Unit	Cost per Unit
Patternmaker	$ 75,000	240	1.5	$ 468.75
Samplemaker	$ 30,000	240	2	$ 500.00

Table 4.8: Distribution of fixed costs

Birnbaum's FVCA analysis methodology

The case studies documents that variations of the FVCA analysis is conducted at present, though none were as extensive as Birnbaum's suggested method. It must be emphasized that an FVCA analysis hardly seems relevant on a per style basis or even a selection of styles, given the intensity of the development environment and the elaborateness of the analysis. It does however seem a useful tool, when fashion companies investigate opportunities for cost advantages by changing business conduct or suppliers.

The theoretical foundation

Birnbaum's theoretical foundation is investigated by looking into costing methods in financial literature[7]. Birnbaum's emphasis on indirect costs and macro costs omits several costing methods, most obviously 'direct costing'. His costing methods are linked to decision-making and shares many characteristics with full costing. This conclusion is based on Birnbaum's procedure for assigning indirect costs to garments in table 4.8[8]. In this example, Birnbaum evenly distributes these costs onto garment styles ignoring the actual time dedicated to each style. His calculation of average days-per-unit harmonize with the full-costing methodology.

Activity Based Costing (ABC) is an alternative method to full costing, and generally considered a more sophisticated tool for assigning costs. ABC includes only costs directly linked to a style thereby evaluating styles proportional to their complexity and workload. Full costing may distort results of an in-depth analysis.

[7] see appendix A for background knowledge on costing methods
[8] [3] p. 84

4.3 Limitations of Birnbaum

It seems that Birnbaum offers interesting lessons to fashion professionals, who might not investigate the palette of outsourcing opportunities and benefits. This said, Birnbaum offers little advice to fashion companies, who already follows his recommendations on business conduct. Companies already collaborating with high-service suppliers may merely be advised to monitor outsourcing trends among colleagues as well as global developments in manufacturing prices. Birnbaum offers no methods for quantifying qualitative macro-costs for analysis purposes, nor does he demonstrate a complete and adequate indirect costing analysis.

Birnbaum's literature helps the reader adopt a different mind-set and attention to other important costs in outsourcing. This report attempts to follow-up with hands-on tools to implement Birnbaum's recommendations.

In the next chapter, will describe general business practices for outsourcing and cost management in a practical perspective. Furthermore, it will introduce the usability of operations research for decision analysis when high profitability is the goal.

Chapter 5

Commen business practice

Upon the insights gained into the fashion industry is practical and theoretical settings, this chapter aims to identify common business practices valid across industries. Focus remains on managerial tools for production related activities such as cost management and outsourcing. The chapter is further extended with a section on how techniques from operations research are used in decision analysis.

Industries who where identified as related in character to the fashion industry are first examined for relevant business practices:

The mobile telephone industry This industry operates in a fashion sensitive market, where product life cycles are very short (1-3 years approx.). The competition is intensive between the few large mobile producers on innovation in both design and technology. Each vendor launches new products fast and often. The majority of consumers are price sensitive. In some countries, consumer purchases are linked with telecommunication companies offering the telephone network.

The industry shares some characteristics with the fashion industry in terms of short time to market, harsh competition, a fashion sensitive market, a generally price sensitive market, and many new products developed each year.

The food industry The food industry is characterized by short product life cycles, many competitors, market layers which resemble price, and price/design sensitive consumers. To differentiate between fairly (functionally) identical products, branding becomes increasingly important.

Exploring various industries' codes of conduct with regards to outsourcing strategies, and cost structures made it clear that tools outside the related industries may prove equally relevant for the fashion industry to learn from. In fact, sound ways to work with outsourcing decisions and cost analyses seems consistent across industries. Whether a company works analytically with its outsourcing strategy and costs, apparently depends more on personal qualifications of the management than its industry characteristics.

Conclusively an overview good practices in general was sought within: outsourcing, supplier evaluation and price comparisons, and costing methods; using industry reports. Numerous practices in business conduct exist and may be deployed with equally good results. This report do not attempt to identify and evaluate on all of them, but rather familiarize the reader with some hands-on methods that have proven both relevant and powerful.

To attain practical and pragmatic knowledge on common practices, two financial managers where interviewed, both with extensive experience in production managing financial analyses and business turnarounds. These interviews contributed with valuable insights which serve as the basis for this chapter.

Manager A Works as a consultant in the food industry, primarily involved with learning ex-state-owned companies, now privately held, how to adapt their business to the more open competitive landscape. Much effort is put into implementing costing methodologies to support profitability analyses as a primary tool, to decide on strategies and tactics.

Manager B Has extensive experience in turnarounds and strategies in industries as variable as medical care, oil, cargo, shipyards, steel production, plastic moulding, and others. Furthermore, a resume of establishing new markets, investment analyses and strategies. Manager B is routinely working with investment analysis, supplier evaluation and cost-benefit analyses in outsourcing scenarios.

5.1 Cost management

All companies delivering products, either being physical or services, must manage their costs in a sensible manner. For companies operating in highly competitive markets cost control is essential to stay competitive. A dissatisfied customer may easily turn to a competitor, regardless of the brand value and the actual design qualities of the original company products.

Even so, small fashion companies rarely have procedures for cost analyses since this is not the primary interest of the designer who typically runs the business. As an exception, Case Company C stands out as their CEO has an economic education with high focus on cost control.

The skill of strong cost management seems to depend more on individual management, than characteristics of a specific industry. Thus the fashion industry may include general methods for cost management, and benefit from it.

In general, companies in business for profit offer a product range to a target market. To stay in business companies composition their product ranges to ensure their continuous existence and finance their drive towards expansion, shareholder pay-outs, and research alike. Products typically have a life-cycle, which requires a continuous update of the product range to maintain a relevant value proposition to the market and a profitable operation for the company. Product ranges must be updated, new products developed, and obsolete items weeded out. The condition of doing so wisely, implies that decision-makers can map their cost and profit landscape of individual products, product families, as well as value interchange in the product range. This requires the means of cost analysis and profitability analysis.

Cost distribution

Costing is by far a trivial task and requires that analysts use the data in a structured and consistent way. Computational power has increased during the 20th century and along with it accounting software has emerged facilitating multiple ways to track and analyze costs. In previous days, where computations where done by hand, costing for internal purposes where often done using tables of standard costs instead of tracking the actual costs, which would be tedious and quickly render obsolete in the time it took to finish calculations. With computer systems, we have the means to make accurate costing and a much greater range of methodologies to choose from, which we must do carefully.

Often companies will use a mix of different costing methodologies, each for different purposes. Costs are roughly divided into variable costs and fixed costs. Examples of variable costs are materials and hired labour. Examples of fixed costs are: staff salaries, administration, buildings and equipment.

A typical method for evaluating products on their costs and profitability, includes distributing fixed costs on the product range, so each product may include both variable costs and fixed costs. By assigning costs to products, management will gain insight into on what terms they are making profit, and which products are more profitable than others. The method for distributing fixed costs can be done in a variety of ways, full costing or Activity-based costing being some of the more commonly known [1].

Example: Making a shirt The shirt is part of Company A's half-annual fashion range. Next season it will be replaced with a freshly designed item. A design team is dedicated to developing new products for this fashion range. The shirt has hand-stitched ornaments on the breast pocket, which required Company A's outsourcing team to find a manufacturer, capable of hand-stitching the pockets and ship them off to Company A's usual shirt manufacturer who then assemble the shirt and apply the pockets. Means must be taken to ensure that pockets and assembled shirts come from the same fabric roll so colours will match precisely[1]. Fabric comes from a textile mill with an exquisite quality of Egyptian cotton. Company A only needs 3000 m of fabric, but the textile mill requires a minimum purchase of 5000m. Table 5.1 shows how the variable costs from making a shirt are accumulated.

Assigning fixed costs to an item is, however, much harder and requires some rule for the distribution of fixed costs.

[1]Slight colour variations occur from roll to roll, often because the fabric or yarns has been dyed in different batches.

Variable costs		
	unit costs	subtotal
1.8 m of Egyptian cotton	€4.6/m	€8.28
0.2 m of interlining material	€2.0/m	€0.4
10 mother of pearl buttons	€0.1/pcs	€1.0
100 m of cotton yarn	€1/km	€0.1
1 neck label	€0.5/pcs	€0.5
1 wash label	€0.4/pcs	€0.4
1 size label	€0.1/pcs	€0.1
Embroidery		€1.1
CM costs		€3.4
total		**€15.28**

Table 5.1: Accumulating costs for a shirt

Fixed costs	
Sampling costs	Shirt has been back and forth three times between manufacturer and Company A, before final salesman samples has been approved for production
Material minimums	2000 meters of surplus materials must be either demolished or circumvented by offering a surplus charge. It is unlikely that the shocking pink fabric with the inweaved mint-coloured hearts can be used for another style or season.
Outsourcers	One "sourcer" has been travelling to India twice to meet with potential suppliers for the embroidered pockets. The sourcer has resolved issues for other styles as well. The embroidered pockets proved particularly difficult to make, and had to be changed during product development, which required additional documentation and communication to ensure that the supplier was sufficiently informed.
Design team	Developed 150 new shirt styles, discarded 70, and altered another 70 during prototype sampling. The shirt in question was developed in two days, and altered four times in the following two months following input from pattern maker, textile/pattern designer, and lead designer.

All staff involved are fixed costs in Company A's accounts, and how we charge their work contribute to the shirt, depends on the costing method(s) we use. With full costing we might include an even share of the fixed costs, or calculate the share by dividing the fixed costs with a distribution key. Activity-based costing would include careful tracking of time used on each task related to the

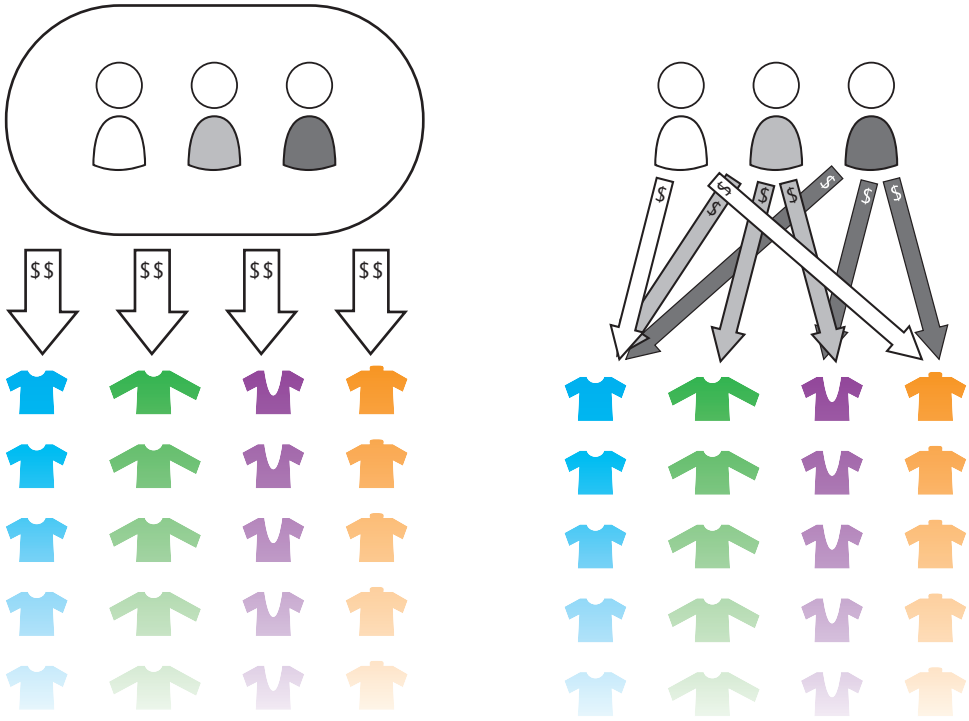

Figure 5.1: Concept of distributing fixed costs for full costing (left) and ABC (right)

product in focus. Figure 5.1 illustrates the concept of distributing fixed costs onto products, for full costing and ABC respectively.

Profitability analysis

Once costs have been assembled, accumulated, and assigned to a product, a simple comparison with revenue for the goods sold yields the profitability of the item(s). While this number is good for learning if Company A makes profit from this product here and now, it would be advisable to evaluate other factors as well. As stated, products have life cycles. Some are at the peak of their popularity and coherence with the brand, others are declining or growing. These considerations must weight accordingly in any decision following an analysis. It could be that products requiring heavy investments as now are the profit stars of the future.

5.2 Outsourcing practices and country evaluations

This section is heavily based on a report from The Confederation of Danish Industries (DI) on outsourcing practises [28], and from interviews with case companies. The report includes many considerations on establishing own production facilities and offices abroad as well as outsourcing some tasks to subcontractors. The Danish fashion industry is mainly characterised by purchasing production services from subcontractors though larger companies may have own sourcing departments abroad. A pattern of frequent supplier shifts was observed among the small and young case companies. Whereas outsourcing may be a new discipline to some industries, it has been common practice in the fashion industry for decades. Fashion companies rarely consider *if* they should be outsourcing but rather *where to next*. That said, many good practices are relevant across industries and the fashion industry could benefit from learning how to analyze and compare their existing and potential market of suppliers.

Why do companies outsource? Outsourcing may benefit companies in a variety of ways. These are some of the common reasons for outsourcing:

- To save money
- Speed to market
- Proximity to market
- To get better products
- To enter new markets
- To focus on their key competences

What do companies outsource? Surprisingly many tasks are candidates for outsourcing:

- Time consuming or simple tasks
- Logistics
- Services, e.g. support, supervision
- Test and analyses

- Accounting

The fact that many of these tasks are very complex and requires educated labour could be an eye-opener to companies hesitant to outsourcing more than the simpler tasks of their business. Suppliers worldwide have sophisticated skills to embrace a variety of advanced tasks and even contribute to their continuous improvement.

Best codes of conduct: This section summarizes the report on outsourcing from DI. Regardless of whether outsourcing implies establishing the company in another country or merely purchasing products or services from a supplier abroad, criteria apply on how to select an appropriate location and outsourcing model.

The majority of fashion companies will purchase production services from suppliers, rather than manufacturing themselves. Some will buy additional services of organizing production with a production agent, others keep this tasks in-house or in offices abroad. Thus, considerations of establishing own production units abroad will be omitted in this chapter.

Know your own costs remember to include indirect costs and consider which parts of the business could be outsourced even further. Having a good understanding of own costs enables later comparing with results from outsourcing and conclusions on the success of the action. This way existing costs may be compared with opportunities abroad.

Decide on the outsourcing model With knowledge of the opportunities for outsourcing, identify which part of the business to outsource. Decide which criteria suppliers must meet to take on these tasks.

Geographic location The choice of geographic location will have heavy impact on the results. Carefully evaluate which countries to consider for outsourcing. Some will have tradition for specific types of production with a sub-industry to support these activities. Vast differences apply between countries in taxes, political climates, and jurisdictions. This may be vital to the economic success of an outsourcing decision. Proximity may benefit time-to-market and customer service offerings. Make a comparative analysis of the countries subject to consideration.

Seek out suppliers Look for suppliers that match the criteria set up previously. To seek out candidate suppliers ask colleagues, embassies, trade councils, unsolicited contacts, look on the internet, etc. Visit potential

suppliers and verify that they have the means to facilitate your business. They must be technically capable of delivering the right product(s), undertaking quality control, providing the financial backing, facilitating production and product improvements, handling logistics, and possessing the managerial competences to meet future challenges. Long term relationships will benefit all parties involved.

Gradual outsourcing Start by outsourcing only part of the production, or outsource the simpler tasks first. Establish success with this before increasing volume and/or complexity of products. Assign resources enough to facilitate the shift. In any new collaboration there will be errors; expect them and be prepared to solve them.

Evaluate results Ask questions like: Are the results as good as expected? What went right or wrong? Any improvements or restrictions? These evaluations will be valuable to future outsourcing decisions.

Be prepared to move Keep and eye out for changes in the world around and be prepared to move. Seek out new opportunities, and allow for inspiration by the actions of other companies. Monitor outsourcing trends. Make sure you did not put all eggs in a single supplier basket.

These codes of good conduct apply to all industries. The fashion business is further stressed by the fact that decisions and evaluations must be made much more frequently than in other industries. Many of the recommendations concur with Birnbaum's focus on macro costs and supplier evaluation.

Best practices for performing comparative studeise between potential suppliers will be dealt with next.

Supplier comparisons

Whereas there are plenty of literature on comparative studies, there is only very little documentation on best practices from the industries. Interviews with managers A and B, and authors of the DI report, revealed that the majority of companies do not have any the structured procedures for these analyses.

Often, sourcing decisions are conducted by filtering potential suppliers down to a list of candidate suppliers who meet all primary requirements. Considerations as to extraordinary costs from the sourcing decision are rarely included after this stage. Each candidate is asked to submit detailed price quotes, breaking down their offer into subtasks. Knowledge of these costs can be used in price

negotiations. After negotiations the supplier with the lowest overall price quote is selected.

As this report aims to provide practical guidelines with learnings from the industry, the subject will be investigated no further. Instead, this section includes an interesting note on negotiations tactics, based on interviews with Manager B which might interest the reader.

Negotiation tactics

A simple but effective negotiation strategy is to collect price quotes from candidate suppliers, and have them break down their prices into comparable subtasks, see table 5.2. The minimum price for each task is then used in negotiations with the preferred supplier(s).

Example: Among the permanent products in Company A's product range is a high quality T-shirt which is always in great demand. Though Company A is happy with their existing supplier of the T-shirts, they consider shifting to a new supplier who claim that they can produce the T-shirts 10% cheaper. Company A may now pursue either of two tactics:

1. Test new suppliers' claims by gradually sourcing increasingly higher quantities of the style to the new supplier
2. Use the entering suppliers' price quotes to re-negotiate prices with the existing supplier.

Double-sourcing items on a regular basis are standard among larger companies but absent in the smaller companies, as their negotation basis is rarely strong. However, even large companies will sometimes find themselves in situations

	Candidate suppliers			
Tasks	Sup A	Sup B	Sup C	Minimum price
Task X	€1000	€1200	€900	€900
Task Y	€450	€300	€500	€300
Task Z	€780	€800	€820	€780
Total	€2230	€2300	€2220	€1980

Table 5.2: Price quote comparisons, as benchmark for negotiations

where the supplier has the upper hand in negotiations, when the special crafting skills or techniques of the supplier are in demand.

5.3 Optimization techniques with operations research

Operations research (OR), a branch of mathematics, enables us to articulate and analyze complex scenario, for decision analysis purposes, profit maximization, resource allocation and much more. Several industries benefit from this discipline. Within logistics, operations research is used for complex planning, plotting optimal routes for carriers, or placing logistic centres etc. In the food industry examples are found on how to maximize profit with limited capacities and uncertain and unstable demand.

Though the field of research originated during World War II and shortly after found usage in the industries, deployment of OR is limited to mainly large firms with the economic and human resources to articulate and solve OR challenges.

The evolution in computational resources within the past half-century, have only recently gained OR popularity among the wider business community. Possibly, graphical user interfaces for management make it easier to gather data and articulate optimization problems. With visual feedback to variations in scenarios, it might be easier to trust the analyses results. The preconditions for widely adaptation of OR in routine business procedures are only just evolving by OR software integrations with enterprise resource planning (ERP) systems. Yet, even small companies may benefit from OR techniques. e.g for product mix analyses and decision analyses.

The potential application of OR is unlimited, but some examples are given below:

Transportation and Assignment problems Airline companies may use OR to make flight plans which minimizes airport costs.

Resource allocation With limited machinery capacity, production resources can be allocated to, e.g., maximize profits.

Decision analysis Decide for one plan among a selection of plans for investing a fixed sum of money.

We have learned that general business practices apply across industries, and

may be part of business procedures in fashion companies as well. Routine cost management and analysis is present, where companies strive to understand the profitability of their operations. Outsourcing practises are less systematic in practical applications, but guidelines on good outsourcing practices have been listed based on the recommendations of The Confederation of Danish Industries. Applications of methods from operations research in other industries, indicate that OR methodologies could prove valuable to the fashion industry.

This chapter concludes part II, which provides background knowledge required to understand the preliminaries for the work presented in this report. Though outsourcing is a vital part of Danish fashion companies' business conduct, there seem to lack structured methods for outsourcing evaluations and decisions. It is possible, a tool for outsourcing evaluations may benefit fashion companies.

Part III focus on developing such a method, and investigate if it indeed has benefits to offer.

Part III

Methods and analyses

In this part..

This part is dedicated to the development of an analysis tool to support, for strategic, tactic, and operational outsourcing decisions.

A company could choose which type of manufacturer, Cut-Make-Trim (CMT) or Freight-on-Board (FOB), they want to work with as part of a strategy. The first chapter presents a method for comparing FOB and CMT costs, so companies may individually decide which collaboration model best enhances their competitiveness and establish supplier collaborations accordingly.

The second chapter is dedicated to the tactical decision of selecting particular suppliers to work with from a range of candidates. A method is suggested for comparing suppliers with respect to price quotations, estimates of macro costs, and indirect costs. Techniques for estimating macro costs and indirect costs are suggested. The comparison of three fictional suppliers is demonstrated.

The first two chapters are in coherence with the views and recommendations of David Birnbaum, accounted for in Chapter 4. The third and final chapter continues the pursuit of cost advantages and profits increase beyond Birnbaum's suggestions. By using operations research techniques methods are presented for increasing profitability after a fashion company has decided which suppliers to use. The methods are intended for use in daily operations.

The last chapter gathers the methods of the previous three chapters and advice on their proper usage as a combined management decision support tool for outsourcing as well as interpretations of results.

Chapter 6

FOB vs. CMT collaborations

This chapter presents a method for comparing FOB and CMT costs across collections and garment types. The objective is to obtain a method for many strategic decisions on which supplier collaborations may be established to increase profitability.

The method presented in this chapter have been developed by the author with input and guidance from Jan Fabritius.

6.1 Method

Though each garment carries its own cost in terms of material consumption, labour costs, etc., it is part of a collection of styles linked to each other through shared materials, design, and season. Thus, garments will be viewed as inseparable entities as a basis for the method developed.

An entire collection is linked together through shared materials, colours, styles and branding. A collection is evaluated as a whole and customers (retailers and end-consumers) will respond in the same way. A collection often consists of basic styles, modified and updated bestsellers from previous seasons, experimental styles, and signature styles. The fundamental economic transaction

links with the entire collection rather than the individual garment. As a result the economic benefits of a sound outsourcing strategy will be reflected in the profitability of the collection (and the company) as a whole.

Design costs relate to the collection rather than the individual piece of garments, as externals apply, i.e.: the initial work in defining a collection style is a one-time effort, the marginal design work for an individual piece of garment is then much less.

Because many styles share the same fabric, splitting the production lot between two different suppliers entails more complicated and expensive logistics. Therefore, it may be reasonable to choose the manufacturer with the combined lowest price, even though lower prices for individual styles can be found among other candidate suppliers.

A model is built in three iterations, starting with a single style and a single candidate supplier, ending with numerous styles and numerous candidate suppliers. The analysis will refer to a fictive fashion company, "Company A". The term 'Manufacturers' denote the collective name for all companies in the business of manufacturing garments. 'Suppliers' on the other hand, are manufacturers who live up to Company A's standard and collaborate with Company A. 'Candidate suppliers' are suppliers which Company A contemplates as suppliers. Suppliers specialize in either CMT or FOB services, which will label the 'Supplier type'.

Assumptions

The method presented in the following is based on a number of assumptions. A set of assumptions reflect a simplified reality, however, for which a given problem can be defined and solved. Making assumptions carries a risk of over-simplifying the original problem which in turn yields inapplicable solutions. For each assumption, implications of accepting them is set out below.

Assumption 1 The method focuses only on design and production related activities, plus related staff costs.
Consequence: The method heavily depends on *qualified* measures of staff costs and production related activities. Failing to do so may yield inaccurate results. Upon evaluation of the analysis results one may benefit to keep these consequences in mind to fully enjoy the recommendations of the analyses.

Assumption 2 There is no correlation between outsourcing decisions, and outside costs such as sales force costs and management costs.

Consequence: Outsourcing decisions may affect which fabric minimums Company A faces. It might prove more profitable to order surplus stock which in turn must be dumped (see Chapter 8), requiring involvement of other departments.

Assumption 3 Company A may need only internal management and key designers purchasing additional product development and production services at suppliers'.
Consequence: This assumption may result in organisational restructures, if the company has previously been organized around a different product development structure.

Assumption 4 Garment quality does not change from one supplier or production collaboration method to another. There is a certain quality standard, which candidate suppliers match.
Consequence: The assumption that garment qualities and fabric ranges are identical between suppliers is a bold simplification. It may be ratified if candidate suppliers chosen for comparison have been carefully nominated based on this requirement. If this assumption fails, it may heavily affect the resulting products and customer perception of the brand.

Assumption 5 Fabric supplies are identical from one candidate supplier to another.
Consequence: This is mostly attainable with supplier proximity to a large textile industry. Should this assumptions fail, it may put restraint style designs.

Designers may feel too restricted if the range of materials and production capabilities are too tight, yielding a less appealing product range. Consequently, the result of the analysis may point to a more costly solution.

Assumption 6 The additional macro costs or macro cost estimates have already been included in the candidate supplier price quotes during data collection for the analyses[1].
Consequence: The use of macro cost estimates is only valid if the estimates have been made to carefully reflect reality. Otherwise results of the investigation may be completely arbitrary. Failing to project cost measures to the same moment in time may yield inaccurate results. Since countries and political agreements are constantly changing, resulting in changed trade conditions. That said, precise macro costs estimates and high data quality will render very probable results.

Assumption 7 All comparative data has been projected to the same moment in time, see appendix B.

[1] more on this in Chapter 7, which presents a method to estimate macro costs.

Consequence: Costs from different years does not include currency inflations or changes in political agreements. Likewise, different compositions of collection complexities and changing fashion may disrupt an accurate comparison.

Developing the method

For the analysis, Company A's activities are divided into 20 categories, see figure 6.1.

The cost structure of Company A is influenced by supplier collaboration. Purchases are a variable cost per garment. For CMT services, this covers functions 10-13; FOB includes functions 2-15 as well. In addition, Company A have additional variable and fixed costs regardless of supplier type. For the analysis, we define the following variables:

p^{cmt}	price quoted by the candidate supplier per garment for functions 10-13
p^{allfob}	price quoted by the candidate supplier per garment for functions 2-14
C^{mat}	Company A's procurement and logistics cost of material, i.e. functions 5-9
C^{fob}	Company A's cost for FOB services when co-operating with a CMT supplier
C^{coo}	Company A's cost of collaboration with a particular supplier, i.e. functions 15, 16, and 18
C^{other}	the costs of non-FOB functions, i.e. functions 1, 17, 19, and 20

Company A's general annual or seasonal cost functions looks like this:

$$C_{total} \equiv C_{fixed} + C_{variable} + Purchase_{variable} \tag{6.1}$$

where $Purchase$ refers to purchases only from the supplier, and C are purchases from other suppliers or Company A's own cost. The actual calculations differ depending on the type of supplier collaboration and assumptions prior to supplier selection.

The analysis has been broken into three steps, starting with the simplest case: one company, one garment type, and one supplier. Though it is highly unlikely that a fashion company will place only one of its items with one supplier, this procedure will demonstrate the methodology, before we move on to increasingly complex scenarios.

	Fob / Cmt Service	No	Function	CMT				FOB			
				Supplier		Company		Supplier		Company	
				Type	Fixed / Variab	Type	Fixed / Variab	Type	Fixed / Variab	Type	Fixed / Variab
		1	Design			Cost.	Fixed			Cost.	Fixed
Sampling	F	2	Pattern making			Cost.	Fixed	Dept.	Fixed	Purch	Variab
	F	3	Gradation			Cost.	Fixed	Dept.	Fixed	Purch	Variab
Production Planning	F	4	Procurement			Cost.	Fixed	Dept.	Fixed	Purch	Variab
	F	5	Material cost			Cost	Variab	Purch	Variab	Purch	Variab
	F	6	Raw mat. Logistics			Cost	Variab	Purch	Variab	Purch	Variab
	F	7	Raw mat. Customs, duties			Cost	Variab	Cost.	Variab	Purch	Variab
	F	8	Raw Mat. Inventory			Cost	Variab	Cost	Variab	Purch	Variab
	F	9	Raw Mat. Qual. Assu			Dept	Fixed	Dept.	Fixed	Purch	Variab
Production	CF	10	Cutting	Process	Variab	Purch	Variab	Process	Variab	Purch	Variab
	CF	11	Sewing	Process	Variab	Purch	Variab	Process	Variab	Purch	Variab
	CF	12	Finished Qual. Ass.	Dept	Fixed	Purch	Variab	Dept	Fixed	Purch	Variab
	CF	13	Packaging	Process	Variab	Purch	Variab	Process	Variab	Purch	Variab
	F	14	Finished logistics			Cost	Variab			Cost	Variab
		15	Finished. Qual. Assu.			Cost.	Fixed			Cost.	Fixed
		16	Finished. Customs, duties			Cost	Variab			Cost	Variab
Post-production		17	Finished inventory			Cost	Variab			Cost	Variab
		18	Insurance, Legal			Cost.	Fixed			Cost.	Fixed
		19	Claims handling			Cost.	Fixed			Cost.	Fixed
		20	Legal aid			Cost.	Fixed			Cost.	Fixed

Figure 6.1: Supplier collaboration type and cost structure

One Company, one garment type, one supplier

To compare the costs of choosing either CMT or FOB production, the company must compare:

CMT production:

$$C_{total}^{cmt} = p^{cmt} \cdot D + C^{fob} + C^{coo} + C^{other} \tag{6.2}$$

where

C_{total}^{cmt}	is the total costs using a CMT supplier
D	is the number of garments

and the cost per garment is:

$$c_{total}^{cmt} = p^{cmt} + \frac{C^{fob} + C^{coo} + C^{other}}{D} \tag{6.3}$$

FOB production:

$$C_{total}^{fob} = p^{allfob} \cdot D + C^{fob} + C^{coo} + C^{other} \tag{6.4}$$

$$c_{total}^{fob} = p^{allfob} + \frac{C^{coo} + C^{other}}{D} \tag{6.5}$$

Comparison: To investigate if FOB cost less overall than CMT, this is a requirement for the costs per unit garment:

$$c_{total}^{fob} \leq c_{total}^{cmt} \Leftrightarrow \tag{6.6}$$

$$p^{allfob} + \frac{C^{coo} + C^{other}}{D} \leq p^{cmt} + \frac{C^{fob} + C^{coo} + C^{other}}{D} \Leftrightarrow \tag{6.7}$$

$$p^{allfob} \leq p^{cmt} + \frac{C^{fob}}{D} \tag{6.8}$$

For the 'One supplier'-case, the cost of collaboration (C^{coo}) and other costs are identical. If we assume that prices are consistent:

$$p^{fob} \equiv p^{allfob} - p^{cmt} \tag{6.9}$$

where

p^{fob} is defined as the implicit price for functions 2-14 less 10-13.

then, our comparison becomes this simple:

$$p^{fob} \leq \underline{C^{fob}} \tag{6.10}$$

The information required to apply this formula will be readily available in the company accounts or they could be estimated, combined with supplier price quotes.

In real life the suppliers offering CMT services are unlikely to offer FOB services as well. We therefore consider the case of multiple suppliers for the same product.

One Company, one garment type, different suppliers

We can no longer assume that the collaboration costs are the same as other costs, thus 6.9 becomes more complicated.

$$p^{allfob} + \frac{C^{coo}_{fob}}{D} \leq p^{cmt} + \frac{C^{coo}_{cmt} + C^{fob}}{D} \tag{6.11}$$

where

C^{coo}_{fob}	is the collaboration costs for the FOB supplier
C^{coo}_{cmt}	is the collaboration costs for the CMT supplier

If Company A is only engaged in a FOB supplier collaborations, we only have an estimate of the price that the FOB supplier would charge for CMT services.

$$p^{cmt}_{fob} \cong \hat{p}^{cmt}_{fob} \tag{6.12}$$

where

p^{cmt}_{fob}	price per garment for CMT collaboration is consistent with the FOB supplier's quoted price for FOB services
$\hat{p}^{cmt}_{fob}$	estimate of p^{cmt}_{fob}

Similarly we only have an estimate for collaboration costs with that supplier, i.e. $\hat{C}^{coo}_{cmt}$. Equivalent to 6.10 the comparison problem yields:

$$p^{allfob} - \hat{p}^{cmt}_{fob} \leq \frac{C^{fob} + \hat{C}^{coo}_{cmt} - C^{coo}_{fob}}{D} \tag{6.13}$$

Equation 6.13 is the same form whether the two suppliers are in the same country or not, as country differences are also captured in the costs of collaboration.

One Company, multiple garment types, different suppliers

Though, it is possible for a company to make specific analyses for each type of garment, with separate price quotes from each candidate supplier, separate tracking of the cost elements and distribution of collaboration costs, C^{coo}, may become rather arbitrary.

At the beginning of this chapter it was argued that the collection is the fundamental economic transaction. Therefore, we will assume that the individual garments are classified and weighted together in a 'standard' garment[2]. The questionnaire in appendix E shows a suggested method for doing so.

$$D^{std} \equiv \frac{\sum_s w_s \cdot D_s}{\sum_s w_s} \tag{6.14}$$

where

D^{std}	number of 'standard' garments
D_s	the quantity of garment style D_s, e.g. D_{AW146} is an order of 520 skirts of style #AW146.
w_s	weighted value w_s of one piece of garment style D_s, e.g. w_{AW146} is the added value €14 for each skirt of style #AW146

Classification of the garment types is guided by material differences' value for Company A. The value can be approximated by the average contribution margin per type for one piece of garment. Using 6.14 our comparison becomes:

$$p^{allfob} - \hat{p}^{cmt} \leq \frac{C^{fob} + \hat{C}^{coo}_{cmt} - C^{coo}_{fob}}{D^{std}} \tag{6.15}$$

[2]This assumption may prove very difficult to accommodate. If so, larger data sets are required to conduct this investigation, and only collections resembling each other in composition, quality and comlexity can be compared, with the accept of an error percentage.

Collection AW05

	Blouse A	Blouse B	Trousers C	Dress D
Complexity rating	4	2	3	5
Demand, D	180	315	176	230
Revenue	€46	€38	€50	€67
Materials costs (CMT only)	€17	€8	€12	€20
Suppliers	Total costs: Landed, duty paid			
Sup. 1 FOB	€19	€12	€18	€29
Sup. 2 FOB	€21	€11	€19	€32
Sup. 3 CMT	€9	€4	€8	€13
Sup. 4 FOB	€19	€13	€16	€26
Sup. 5 CMT	€10	€6	€8	€15
Sup. 6 CMT	€8	€3	€9	€14

Example: The standard garment D becomes:

$$\begin{aligned} D &= \frac{4*180+2*315+3*176+5*230}{(4+2+3+5)(180+315+176+230)} \\ &= \frac{3343}{14*901} \\ &= 3.7(weight), 238, 79(demand) \end{aligned}$$

The estimate of CMT prices are not straight forward. We must therefore discuss methodologies to find good estimates for CMT prices and good estimates for CMT collaboration costs for companies who collaborate with FOB suppliers. Firstly limitations and success criteria for the method developed will be evaluated.

Limitations

The method given above, has some limitations especially where Company A's business conduct is concerned.

- Though we evaluate a collection, we do not take into account all aspects of seasonal production, back-ordering, etc. Examples: replenishing inventory, supplier overhead costs, mid-seasonal styles.
- This analysis does not include setup costs for switching from a supplier to a candidate supplier. This cost is considered a one-time investment though it may range over several collections. It is implicit that continuous switching

to cheaper candidate suppliers, will be less profitable than establishing longer relations to existing suppliers, who already understand the design and quality requirements of Company A.

- Company A must be willing to use the material available to it's FOB suppliers. We assume that all candidate FOB suppliers can offer a wide range of fabrics, qualities, and patterns which will match Company A's standards. Company A for its part, is open to selecting among the available fabrics, and not locked on to one specific textile manufacturer.

Estimating CMT collaboration costs with FOB suppliers

Proper estimates of CMT collaboration costs are important to conduct the analysis. However, evaluating on techniques for doing so is outside the scope of this report.

Converting collection garments into a standard garments measure, D^{std}

Equation 6.14 can be calculated with weights depending on Company A's preferences. The weighting can be carried out with alternative factors of importance, e.g.:

- The mark-up value for a garment (net. unit revenue)
- Complexity degree
- Novelty value
- Brand value

It is the authors belief collection styles may be weighted into a standard garment in a satisfying way, though it requires qualitative and consistent evaluation for each style to yield good results. This report suggest using complexity degree as weight. The weight can be based on a rating as suggested in the questionnaire of appendix E.

Data collection

To use the method presented in this chapter, data must be collected prior to analysis. The collection of data may be automated, granted all measures have been collected through an ERP system.

6.2 Results interpreted

A method has been presented for comparing cost of FOB and CMT collaborations, buy including all activities of the production process. To compare collections of different style compositions and complexities a method for weighting these variations into a standard garment is presented. The comparison of FOB and CMT collaboration costs may be useful for identifying which supplier collaboration model is most profitable for a fashion company. The method is suggested for use in strategic considerations.

The following chapter suggest a method for comparing suppliers based on their price quotations, geographic location and quality standards.

Chapter 7

Supplier comparison analysis

This chapter is dedicated to improving the information outsourcing decisions are based upon, and consequently select suppliers, which are least expensive overall. A method for comparing suppliers, with considerations to direct costs, indirects costs, and macro costs is given. To make proper estimates for macro costs a method is developed based on a ranking system. Methods for costing indirect costs are also provided. The objective is to create an easy-to-use compounded method for supporting tactical decisions, which can be incorporated into business routines for managers and sourcers.

All methods presented in this chapter is developed by the author. The inspiration for including additional costs in supplier comparisons comes from David Birnbaum (see chapter 4).

7.1 Quantifying Macro Costs

Before deciding to collaborate with a supplier in a given country it would be wise to consider macro-factors (political climate, infrastructures, trade barriers, etc.) facilitating or obstructing collaboration across borders, or in more general terms: the business environment. To compare the data of different candidate

		Score		
Factor	Weight	Country A	Country B	Country C
Labour cost	0.5	3(1.5)	2(1.0)	1(0.5)
Labour supply	0.3	1(0.3)	3(0.9)	2(0.6)
Stability	0.2	2(0.4)	1(0.2)	3(0.6)
Final score		2.2	2.1	1.7

Notes:
(1) Weights are subjective but must total to 1.0
(2) Best score = 3
(3) weight × score
(4) Final score = total of ()

Table 7.1: The raking model suggested by Jones

suppliers across borders we must include considerations to the differences in business environments. Jones[32] gives his suggestions on how to quantify the macro costs for comparative purposes, see table 7.1[1]. This method enables the company to do its own weighting based on experience and/or extensive analysis. The method can easily be expanded to include other factors as well. However, it requires internal ressources and insights to do a good weighting based on own experiences which fashion companies may have different prerequisites to successfully conduct. Alternatively, the Economist Intelligence Unit provides a yearly Business Environment Ranking (BER) ([38]) which may be adequate. The ranking is based on evaluations by business professionals with regional expertise. Rather than developing an individual weighting system, this may serve the purpose adequately. If necessary it can be adjusted to better suit the purposes of the method.

EIU: Business Environment Ranking

> The Economist Intelligence Unit's business environment ranking model seek to measure the attractiveness of a country's business environment and its key components. The assessment of the business environment, based on the opportunities for, and hindrances to, the conduct of business enables each of the 82 countries covered to be ranked on its overall position and in each of ten categories on a global and a regional basis. The model uses quantitative data, business surveys and expert assessments to measure the attractiveness of countries' business environments.[38]

[1] [32], p. 183 bottom

The BER yields a single country score based on both quantitative data and qualitative data within 10 different categories, (see listing below). The rating does not include tariffs and quota costs, which are prevalent in the fashion industry. These variable costs are, however, well known and can be included separately in an final FVCA analysis. The categories are:

1. Political environment
2. Macroeconomic environment
3. Market opportunities
4. Policy towards private enterprise and competition
5. Policy and attitudes towards foreign investment
6. Foreign trade and exchange regimes
7. Tax regime
8. Financing
9. Labour market and skills
10. Infrastructure

In total, a questionnaire of 95 questions, quantify the qualitative data. For each question the respondent gives a ranking between 1-5. Quantitative data is likewise divided into five subdivisions. Finally, the aggregate category scores are weighted together, and several incremental steps finally yields a country score on a scale ranging from one to ten.

During the research previous to this report no examples were found on using the rankings as explicitly as suggested here. Rather, the rankings seem to be used mainly for briefing purposes. The attempt to use this score to include macro costs in a price quote evaluation must be considered experimental.

Method of inclusion

We decide that a candidate supplier price quote, P_{quote}, must be weighted with the macro costs factor, x^{BER}, to reveal the business environment cost p^{BER} to the fashion company.

$$p^{BER} = p^{quote} \cdot x^{BER} \tag{7.1}$$

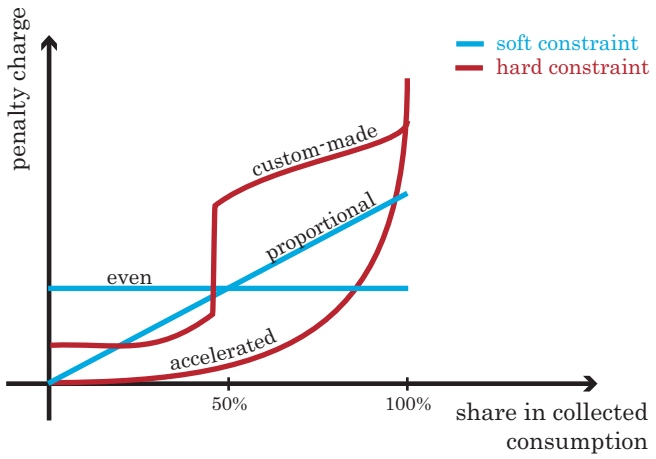

Figure 7.1: Different examples for constraint functions

The key is to develop x^{BER} to ensure increase with decreasing values of the rank. To achieve this, x^{BER} is converted into an inversely proportial function of the BER, with the convertion formula $f(r)$ and adjust it with a. The results is:

$$x^{BER} = \alpha \cdot f(r_{BER}) \tag{7.2}$$

where

r_{BER}	is the BER rating
$f(r)$	is the conversion function, converting r_{BER} into a percentage

The function, $f(r)$, can be defined however we prefer. An initial linear conversion function is defined:

$$f(r) = \left(1 + (1 - \frac{r_{BER}}{10})\right) \tag{7.3}$$

As we gain more experience with using these parameters in comparative studies and compare our forecasts with reality, a and $f(r)$ may need adjustments. The function $f(r)$ may be modelled with soft or hard contraints (see figure 7.1) towards the extremeties of the BER to avoid considerations of suppliers in very low BER rated countries.

To verify the model and parameters, companies can develop cost forecasts for a collection from a previous season for immediate comparison with the actual outcome, granted all data is available. If not, procedures for data collection must be extended to facilitate these types of analysis on future collections.

After carefully testing the model for different values of a and $f(r)$, the forecast still fails to deliver satisfactory results, changes on the BER might be necessary.

Modifying the BER for fashion business purposes.

Changing the BER to better suit fashion businesses requires careful analysis of the data feedback from earlier models and a clear understanding of how the BER rate is calculated. Below, a procedure for modifying the BER is suggested.

1. Compare supplier price quotes and estimated total costs with x^{BER}, with actual costs[2]. Observe any patterns in differences. Graphics might be useful for identifying the patterns, or statistic correlation between country costs and error fluctuations.
2. Analyze which factors cause the fluctuations and to which BER categories they belong, consequently discovering which factors of the BER could be weighted differently.
3. Study exactly how the BER has been generated. The tool has been created by skilled analysts and their method may provide good guidelines. Consider consulting a statistics analyst.
4. Use Jones' (table 7.1) example as a guideline to adjust the ranking.
5. Evaluate on the new country scores by comparing against older data.

If modifications to the BER still yields inaccurate results, the model may be rejected to seek new approaches to estimate the impact of macro costs.

The next section focus on tariff an quota costs.

Tariff and quotas

Tariffs and quotas are part of the trade barriers, which are setup between countries or regions. Tariffs relate to the costs of bringing goods into a country and they apply regardless of where the production is from[3]. Quotas set a physical limit to how many items can be imported into a country or region, and they

[2] The actual costs must be carefully analyzed to give a true indicator. Methods within Activity Based Costing may be relevant

[3] Inside the EU internal trade is tariff-free, though.

may be targeted towards specific countries[4]. Quota's yields a quota charge on the supplier price quotes. In Denmark, all imported goods are subject to tax tariffs. Depending on the type of goods, their composition and assembly-state a tax is added. Apparel tariffs typically range from 6% to 15%. Where tariffs are usually straightforward to predict, quota charges must be collected by inquiry. Once this is done they are easy to account for:

$$p^{quota} = \text{a fixed cost} \tag{7.4}$$
$$p^{tariff} = p^{quote} x^{tariff} \tag{7.5}$$
$$x^{tariff} = \text{a percentage of the garment value upon import} \tag{7.6}$$

Macro costs influences on supplier price quotes are thus:

$$p^{macro} = p^{quote} \cdot x^{tariff} x^{BER} + p^{quota} \tag{7.7}$$

An example of a macro cost calculation is demonstrated below:

Macro costs for a shirt

	Vietnam	Lithuania
Price quote	€3.5	€6.8
BER rank	5.92	7.04
BER cost ($\alpha = 0.3$)	€1.48	€2.64
Quota	€0.5	-
Subtotal	**€5.48**	**€9.44**
Tariff rate	12%	-
Tarif costs	€0.66	-
Macro costs total	**€2.64**	**2.64**
Total	€6.14	€9.44

7.2 Identifying and Including Indirect Costs

Methods for estimating and including macro costs in total price estimates have been demonstrates. The impact from indirect costs and how to identify them is yet unexplored. Indirect costs which are not measured in money value yield a particular challenge. In this section we shall look closely at supplier collaboration costs, damaged goods, delays, and wrong lot size deliveries, especially.

[4]the EU has quota restrictions on imports from China. The quotas were established to protect home industries from fierce competition and fear of price dumping. These quotas were due to phase out on January 2005 and many fashion importers anticipated the date with delight. After this date, imports from China sky-rocketed and an outcry from the EU's local manufacturing industry followed. In June 2005 quotas were temporarily re-established, much to the dismay of the Danish fashion industry having shipments frozen in customs. With the beginning of 2008 quota restrictions are abolished

Evaluating supplier collaboration costs

Errors occur and in the fashion business this is particularly true. Sometimes deliveries contain damaged garments, lack ordered items, or arrive with additional items; occasionally the orders arrive late. Obviously these are all situations we wish to avoid and errors typically occur more frequently under stress and with less skilled suppliers. Misunderstandings, errors, etc., are risk factors which affect the profitability of Company A and should be considered when evaluating candidate suppliers. During a comparison analysis of candidate suppliers it may prove convenient with measures to valuate these collaborations costs. This report attempts at that. Indirect costs are:

$$p^{indirect} = p^{errors} + p^{delay} + p^{underdelivery} + p^{overdelivery} \tag{7.8}$$

Damaged garments:

Company A has 4 options if a damaged garment arrives from the supplier:

1. **Accept** and sell garment at full price.
2. **Discard** and throw away the garment.
3. **Repair** self-repair the garment or return it to the supplier for repair.
4. **Discount** sell the garment at a discount.

Option (1) is highly unlikely, options (3) and (4) are undesirable with no particual benefit to Company A. They might converge to the same value as (2). Only options (1) and (2) will be considered in the quantification of damaged garments. Compensations for the expected error percentage, x^{err}, may be evaluated like this:

$$x^{errors} = \frac{\#\text{of damaged garments}}{\#\text{ ordered items, } D} \tag{7.9}$$

$$p^{errors} = p^{quote} x^{err} \tag{7.10}$$

With this definition of x_{errors} Company A might consider ordering additional garment styles to cover the lost garments and includes this cost in the supplier evaluation:

$$x^{order} = Demand(x^{error} + 1) \tag{7.11}$$

Alternatively, Company A might charge a cost proportional to the profit contribution value[5] of this garment to the collection.

$$p_s^{error} = p^{quote} \cdot \frac{p_s^{profit}}{P_{collection}^{profit} \cdot Demand_s \cdot x^{errors}} \tag{7.12}$$

where s refers to a specific style. It is up to Company A to decide how they will respond to and valuate errors.

Delays

Occasionally orders are not delivered at the agreed date. Companies have very different ways to handle delays in delivery. The case studies indicate that most companies tolerate some delay but grow increasingly intolerant of prolonged delays. Intolerance peaks, when delays result in a complete refusal of the entire delivery. Delays must be a function of time and might look like:

$$p^{delays} = p^{quote} \cdot x^{delay} \tag{7.13}$$

$$x_{delay}(t) = a^{s\Delta_t} \text{ , for } t \in [0 - q] \tag{7.14}$$

$$x_{delay}(t) = 10.000\% \text{ , for } t > q \tag{7.15}$$

where

Δ_t	time, measured in days, $\Delta_t \in \mathbf{I}$
a	weight of cost, defined by Company A
s	parameter to accelerate or deccelerate the curve, defined by Company A
q	maximum accepted delay time, measured in days

The final value of x_{delay} depends on the individual supplier's ability to deliver on time.

Observations from case company interviews indicated that decreasing size of fashion companies would increase their tolerance to delays. This may be linked to the fact, that larger companies may work towards more frequent collection turnover, and smaller fashion companies have a greater share of their total order tied up with each supplier.

Wrong lot size

Overdelivery and underdelivery cause different inconveniences to companies. Furthermore both situations may occur simultaneously.

[5] or any other scalar value suitable to reflect the costs of unsaleable items

	Silk blouse				total
sizes	34	36	38	40	
order	30	48	53	43	174
received	32	48	52	43	175
difference	**↑ 2**	**0**	**↓ 1**	**0**	**↑ 1**

Table 7.2: Overdelivery and underdelivery on the same order

Example: See table 7.2.
Company A orders 174 silk blouses in sizes 36-40. Upon delivery, Company A counts 175 items, but the wrong lot size is 3 items: 1 size 38 missing, and 2 size 34 surplus stock. The two cases, underdelivery and overdelivery, will be handled differently, as we shall see.

Underdelivery Company A might reorder the missing items and subsequently treat them as delayed items or as damaged items.

$$p^{underdelivery} = \begin{cases} p^{delays} & \text{delayed item} \\ p^{errors} & \text{damaged item} \end{cases} \tag{7.16}$$

Underdeliveries cause Company A inconviniences as it may not be able to deliver complete orders to clients, risking a reject of the entire order.

Overdelivery Overdeliveries are nearly as inconvenient to Company A, as underdeliveries. In case of overdelivery, Company A has surplus stock and costs linked to it: inventory charges, handling charges etc. with no guarantee that this surplus stock will earn.

Different measures can be used to avoid this situation in the future:

- supplier penalty charge[6].
- ignore it, but use this in future price negotiations with the supplier.

The cost of overdelivery is somewhat more difficult to estimate. Most companies, however, do keep track of their costs directly related to a garment: inventory, handling etc., and they may include these in their unit costs.

[6]Case Company C 'claims' their supplier. The additional items are not paid for, and the supplier must deduct the cost of one additional item from the price.

Direct costs	Price quote
Macro costs	BER costs
	Quota charge
	Tariff costs
Indirect costs	Damages
	Delays
	Underdelivery
	Overdelivery
	Order minimums
Total	

Table 7.3: The cost elements of a supplier comparison, ordered by calculation procedure

$$p^{overdelivery} = p^{inventory} + p^{handling} + p^{salescosts} + \dots \quad (7.17)$$

Minimums Previous examples have been given on including minimums in cost comparisions. This is the forumula:

$$p^{minimums} = (Demand^{min} - Dclientorders)\frac{p^{quote}}{D^{clientorders}} \quad (7.18)$$

All indirect costs are gathered in this formula for evaluating supplier price quotes.

$$p^{indirect} = p^{quote}x^{underdelivery}x^{error} + p^{overdelivery} + p^{minimums} \quad (7.19)$$

7.3 Supplier comparison

The order in which costs are calculated matter when accumulating costs. The correct order is illustrated in table 7.3. To perform a comparison analysis, a company must decide on parameters and procedures of preference, as suggested in the previous sections, to calculate each cost.

This chapter presented various methods for estimating macro costs and indirect costs, which could be used in price comparisons of different suppliers. In total the chapter presents a method to include these costs to uncover the financial consequences of selecting a given supplier. The tool can be integrated with accounting systems and in business routines, and provide supportive analysis for tactical decisions.

Next, we consider how techniques from Operations Research may be used in daily operations, to discover cost advantages as a consequence of price structures in the fashion industry.

Chapter 8

Optimizations with Operations Research

Even after a careful consideration of supplier type, and candidate supplier comparisons, further cost advantages are still obtainable once Company A has decided which supplier wins the order. This chapter demonstrates how fashion companies may benefit from using Operations Research methods to perform cost minimization and profit maximization analyses as a means to support purchasing decisions that will increase company profitability.

8.1 Production Cost Minimization

To illustrate the relevance of a cost minimization model this section put forward an example:

Example: For each garment style s in the collection, Company A have prebooked orders D_s as a result of the sales team efforts. The costs of meeting the demand for all collection styles can be minimized, using operations research methodologies as will be demonstrated, in this section.

The first cost minimization problem constructed in this section is simplified in such a way that it could in fact be solved without operations research methods. It does, however, demonstrate the methodology behind solving more complex problems.

Supplier price quotes are often given in stepwise decreasing prices, where surcharges apply for orders smaller than supplier minimums, while discounts are offered for larger orders (see table 8.1). This applies in both FOB and CMT

Style S				min. 200pcs
Quantity ranges (pcs)	0-199	200-499	500-999	1000 $\leq$
Price per item (LDP)	€21.6	€18	€15.3	€10.8
Surplus charge/Discount	20%	-	-15%	- 40%

Table 8.1: Stepwise decreasing prices for a garment style

collaborations. For CMT collaborations, Company A must furthermore consider material minimums and discounts (see table 8.2). The customer demand

Fabric F			min. 200m
Quantity ranges (meters)	200-999	1000-4999	5000 $\geq$
Price per meter	€6	€5.4	€4.5
Discount	-	-10%	-25%

Table 8.2: Fabric purchase, with quantity discounts.

for a collection of styles will be referred to as the *mto* (Made-to-order lot). Additional items ordered, e.g. to obtain quantity discounts, is called the surplus lot. Due to stepwise decreasing unit prices, it occasionally cost less to increase the order size. This phenomenon is illustrated in figure 8.1. If mto falls within certain quantity ranges (see figure 8.3) order quantities may cost less totally if the quantity is increased. Thus, by ordering a surplus lot, x, Company A may actually decrease it's production purchase costs.

The fractioned curve of figure 8.1 is described as[1]:

$$p = ax + b) \begin{cases} x \in [1 - 200[, & a = p_{[0-200[}, & b = 0 \\ x \in [200 - 500[, & a = p_{[200-500[}, & b = 0 \\ x \in [500 - 1000[, & a = p_{[500-1000[}, & b = 0 \\ x \in [1000 - \infty], & a = p_{[1000-\infty[}, & b = 0 \end{cases}$$

All b-values equals 0, because the quantity discounts applies to the entire order (see figure 8.2). We can solve this by constructing a cost minimization problem.

[1] see also figure 8.2.

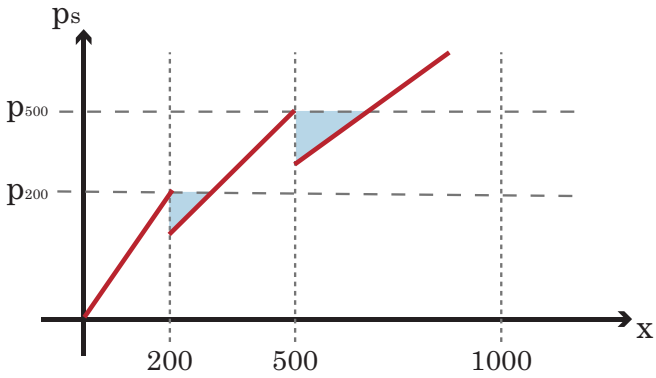

Figure 8.1: Stepwise decreasing item prices, illustrated

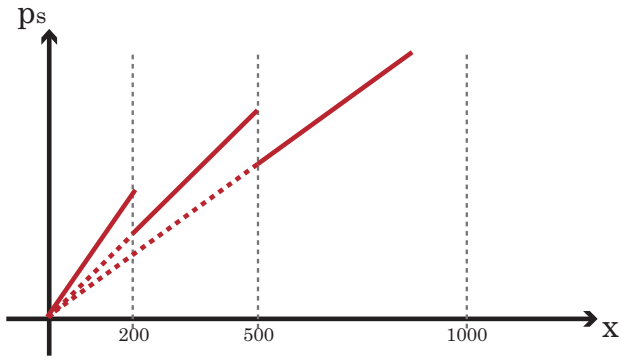

Figure 8.2: All b-values are 0

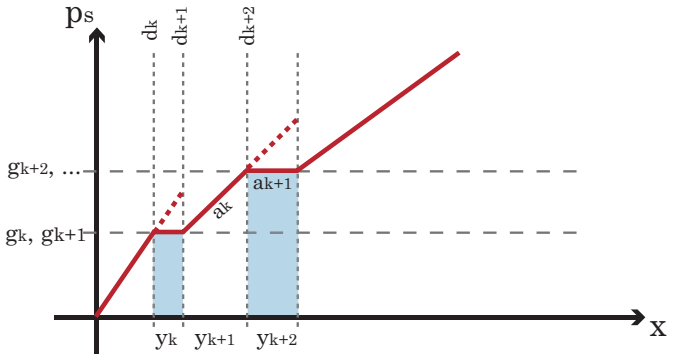

Figure 8.3: Stepwise decreasing prices, continuous price curve

Cost Minimization Problem, Mixed Integer Programming

The overall objective is to minimize the production costs, and still meet the demand, D. The fractioned curve of figure 8.1 has been replaced with a continuous equivalent in 8.3 . This equivalent curve illustrates that where demand, D, exceeds the quantity d_i for some intervals production costs are lowest when ordering d_{i+1} items. Naturally, Company A would place their order accordingly.

This can be articulated as a simple minimization problem:

Objective:

$$\min \quad Z = \sum_{k=0} (g_k y_k + a_k x_k) \tag{8.1}$$

Decision variables:

$$\begin{aligned} x_k &\in [0, d_{k+1} - d_k] \\ y_k &\in \{0, 1\} \end{aligned}$$

Constraints:

$$\begin{aligned} \sum_{k=0} y_k &= 1 \\ y_k(d_{k+1} - d_k) - x_k &\geq 0 \quad , \quad \forall k \\ \sum_{k=0} (d_k y_k + x_k) &\geq D \end{aligned}$$

where

D is the demand, which must be met
k is the interval between d_k and d_{k+1}
g_k is cost of producing d_k units
a_k is the unit price of additional units the interval k
x_k is the variable we wish to determine the surplus lot from, $x \in \mathbf{I}$
y_k is a binar decision variable for interval k

This problem can be solved for each garment style s individually, as production costs for garment styles are yet unrelated. In reality, garments are linked together through shared material consumption, but this consideration is mainly relevant for companies ordering CMT. Working FOB places the responsibility of including material purchase costs in the calculations on the supplier; working CMT places the same responsibility on Company A.

CMT specifics

Working CMT, the production costs are:

$$P_{CMT} = (P_M + P_S) \tag{8.2}$$

where

P_M is the collection material costs
P_S is the production costs

The cost of materials P_M is the product of all materials, Q_f, consumed and material unit prices p_f. For simplicity fabrics will be the only materials referred to henceforth in this chapter.

$$P_M = \sum_{j \in F} p_j Q_j \tag{8.3}$$

An overview can be generated in matrix form, with q_{ij} denoting quantity (the material consumption F_j and style S_i):

Garments		Fabric			
Style	Demand	F_1	F_2	F_3	$\dots$
A	D_A	q_{af_1}	q_{af_2}	q_{af_3}	$\dots$
B	D_B	q_{bf_1}	q_{bf_2}	q_{bf_3}	$\dots$
C	D_C	q_{cf_1}	q_{cf_2}	q_{cf_3}	$\dots$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$
		Q_{f_1}	Q_{f_2}	Q_{f_3}	$\dots$
	minimums	$F_{1_{min}}$	$F_{3_{min}}$	$F_{3_{min}}$	$\dots$
	unit price	p_{f_1}	p_{f_2}	p_{f_3}	$\dots$

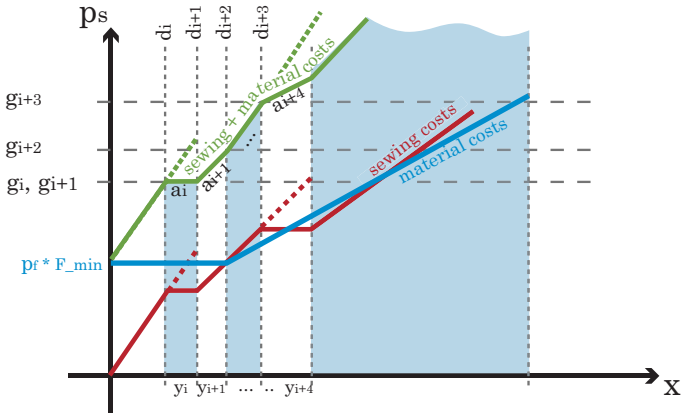

Figure 8.4: Material costs rise as more garments are produced

and fabric consumption costs P_M costs:

$$P_M = \sum_{i \in S} D_i \sum_{j \in F} p_j \cdot q_{ij} \tag{8.4}$$

As Company A cannot always meet fabric minimums we must include this cost of additional material somehow.

Example: only 367m of fabric is needed, but factory minimums are 500m. The additional 133m also carries costs which must be distributed on the garments.

For CMT collaborations, ordering surplus lots becomes increasingly complex, because of fabric minimums. As long as fabric minimums are not met we may view the production of a surplus lot as free of fabric costs.

Furthermore, if fabric minimums are not met, Company A might consider discarding the entire fabric and the style variants using this fabric, with resulting image loss due to incomplete order delivery. Yet, this is not an option if the demand, D, must be met. We shall return to this debate, however, in section 8.2 concerning profit maximization.

Balancing all expenses and cost saving opportunities is challenging but with operations research methods the problem becomes much easier. We articulate the mininimization problem for the collection as a whole, including surcharges for excess materials.

Objective:

$$\min \quad Z = \sum_{i \in S} \sum_{k=0} (g_k y_k + a_k x_k) + \sum_{j \in F} p_j Q_j^{excess} \tag{8.5}$$

Decision variables:

$$\begin{aligned} x_k &\in [0, d_{k+1} - d_k] \\ y_k &\in \{0; 1\} \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned} \sum_{k=0} y_{(i,k)} &= 1 \quad , \quad \forall i \\ y_{(i,k)}(d_{(i,k+1)} - d_{(i,k)}) - x_{(i,k)} &\geq 0 \quad , \quad \forall k, \forall i \\ \sum_{k=0} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) &\geq D_i \quad , \quad \forall i \\ Q_j^{excess} + \sum_{i \in S} q_{ij} \sum_{k=0} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) &\geq Q_{min(j)} \quad , \quad \forall j \\ Q_j^{excess} &\geq 0 \quad , \quad \forall j \end{aligned}$$

and:

$$x_i = \sum_{k=0}^{n} x_{(i,k)}$$

Q^{excess} becomes a variable which is always positive and at minimum the amount of surplus fabric.

Unfortunately the $d_{(i,k)}$'s depend on the how much fabric has been consumed, and ought to be described as a function of x_i's. This would, however, lead to non-linear constraints, yielding a mixed-integer programming problem, which can only be solved using heuristics. The effect of correctly updated $d_{(i,k)}$'s on the value of x_i is expected to be minimal though slightly in favour of smaller values of x_i with less than the minimal optimum as a consequence. The small imprecision is considered acceptable, however, and the minimization problem shall be proceeded with in its existing form. Before making a demonstration of the method in action, the adaptness of the model is indicated.

Including additional costs

The minimization model is very versatile. Surplus lot orders are effectively separated from the made-to-order lot, with individual costs summed up in a_i. The

value a_i may contain additional handling costs and inventory costs for surplus lot items which does not apply to made-to-order items. Material quantity discounts are included initially in the model, as intervals and costs are defined. As long as the values a_i and g_i are kept constant within an interval, this minimization model applies to a range of cost scenarios and can be solved as a mixed integer problem. In the next section the minimization problem will be included in a new objective function with additional decision variables. First a demonstration, though, of cost minimization on a data set.

Demonstration

To demonstrate the results obtained with the cost minimization model we conduct the analysis on some realistic data.

		quantity ranges, unit prices			
Style	Demand	≤ 200	201-500	501-1000	1000 $<$
A	51	€11.4	€9.5	€8.1	€5.7
B	105	€4.8	€4	€3.4	€2.4
C	150	€15.6	€13	€11.1	€7.8
D	167	€9.6	€8	€6.8	€4.8

Table 8.3: Style specifications

F1			minimum: 100m
Quantity ranges (meters)	100-500	501-1000	1000 $<$
Price per meter	€12	€10.2	€7.8
Discount	-	-15%	-35%
F2			minimum: 300m
Quantity ranges (meters)	300-1000	1001-3000	3000 $<$
Price per meter	€6	€5.4	€4.5
Discount	-	-10%	-25%
F3			minimum: 500m
Quantity ranges (meters)	-	500-5000	5000 $<$
Price per meter	-	€4.5	€3.0
Discount		-	-20%

Table 8.4: Fabric specifications

Garments		Fabric		
Style (s)	Demand (D)	F_1	F_2	F_3
A	51	2.5	–	–
B	105	1.5	0.3	–
C	150	–	–	2.8
D	167	–	1.1	–
	sum	285	215.2	420
	$minimums$	200	300	500

For each style we must construct a compounded and continuous cost curve, which we will use in the cost minimization. The values d_i and intervals y_i are decided from each curve segment of both production prices and material prices. Before compounding the costs, we must scale the cost curve of a fabric with the style that we are investigating, like this:

$$\begin{aligned} f(x) &= a_i x_i + b, x \in]d_i, d_{i+1}] \\ a_i^{sewing} &= \begin{cases} 0 \\ p_i^{sewing} \end{cases} \\ b &= a_i x_{min} \\ a_i^{materials} &= \begin{cases} 0 \\ p \cdot q \end{cases} \\ d_i^{materials} &= \frac{d_j}{q} \\ g_i &= f(d_i) \end{aligned}$$

Finding new quantity intervals of the compounded cost curve is done like this: Finding the d values:

$$d = \left\{ \begin{array}{lll} \forall d^{sewing}, & & \\ \forall d^{materials}, & & \\ \forall \Big(f_i^{sewing}(d^{\hat{sewing}}) & = & f_{i+1}^{sewing}(d_{i+1}^{sewing}) \Big), \\ \forall \Big(f_i^{materials}(d^{\hat{materials}}) & = & f_{i+1}^{materials}(d_{i+1}^{materials}) \Big) \end{array} \right\}$$

Per-style evaluation

Cost minimization will first be conducted on a per-style basis to check for any differences between individual style evaluations, and analysis of the collections as a whole

FOB production: Cost curves for FOB production would resemble those of style costs only (see table 8.3). All of the following references to FOB production

Style	Demand	Surplus lot
A	190	10
B	170	30
C	450	50
D	490	10
Original cost		**€12,752.00**
New cost		**€11,650.00**

Table 8.5: Results of FOB cost minimization

Style A

y_k	d_k	g_k	a_k
y_1	0	0.00	11.40
y_2	167	1900.00	0.00
y_3	200	1900.00	9.50
y_4	427	4050.00	0.00
y_5	500	4050.00	8.10
y_6	704	5700.00	0.00

Table 8.6: Manufacturing cost curves

in this chapter refers to analysis of the style costs only, even though prices may be unrealistic compared to CMT.

Table 8.6 shows the manufacturing cost curves for style A. If demand for style A falls within the ranges 167-200, 427-500, or 704-1000, surplus styles can result in cost savings. The result of cost minimization is displayed in table 8.5

CMT production: Including material costs from 8.4, style A now only achieves cost advantages if the demand falls within the of range 170 to 200 (see table 8.8). Performing cost minimization yields results in table 8.7.

Style	Demand	Surplus lot
A	190	10
B	170	0
C	450	0
D	490	0
Original cost		**€29,408.00**
New cost		**€29,397.00**

Table 8.7: Results of FOB cost minimization

Style A

y_k	d_k	g_k	a_k
y_1	0	0.00	41.40
y_2	167	6910.00	30.00
y_3	170	700.00	0.00
y_4	200	700.00	35.00
y_5	427	14,938.50	25.5
y_6	500	16,800.00	33.60
y_7	704	23,652.0	25.50
y_8	1000	31,200.00	25.50

Table 8.8: Compounded cost curves

Cost minimization for the collection as a whole:

Evaluating on surplus stock ordering on a per-style basis may be suitable for illustrative purposes, but for decision-making analyzing the collection as a whole seems more appropriate.

FOB production In the case of FOB production, there are no differences between evaluating on styles individually and the collection, since the styles in the model only linked through their material consumption. In FOB production this relatedness is absolved. CMT production is another story.

CMT production: Performing cost minimization for the CMT production and the collection as a whole, yields the same results as the per-style evaluation on this data set.

Though cost minimization is important in any well-run business it is nothing without successful sales, which is the key to making a profit. In fact, the overall objective for focusing on costs may prove more valuable if shifted to focussing on profits. This includes additional dimensions to the minimization problem of section 8.2.

8.2 Profitability maximization

Companies may have large turnovers and focus on costs minimizations, without making the most profitable decisions for their company. Profit maximizations is

more difficult than cost minimization, because it includes input data based on qualified estimates. Gross Margin Percentage[2] (GMP), useful for profitability evaluations, is defined as:

$$GMP = 100 \cdot \frac{\text{Revenue - Cost of Goods Sold}}{\text{Revenue}}$$

This may lead the company to focus on profitability maximization rather than profit maximization. For simplicity only profitability maximization is considered for the mto lot. Surplus lot considerations are included later on.

Profitability maximization without surplus ordering

Company A requires that the gross margin percentage of each style, gmp_i, must at least measure up to the minimum gross margin percentage $\hat{gmp}$. Company A may even require that the entire collection yields a gross margin percentage of $\hat{GMP}$, a compound of the weighted gmp_i's. As many fashion companies work with target costing, revenues are fixed. The gmp values are thus decided by the production costs alone. The greater the GMP, the more profit the company will make given that all other costs remain stable.

Garment styles	P	R	GMP
A	p_a	r_a	gmp_a
B	p_b	r_b	gmp_b
C	p_c	r_c	gmp_c
$\vdots$	$\vdots$	$\vdots$	$\vdots$

$$GMP_S \geq \hat{GMP}$$

One could argue that discarding a style with a low gmp_i is better than letting it weigh down GMP_S. Identifying low profit items, might result analysis recommendations to reconsider some styles:
if $gmp_i \leq \hat{gmp}$:
reconsider style i
endif

However, complexity for making this decision increases when collection styles are interrelated, e.g. a style carries fabric surcharges which it shares with other

[2]the ratio of gross profit to revenue. Gross profit is revenue and the cost of making a product or providing a service, before deducting overheads, payroll, taxation, and interest payments.

Style	Material ($j \in F$)					
($i \in S$)	1	2	...	m	Revenue	Demand
1	$q_{11}p_1$	$q_{12}p_2$	...	$q_{1m}p_m$	r_1	D_1
2	$q_{21}p_1$	$q_{22}p_2$	...	$q_{2m}p_m$	r_2	D_2
3	$q_{31}p_1$	$q_{32}p_2$	...	$q_{3m}p_m$	r_3	D_3
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$
$n-1$	$q_{(n-1)1}p_1$	$q_{(n-1)2}p_2$	...	$q_{(n-1)m}p_m$	$r_{(n-1)}$	$D_{(n-1)}$
n	$q_{n1}p_1$	$q_{n2}p_2$	...	$q_{nm}p_m$	r_n	D_n
minimums	Q_{min1}	Q_{min2}	...	$Q_{min(m)}$		

Table 8.9: Collection overview for styles and material linkage

styles. A decision to withdraw the style will result in lowered gmp_i's for remaining styles if surplus materials thus increase. If company A is tolerant to slightly faltering *gmp* values, but less understanding if *gmp*'s are very low, a penalty charge to low *gmp*'s may be the answer. We shall se how in the next section.

Profit maximization, a Mixed-Integer-Problem

Firstly we will construct a profit maximization problem with hard constraints for *gmp* values. All styles with $gmp \leq g\hat{m}p$ are discarded:

Objective:

$$\text{maximize} \quad Z = \sum_{i \in S} gmp_i x_i - \sum_{j \in F} p_j Q_j^{excess} \tag{8.6}$$

Decision variables:

$$\begin{aligned} x_i &\geq 0 \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned} gmp_i^{excess} x_i &\geq 0 \quad , \quad \forall i \\ x_i &\leq D_i \quad , \quad \forall i \\ Q_j^{excess} &\geq 0 \quad , \quad \forall j \\ Q_j^{excess} + \sum_{i \in S} q_{ij} \sum_{k=0} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) &\geq Q_j^{min} \quad , \quad \forall j \end{aligned}$$

and

$$gmp_i^{excess} = \frac{r_i - p_i^{FOB} - \sum_{j \in F} p_j q_{ij}}{r_i} - g\hat{m}p$$

If we wish to tolerate styles whose *gmp* values only just fall short of the requirement $gmp > g\hat{m}p$, lagrange relaxation can be used to soften the constraint. We define the lagrange parameter λ as the constraint on low *gmp* values. Varying this parameter will control whether the control is hard or soft. As an additional bonus, the parameter reward styles with increasingly higher *gmp*. Company A's willingness to accept low *gmp*'s may be reflected in the value of λ.

Objective:

$$\text{maximize} \quad Z = \sum_{i \in S} \Big(gmp_i + \lambda(gmp_i - g\hat{m}p) \Big) x_i - \sum_{j \in F} p_j Q_j^{excess} \tag{8.7}$$

Decision variables:

$$\begin{aligned} x_i &\geq 0 \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned} x_i &\leq D_i \quad , \quad \forall i \\ Q_j^{excess} &\geq 0 \quad , \quad \forall j \\ Q_j^{excess} + \sum_{i \in S} q_{ij} \sum_{k=0} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) &\geq Q_j^{min} \quad , \quad \forall j \end{aligned}$$

As we have developed a model for profitability maximization on the made-to-order lot, we shall continue by considering profitability maximization for the surplus lot, and be inspired by combining equations 8.1 and 8.2.

Surplus ordering

When cost optimizations indicate cost advantages from surplus stock ordering, the decision to act on it may be accompanied by considerations of benefits and pitfalls following that decision.

Surplus stock has extra expenses linked to it that differ from made-to-order stock:

Inventory The surplus stock is more likely to carry inventory costs for a longer period than made-to-order stock. A good estimate of these costs is important to support a profitable decision.

Handling Additional handling costs, shifting stock, additional logistic expenses etc.

Materials Surplus stock will carry material costs as well.

Sales force Selling the surplus stock to make a profit will involve the sales staff and thus additional costs. The chances of disposing the surplus stock through additional sales must be evaluated with assistance from the sales force.

The chances of making an additional profit from ordering surplus stock are based on estimates:

Sales price The surplus stock may be easier to sell if sold at a discount. The sales force must provide a good estimate for sales price to ensure a fast turnover, while still earning a reasonable profit. The discounted sales prices could be limited by a fixed minimum GMP in company policies. The sales force must bear in mind that heavy discounts might adversely affect the brand value.

Maximum surplus lot sale An estimate of the maximum number of items, $D^{surplus}$, which can be sold at the surplus lot sales price.

We shall consider profit maximization when evaluating whether to order surplus lot or not. We know from section 8.1 that a can absorb all costs - even additional ones applying to a surplus lot only.

Objective:

$$\text{maximize} \quad Z = \sum_{i \in S} \sum_{k=0} (g_k^{new} y_k + a_k^{new} x_k) - \sum_{j \in F} p_j Q_j^{excess} \tag{8.8}$$

Decision variables:

$$\begin{aligned} x_k &\in [0, d_{k+1} - d_k] \\ y_k &\in \{0; 1\} \\ Q_j^{excess} &\in \mathbf{R} \end{aligned}$$

Constraints:

$$\begin{aligned}
\sum_{k=0} y_{(i,k)} &= 1 \quad , \quad \forall i \\
y_{(i,k)}(d_{(i,k+1)} - d_{(i,k)}) - x_{(i,k)} &\geq 0 \quad , \quad \forall k, \forall i \\
x_i &\geq D_i^{mto} \quad , \quad \forall i \\
x_i &\leq D_i^{mto} + D_i^{surplus} \quad , \quad \forall i \\
Q_j^{excess} + \sum_{j \in F} q_{ij} x_i &\geq Q_j^{min} \quad , \quad \forall j, \forall i \\
Q_j^{excess} &\geq 0 \quad , \quad \forall j
\end{aligned}$$

and

$$\begin{aligned}
x_i &= \sum_{k=0}^{n} (d_{(i,k)} y_{(i,k)} + x_{(i,k)}) \\
gmp_{g_k} &= \left(\frac{r - \frac{g_k}{d_k}}{r} \right) \\
gmp_{a_k} &= \frac{r - a_k}{r} \\
g_k^{new} &= d_k * (gmp_{g_k} + \lambda(gmp_{g_k} - g\hat{m}p)) \\
a_k^{new} &= (gmp_{a_k} + \lambda(gmp_{a_k} - g\hat{m}p))
\end{aligned}$$

Combination: profitability maximization for made to order lot and surplus lot

As a matter of principle, a collection ought be profitable in itself without surplus lot ordering. Even more so since surplus lot demands and revenues are only estimates where as made-to-order are based on actual orders. Therefore, profitability maximization analyses could be performed for made-to-order lots (Eq. 8.2), followed by surplus lot evaluations (Eq. 8.2). Only styles and quantities passing the first maximization evaluation, may be subject to surplus lot evaluations.

In the following section a demonstration is conducted using the same as in the previous demonstration for cost minimization.

Demonstration

Profitability maximization is performed on the collections as a whole. Results are displayed in the following table:

FOB $\hat{gmp} = \mathbf{0.50}$, $\lambda = \mathbf{10.0}$

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.78	**190**	20	€18	**20**
B	170	€58.00	0.92	**170**	28	€16	**28**
C	450	€40.00	0.68	**450**	60	€17	**50**
D	490	€55.00	0.85	**490**	30	€30	**30**
New costs		**€12752.00**		**Original costs**			**€12,031.40**
New profit		**€55216.60**		**Original profit**			**€51,938.00**

CMT F1min = **100** F2min = **300** F3min = **500** $\hat{gmp} = \mathbf{0.50}$, $\lambda = \mathbf{10.0}$

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**		**Original costs**			**€22,670.00**
New profit		**€33040.00**		**Original profit**			**€32,282.00**

In the table with collection evaluation for CMT production, the recommended production lot for style C has dropped from demand 450 items to recommended 179 items. This reflects that the *gmp* for C is lower than the required $\hat{gmp}$ and ambiguity follows: It rarely makes sense to produce only part of a styles total order, especially if fabric minimums are not met. Alternatively, style C must be investigated to identify why the *gmp* is so low and if this can be changed. It may be so, that a low *gmp* is impossible to improve but, as the style is part of the company branding, it may be continued anyway. Style A as been cancelled as *gmp* values are simply too low, and recommendations for ordering surplus lot of style D as increased to 30 while surplus lot recommendations for style A as been cancelled. The results from the profitability analyses yield substantially increased profits and lowered costs.

8.3 Implementation details

The implementation of the methods presented in this chapter used tools to solve demonstration scenarios that were written in the programming language Python (v.2.3), using the libraries PyCplex[3], MatplotLib[4] and the proprietary program CPLEX[5].

Readers wanting to implement the models put forward in this chapter must have access to a software library able to solve mixed-integer programming problems.

8.4 Sensitivity analysis

Before accepting the models, they will be validated by conducting a sensitivity analysis to ensure the models are robust enough in use and as a mean to gain confidence in the results from using the model. By varying the input data, we shall observe how these changes affect the results, and thus gain insights into which parameters and variations the model is sensitive towards. Variables $g\hat{m}p$ and λ are expected impact the results as well as variations in demands and revenues. Appendix F shows the results from variation in these parameters.

Variations in revenue Obviously the model is sensitive to variations in revenue data. We see a clear indication that style A is not profitable due to high production costs. Only if the sales revenue for this style is high, e.g. €92.00, is it recommendable for production. Style D appears to be a profitable style. Variations in recommendations for styles B and C are evident logical with changes in revenue. Also note that, as revenues increase for the surplus lot, recommendations rocket upwards for ordering additional styles.

Variations in $g\hat{m}p$ Sensitivity towards variations in $g\hat{m}p$ is also apparent yet reveils no surprising results. When selecting $g\hat{m}p$ for analytical purposes, the company need have a clear understanding of why $g\hat{m}p$ is chosen, and it would be wise to comply with the actual level of gmp's in the company. So that $g\hat{m}p$ only rules out significant low gmp's. The $g\hat{m}p$ values barely affect the surplus stock recommendations, but that may be due to low revenues in the first place, as we have seen the changes previously for variations in surplus stock revenues.

[3] python interface to CPLEX library, `http://www.cs.toronto.edu/~darius/software/pycplex/`
[4] open source matlab clone, `http://matplotlib.sourceforge.net/`
[5] `http://www.ilog.com/products/cplex/`

Variations in λ Variations in λ shows that low values clearly increase recommendations for surplus stock and effect the made-to-order lot recommendations steadily as well. Higher values of lambda will have effects on the made-to-order lot and smoothly rule out lower gmp's. Where $\lambda = 0.15$, gmp values for B and C are listed as the same, but we must assume some differences in lower decimals, since recommendations are different for style B and C.

Variations in λ and $g\hat{m}p$ combined An interesting thing happens where both λ and $g\hat{m}p$ are low: purchasing surplus stock for style A is now recommendable, which did not occur when the two parameters were tested separately. Low values of λ will increase tolerance towards low gmp's even if $g\hat{m}p$ is high. Where λ is high and $g\hat{m}p$ is low changes apply mainly to the surplus stock.

Variations in fabric minimums With increasingly higher fabric minimums, there is a tendency to accept styles with small gmp's, where we would have discarded them previously. But the main affect is on surplus stock recommendations, which are used to compensate for the greater fabric expenses. More worryingly, **styles are not discarded when fabric minimums increase**. Moreover, gmp values do not change with increasing fabric minimums as they are calculated from a fabric unit price with no concerns to fabric minimums. Since the model for discarding styles is built around gmp values styles are never discarded even though fabric minimums will cannibalize all profits as illustrated in the test table.

As expected the results respond to the input data, in a robust and reasonable way. None of the outcomes are very surprising but behaves very much in balance with expectations. Naturally, the balance between revenue from sales and production costs are the important factor to which the parameters will respond accordingly. The model attract the analyst's attention towards styles with low gmp's and point out cost advantages from surplus stock ordering. Focus must be given to profits as well, especially to identify destructive fabric minimums.

Following the recommendations will, in some cases, decrease the total revenue from the starting point, but considering the risks run by producing a low profitable style, this may be acceptable. Evaluations will follow on how to avoid low-profitable styles in the future, or at least ensure that they do not become the majority of a collection. If some of these styles are signature styles of the brand, and thus important for the image of the brands, management could consider balancing this costs with some high-profit products to finance the branding. Knowledge of which styles are good for the bottomline, could prove valuable when planning collections ahead.

8.5 Expanding the models

The model is complete for cost and profit analysis for collection evaluation, but could be extended in several useful ways to shed light on more aspects present in deciding.

Use fabric minimums As we have seen in the sensitivity analysis, the model does not respond to high fabric minimums, giving no indications that fabric minimums jeopardize the profitability of the entire collection. It would be useful to incorporate considerations to high fabric minimums, e.g. by requiring a collection $G\hat{M}P$, or other means to inform analysts of the disadvantages of proceeding based on the current data.

Updating intervals As previously stated, d_i values marking the intervals for g_i and a_i values in surplus stock evaluations ought in fact be updated as surplus quantities are defined. This update has previously been discarded, as it would complicate optimizations procedures greatly and likely require a heuristic to solve. For simplification purposes it was discarded, but implementing and testing such a consideration may yield surprising results or merely confirm the reason in discarding it in the first place.

Surplus stock scenarios In the analysis, surplus stock recommendations are based on estimates on revenues and demands. Managers may prefer viewing the outcome from different scenarios by displaying results for different estimates of demands and revenues. This can be done by implementing a stochastic model to determine the optimal order of surplus stock, which minimizes costs and maximize profits when demand is unknown.

8.6 Findings

This chapter demonstrates the relevance of operations research techniques to support purchasing and ordering decisions for fashion companies at all levels[6].

Two two robust models have been presented for cost minimization and profitability maximization respectively, taking advantage of the price quotation characteristics of the fashion industry. These models provide a tool on low-profit styles, or cost-saving opportunities, which management may use for evaluations before making important decisions based on quantitative insights.

[6]In fact the software developer ILOG behind CPLEX has products aimed towards manufacturing companies, and facilitates integration with the widely used software system SAP, `http://www.ilog.com/industries/manufacturing`

Firstly, a cost minimization model was developed to take advantage of the price quotation characteristics of the fashion industry, leaving room for cost savings by purchasing surplus stock items up to a certain limit. The knowledge of these surplus lot order suggestions may be used by management, either to order the recommended quantities or negotiate prices with suppliers. A demonstration of using the model is given, and satisfying recommendations for surplus lot orderings are obtained. By following the recommendations of the analysis the company can actually obtain cost savings from ordering the needed items. Secondly, the cost minimization model is extended into a profitability maximization model, in which sales revenues and tolerances towards low profit margins are incorporated. Buy using langrarian relaxation, companies are able to weed out dramatically poor-profit products, while accepting low-profit products with some restrictions. Choosing appropriate parameters for this analysis it vital, and best utized with consideration to the company characteristics. The maximization model is demonstrated and proves robust in use, with recommendations to increase company profitability. Occasionally this yields a decrease in company profits, but only if the collection includes styles with low profit margins. The recommendations of the model is not intended for implicted application, but used as a managerial tool to make better informed decisions. Especially results where styles with less-than-desirable profit margins are at present, may result in lowered made-to-order quantity recommendations from the original data input. These evaluations could spur management to investigate the styles rather than following the literal interpretation of the results. The following sensitivity analysis tests the models with variations in input data and decision parameters especially. The test confirms that the model is robust to data variations, but requires better methods for responding to high fabric minimums.

The models are expected to work well for companies at all levels. Larger companies may gain the ability to monitor development in collections and styles, to support fast, well-informed decisions. Smaller companies may gain a stronger insight into which activities and styles are providing them with the means for future growth. Companies with IT systems can relatively easy incorporate these analyses in their business routine, facilitating informed decisions without much extra time invested in conducting them. Access to a software library for solving mixed-integer programming problems is required.

This chapter demonstrates that fashion companies can make use of the price structures in the industry to obtain cost savings by ordering surplus stock. It is possible to use operations research to discard low-profit products while still striving towards profitability maximization, and gain very good results. The methods of this chapter yields a decision-tool for managers to support operational decisions in a more complete and informed way, increasing profits even after a specific supplier has been decided upon.

The following chapter links the first three chapters of part III and advices on their proper usage.

Chapter 9

Outsourcing decision tool

This chapter illustrates how to link the methods of the previous three chapters together and use them as one tool, to gain a detailed view on available outsourcing options and their economic consequences.

The methods presented in the previous chapters are intended for use in a combined tool, aiding fashion professionals in strategic, tactic, and operational decisions, in that order. Here follows advice on the intended usage of each method:

Step 1: Strategy A fashion company should decide which type manufacturing services they desire from their suppliers. The level of service affects the company's organisational structure, work force compositions, and business procedures. The type of supplier collaboration should be selected to increase the company's competitiveness, whether that be in speed of service or higher mark-up. This analysis might be conducted with regular intervals, e.g. bi-annually, with considerations to latest outsourcing patterns in the industry or evolving competitive factors of the market.

Step 2: Tactic The choice of collaboration type impacts which candidate suppliers are considered as suppliers. At this stage, costs and qualitative measures on delivery is of high importance. Both criteria may be joined into one method for comparison allowing for different weights on their importance balanced with company guidelines. The method presents ways

to estimate additional costs from an outsourcing decision, such as macro costs and indirect costs. Using this method, decision makers gain detailed insights to the full costs of collaboration with suppliers, and may choose suppliers, which benefits the fashion company most. The methods for analysis can be automated. Thus, an analysis can be conducted each time a selection of candidate suppliers are considered, providing managers with a stronger base for decisions.

Step 3: Operate When suppliers have been selected, it is possible on an operational level to work towards further benefits for the fashion company. With methods from operations research, the methods proposes solution scenarios to conduct mainly profitable activities, while making most use of cost savings available for profit maximization purposes. The methods suggested may conducted automatically with data from the company's IT system and included for evaluation in daily business routines. By viewing automatically created scenarios decision-makers may base purchasing orders on output recommendations, and investigate low-profit products brought to their attention by the analysis.

The three steps join together in a single tool to make the most of outsourcing decisions. Each step does not affect the results of the next, but sets the stage of what is subject to analysis. Their combined usage will reflect on the financial result. The candidate suppliers subject to comparison are gathered according to company strategy guidelines on preferred supplier types. But the outcome of the analysis is only given by the single supplier comparison analysis method alone.

The selection of supplier, will set the stage for which data is analysed for increased profitability and costs savings, but does not affect the outcome of the analysis. However, as surplus stock quantities are ordered, and styles either accepted, discarded, or re-considered, the profit yielded in the last method is still subject to additional costs identified in the supplier comparison. The profit will decrease with indirect costs and macro costs and they best financial result attainable, is in turn a condition of the supplier type selected.

This chapter concludes part III, in which a tool is suggested to aid fashion companies in their outsourcing decisions. The tool is assembled from three methods presented in the previous chapters, who may be used with different frequency. Combined, the three methods contribute with a more detailed view on outsourcing options and their economic consequences. As outsourcing is generally the pre-requisite for Danish fashion companies, using the tool may contribute with alternative decisions for outsourcing yielding additional profits.

Part IV which follows, is dedicated to evaluation of the report and its suggestions.

Part IV

Evaluation and conclusions

In this part..

This part rounds off the report with suggestions for further work and conclusions on the work presented. Furthermore, new trends in competition and presumptions for the fashion industry is described. Finally, results of the work presented concludes the report.

Chapter 10

Evaluation and future work

Much of the work in this report is conducted on the assumption that price is an important competitive factor in the Danish market. The current trend of successful fashion companies suggest that FOB production collaborations may be superior to CMT in increasing company profits. However, since the 1990's, large retail chains such as H&M and Zara have proven that fast market response, high flexibility in client services and speedy delivery are increasingly important as competitive parameters in future. Zara has set new standards for product development cycles and speed, based heavily on in-house CM and CMT production or closely linked CM supplier collaborations. This indicative of opportunities not to be missed. Fashion companies is well advised to monitor this trend and to conduct the analyses recommended in this report.

Knowledge of the benefits and disadvantages in production collaborations and geographic locations of suppliers, may lead to a more profitable sourcing strategy for the individual companies; especially, if combined with awareness of value proposition

The methods developed in this report may seem too elaborate for small businesses. It is advisable to conduct analyses in balance with a company's size and target audience, yet acknowledge that companies of all sizes may benefit with additional insights and profit opportunities proposed by methods presented in this report.

It would be very interesting, to conduct a national investigation of competitive factors and which supplier collaboration methods best support them.

The method of using a ranking systems to estimate macro costs, would benefit from evaluations on the result it yields on real data.

Chapter 11

Conclusions

This report presents a tool for supporting management decisions in outsourcing. The objective is to increase the competitiveness of Danish fashion companies, and thus increase chances of export and growth. The tool combines three methods, corresponding to strategical, tactical and operational decisions.

The first method, suggests how to evaluate which type of supplier best facilitates the competitiveness of a fashion company. Based on the outcome of the analysis, managers may decide which suppliers to seek out. The method may also be used to match supplier collaborations types with competitive parameters.

The second method is designed for comparing suppliers based on their price quotations, geographic locations, and additional information on qualitative measures. This method requires means to estimate macro costs and indirect costs.

A technique for estimating macro costs is suggested, which makes use of the Business Environment Ranking, regularly released by the Economist Business Intelligence Unit. Guidelines are suggested for including quota costs and tariffs.

To estimate indirect costs, techniques are developed for measuring the costs of delays, damaged goods, and wrong deliveries. The importance and size of each costs can be weighted individually in accordance with company guidelines. Using this method, decision-makers may have a better understanding of the

costs following the selection of a supplier.

The last method aids decision-makers in ensuring that mainly profitable activities and purchases are carried out, and cost advantages are made the most of. This is done with operations research techniques for profit maximization, which will suggest a purchasing scenario indicating if any styles should be discarded or reconsidered. The method may further recommend purchases of surplus garments if they facilitate increased profits or lowered total costs.

The three methods combined may improve the overall profitability of a company integrating these analyses in business procedures.

Part V

Appendices

Appendix A

Cost accounting

The methodology of dividing costs into categories of direct, indirect, and macro costs, is only one of many cost accounting (a.k.a. costing) approaches that may be used to analyze a company's operational costs. Most companies will often utilize a mix of different costing methodologies depending on the scope of the outcome. Some costing methods are relevant for long-term managerial decisions, others for making profit analyses of single products or for identifying bottlenecks in generating profits, etc. The type of products may also affect which costing system is more appropriate, e.g. oil refinement and a consultant project within marketing are two widely different products and they require very different costing systems.

Overall, cost accounting systems can be split into two parts:

- Controlling
- Decision support.

Costing methods from controlling and decision making may be combined and used together. Both components are required for running a business.

Controlling

Control costing systems provides numerous ways to motivate production flows in a desired direction. Three main costing systems are represented: Standard costing, Throughput costing, and Backflush costing.

Standard Costing

> A control method involving the preparation of detailed cost and sales budgets. Such budgets are then compared with the actual results for a specific account period and any significant variances between the actual and the budgeted results are investigated.[1]

Standard costing was invented in the early 20th century, before computers made calculations less tedious and time consuming. The methodology is obsolete in many of today's scenarios but can still be useful with some modification in others. Standard costing can be useful for, e.g., the pricing of projects. It is not relevant for short-lived products or environments subject to continuous improvement.

Throughput Costing

Focus on identifying financial bottlenecks in a production, e.g. the least profitable product in a product series or the least profitable customer order. Throughput costing can be used to prioritize which orders to process first, thereby ensuring that the company always works on the most profitable task. Throughput costing is most relevant to industries working with batch productions and continuously serving customers with the same product.

Backflush Costing

A costing method that applies costs based on the output of a process. The methodology is generally associated with repetitive manufacturing. It uses a bill of material or a bill of activities to draw quantities from inventory through work in process, to finished goods; at any intermediate stage, using the output quantity as the basis. These quantities are generally costed using standard

[1] (`http://wps.pearsoned.co.uk/wps/media/objects/1065/1090612/glossary.html`)

costs. The process assumes that the bill of material (or bill of activities) and the standard costs at the time of backflushing represent the actual quantities and resources used in the manufacture of the product. This is important since no shop orders are usually maintained to collect costs.

Decision Making

Costing methods within this category centers around production costs. Traditionally there was Full costing and Variable costing. Activity Based Costing (ABC) joined the two around 1990.

Variable costing

Also known as direct costing, or marginal costing. The methodology focus only on direct costs, and is suited only for short-term decision making, since it ignores all other costs. Among other uses, the methodology is applicable for profitability modeling. Naturally, the neglect of indirect costs make the direct costing unsuitable for long-term decision making, but most companies will regularly find use for the method.

Full costing

Alternatively: absorption costing. A method of costing that assigns all manufacturing costs to products or other cost objects. The costs assigned include those that vary with the level of activity performed and those that do not. Full costing may be better known by its' two sub-methods: job costing and process costing:

Job costing Projects or production development is broken into appropriate batches, inside which all resources consumed are registered: materials, labor, overhead, machine time, etc. Job costing is well suited for production or professional service companies, in other industries, such as retailing (service industry) it has little relevance.

Activity Based Costing (ABC)

> A methodology that measures the cost and performance of activities, resources, and cost objects. Resources are assigned to activities, then activities are assigned to cost objects based on their use. Activity-based costing recognizes the causal relationships of cost drivers to activities.[2]

The methodology can, if not carefully managed, consume more resources than can be justified by the gains. If managed well, however, it provides managers with valuable insight to base their decisions upon. Activity Based Costing was developed as productions became more complex, and automation moved direct costs to indirect costs making it more difficult to spot the cost drivers in a production.

A.0.0.1 Target Costing

In Target costing one decides for the finished product value in the market, with the question: *"What are the consumers willing to pay for this item?"*. Then the company decides for a minimum markup on the price, which yields the earning on the product. Using these values the company backtracks to a desired target production price. If this price cannot be met, the item will not be put into production. Target costing is convenient for companies working in highly competitive markets with many players.

[2] (`strategicsourcing.navy.mil/reference_documents/defs.cfm`)

Appendix B

Investment Analysis

It is outside the scope of this project to demonstrate advanced knowledge in economics. Rather, it is my intention to utilize financial tools, which are currently available to solve real-life problems resonably well. Some novice financial tools are presented.

Current value/Present value

This method is used to compare values across time, with consideration given to currency inflation. In order to compare values, one must make sure that the values are considered at the same period of time. If the values are from different time periods they must all be projected to the same point in time (either back or forth). The equations for projecting forward in time [1] are:

$$\textbf{Single sum:} \quad K_N = K_0(1+R)^N \tag{B.1}$$

$$\textbf{Multiple sums:} \quad K_N = \sum_{t=0}^{N} NB_t(1+R)^{N-t} \tag{B.2}$$

Multiple sums are used, e.g. when a bankloan is paid in mortgages, where each amount must have correct current value in a comparison analysis.

[1] (source: investeringsteori s. 191)

Return on Investment analysis

One can view activities in a fashion company from an investment point of view. Finding new manufacturers to take over part of the production requires funds: finding costs for locating new manufacturers and evaluating their potential as subcontractors and start-up costs while the manufacturer and the fashion company learns to communicate and interpret each other's answers correctly. Furthermore, it will take a while before the manufacturer understands all requirements in relation to design, quality etc. The money already invested in the old manufacturer will be lost, if all collaboration ceas.

Letter of Credit

Manufacturers often require a Letter of Credit (LOC) from the company when an order is placed.

> A letter of credit is an irrevocable payment undertaking of an issuing bank issued to a beneficiary upon request of an applicant for supply of goods, services or performance with documents stated in the letter of credit presented to the issuing bank, a nominated bank or confirming bank, if any, within the expiry date of the letter of credit or within a stated number of days after shipment, where applicable, in full compliance with the terms and conditions of the letter of credit, the applicable UCP and international standard banking practice. It is a legally enforceable obligation or undertaking on the part of the issuing bank and is not a contract (although it is sometimes mistakenly referred to as such). [36]

An LOC freezes this sum from the company's funds, and prevents possible intermediate investments of the money, further straining the company's budget. If, on the contrary the manufacturer was willing to work with open accounts, the company could save money.

Appendix C

Case stories

Each case company is described by background, their LPD and GMP calculation, process for selecting suppliers, and evaluation procedures for supplier performance.

Company 2

Background

Company 2 is part of a larger group and serves the Danish mid segment. The Company 2 targets a lower price segment than the other case companies, but may share consumers. This brand differs from the other ones, by having a significantly larger turnover, and a larger organization. Company 2 main purpose is to contrast the other case companies and juxtapose their differences in production expenses.

Company 2 often reuses styles from previous seasons, changing mainly details or fabric. Since choice of fabric and details affect the manufacturer selected for production, Company 2 has found it more expedient to develop their own patterns, and share them with the manufacturer as required. Let it be stated

that the manufacturer is responsible for adjusting the pattern to the specific design and create additional pattern pieces, required in the production of the garment.

Organization

Surrounding the design department, and the technical designers, are the sourcers in charge of selecting manufacturers. The sourcers run the dialogue sourcing offices, the agents and manufacturers selected for production.

The process of choosing manufacturer

LPD comparisons based on offers for initial designs and fabric selections.

When the garment design is completed, a final price of production is negotiated. After the sales period, prices are negotiated once more. Conclusively, if the designer makes radical changes to the garment, e.g., adding labor-intensive details, there is a chance that production prices could have been lower with another manufacturer. However, Company 2 will stick with the previously chosen manufacturer. Occasionally, Company 2 will double-source[1] an item, to evaluate new manufacturer candidates.

Evaluation of manufacturers

Based on claims, short deliveries or delays, manufacturers are evaluated by Company 2's sourcers. Input is also received from the sourcing offices or sourcing agents.

[1] collects price quotes from two or more manufacturers, by producing a salesman sample from each, ensure that the quality is equivalent, and compare prices before selecting supplier.

Company 3

Background

The company brand is in the Danish high-end, and has existed for little over a decade. The company has recently received investment capital and consequently organisational restructuring. Professional management has been added, as well as new colleagues with intense industry experience. Company 3 works with a mix of FOB and CMT production. Simpler styles are produced FOB, where very complicated styles or styles using a particular fabric is produced CMT.

LPD analysis and gross margin calculation

No analysis of this nature was identified during interviews.

Manufacturers

Sourcing is done mainly inside the EU.

Company 1

This company is owned by a fashion group which supplies distribution, software solutions, financial support, financial data analysis, and sourcing office services. Sharing this administrative platform with sister companies under the same parent company, Company 1 benefits to some extent from economies of scale. Company 1 is entirely responsible for its own product development, sales and marketing, and production planning (incl. choosing sourcing office or manufacturer). The company works solely with FOB production, performs target costing before selecting suppliers or negotiating with suppliers. From their target costing they find their target LDP values, and these serve as a basis for negotiations with suppliers. Top management has an economic educational backround.

Not all costs are considered, however, in a final profitability analysis. Mostly because the remaining costs are either difficult to price tag or these future similar costs are eliminated in the evaluation process of manufacturers - without using expensive time on analyzing the exact cost spent.

Background

Company 1 is less than five years old, founded with investment capital for the purpose of creating a mid-high, fast-growing brand.

The company must develop an indentity, acquire market shares, all sufficiently backed by investments to pursue these goals. It has a CEO with a strong foundation in finance and, an experienced designer, and a trained team of employees. The CEO a close eye on the development of Company 1 and is heavily involved in the sourcing process.

LPD analysis and gross margin calculation

1. Estimated sales price made → leads to target production price. Gross margin 1 calculated.
2. Production prices gathered. Compare with target price. Some products are skipped. Gross margin 2 calculated.
3. Sales period ended. Products ordered, and new prices negotiated. Gross margin 3 calculated
4. Production. Gross margin 4 calculated

The process of choosing manufacturer

Manufacturers are chosen from a pool of potential candidates, most of which has been used before. This pool is continually updated with new manufacturers and the exclusion of others, based on multi-yearly evaluation runs conducted by CEO, Designer, and Head Sourcer.

A specific manufacturer may be chosen for production of a particular garment based on either criteria:

- The manufacturer sources the fabric chosen for the style
- The manufacturer is geographically close to the textile supplier for the garment
- Other garments sharing the same textile, are produced with this manufacturer

- A similar garment was produced satisfactorily at this manufacturer in a previous season
- The garment requires specific work skills
- Production quality is tested using a new manufacturer

Designers chooses material, and based on collection designs the Designer makes the sourcing decision.

Manufacturers are further evaluated based on their communication skills, error percentage, shortage percentage, and transportation time.

Company 4

Work on a CMT basis, partly FOB within knits and dresses. Patterns are developed in DK. For CMT production, gradation takes place on manufacturer's location.

Background

Very small organization: two persons + two to four internships. Company 4 works primarily on a CMT basis, but with pattern assistance from manufacturers to implement pattern modifications and gradation. Company 4 has no long-term relations to their manufacturers, and production has previously been suffering heavily from late deliveries. Company 4 is searching for more stable collaboration partners and will most likely settle with at slightly higher direct production costs, if service quality in terms of stability, proneness to errors will improve correspondingly.

LPD analysis and gross margin calculation

Currently Company 4 makes no data mining, nor does it perform LPD analyses, and any such analyses would contribute to a better understanding of the indirect costs and macro costs included in a production batch.

Choosing manufacturers and evaluation of performance

Based on previous bad experience, Company 4 will attempt to spread the risk, by using multiple manufacturers, and evaluations of their performance will be compared with data from previous collections as with a subjective interpretation.

Appendix D

Glossary

Terminology and acronyms

CMT, Cut-Make-Trim The process of Cutting, Making (sewing) and adding Trims to a garment, given fabrics, findings and cutting marker from customer.

FOB, Freight on Board Originally a term used solely for products that are transporated by boat. Now, it is generally used as a term for the total price of a product from production start till it has been packed etc. and picked up by a courier.[9]

LPD, Landed, Duty Paid A term invented by David Birnbaum. Used to describe the complete cost of a garment from initial designing till delivery in the customers' target country.

Total cost of ownership

MFN Most favoured nations

Apparel garments, clothes

Double-sourcing The Collect price quotes from two or more manufacturers, by producing a salesman sample from each, ensure that the quality is equivalent, and compare prices before selecting supplier

Claims An item which has been discarded or returned to the deliverer for some reason. The buyer claims the seller for this item.

Sourcer Employee in charge of collaborating with the manufacturing company.

Pattern making

Appendix E

Company data collection

The material in this chapter, has been used to collect data from case companies.

Confidentiality

The data requested is recognized as being highly sensitive to your company, and will be treated with utmost respect and confidentiality. Enclosed with this document is a confidentiality agreement from The Technical University of Denmark, which I suggest we agree upon before exchanging any sensitive information. Company sensitive information in the final thesis will be kept confidential.

Collaboration outcome:

Three analyses are conducted:

- Which production method is most profitable, FOB or CMT?

- How to forecast actual production costs, from price quotes, choice of manufacturer and manufacturing country.

- How to use Operations Research to optimize production profitability.

Based on the data given, I will deliver back to you my findings, submitted in the thesis report.

Company data collection

I seek information from two to three equivalent seasons from one fashion brand, e.g. seasons SS05, SS06, and SS07. The information aims to cover all production related activities for an entire collection in one season. Where extensive data is not avaible, qualified estimates will be much appreciated. You may export tables from your databases into any comma or tab separated file or submit data to the MS Excel spreadsheet. If the spreadsheet proves too troublesome, the company's own spreadsheets may be copied instead into any comma, or tab separated file.
I have attempted to make the data collection process as easy as possible, by stripping down the required data to an absolute minimum, directly available to export from most database tables. This may lead to handing out more company sensitive data than absolutely necessary which can, with a little extra effort, be kept anonymous. This document indicates how to do so.

Tables E - E, explain in detail what data is requested and provides examples of these, while figure E illustrates the relations between these tables.

Table E differs from the others with focusing much more on the fixed costs of the company. Some information in this table and the other tables may overlap slightly depending on the cost tracking methods of the company.

NB! Table cells marked with an asterisk (*) can be replaced with anonymous values.

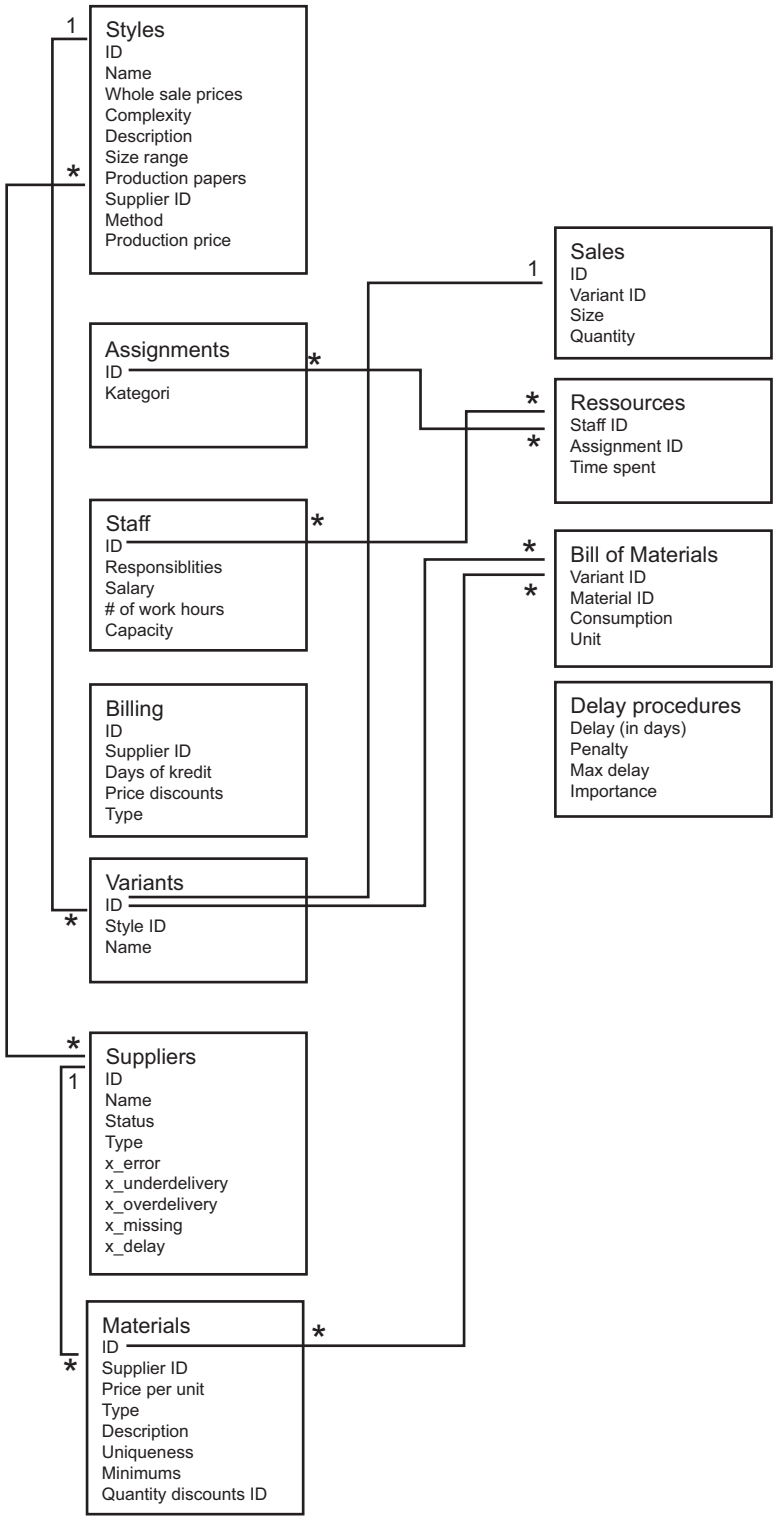

Figure E.1: Illustration of the data collected from companies and the interrelationship between the data blocks.

Cost summaries

FOB(F) / CMT(C)	Function	
	Design	The process of selecting materials, the look of the style, the colors etc.
F	Pattern making	Building a pattern for the style: sketching, evaluating, redrawing, digitizing, etc.
F	Gradation	Scaling the pattern for the size range available and preparing it for production.
CF	Sampling	Prototype and salesman samples, manufacturing, development and material costs.
F	Procurement	Ressources spent on supplying raw materials and preparing logistics.
F	Material cost	The direct cost of the materials purchased at suppliers.
F	Raw mat inventory	The storage costs linked to materials in transit or waiting for production.
F	Raw material quality assurance	Resources spent on pre-production inspection of materials.
CF	Sewing & Cutting	Cutting the pattern pieces from materials and assemling them into finished garment during sewing.
CF	Finished Qual. Assur.	Inspection costs of finished garments.
CF	Packaging	Separate expenses for packaging.
F	Finished logistics	Ensure freight to delivery address.
	Finished Quality Assur.	Additional QA of packaged and shipped garments.
	Finished, customs, duties	Handling costs and charges for entering garments into country.
	Finished inventory	Costs assigned to garments for storage until delivery to customer.
	Insurance, Legal	Legal disputes over products and insurance handling or negotiation.
	Sales, Marketing	Collected sales and marketing expenses for the company.
	Admin. Finan. Mgr.	Management salaries.

Styles

ID *	The unique identifier of the style, typically a number or a HEX code. *(* May differ from the true ID of the garment.)*
Name *	The name of the style. *(* May differ from the actual name of the garment.)*
Whole-sale prices	The style's whole-sale price
Complexity	On a scale of 1-5 identify the complexity of this garment, using these guidelines: **1** Very basic and easy to make, eg. plain t-shirts and scarves. **2** A fairly basic style with some added details like print, applications, a simple pocket or lining. **3** Standard style, can be ressource or precision demanding, but the style itself does not vary much between the seasons, eg. jeans, shirt, skirt w. pockets, plain dress with zipper. **4** A fairly standard style but with modifications and variations or difficult materials, which requires a higher level of understanding from the manufacturer. **5** Highly complex products in both quality and details. Collars, complex patterns, labour intensive garments, high quality materials. Company styles do no get more complex than this.
Description *	A short description of the style, stating basics and important additional notes. *(* May be omitted if 'Production Papers' are handed out.)*
Size range	The size range available to pick from, e.g. EUR 34-44
Production papers *	The style drawing and specifications, which the designer articulates and sends to the production agent. Papter to state details about the style, special instructions etc. *(* May be omitted if 'Complexity' has been filled out.)*
Supplier ID	The ID of the supplier manufacturing this style
Method	Is this style produced FOB, CMT or other (specify).
Production price	The calculated or reasonably estimated complete production cost of this item. This number should be picked from some of the internal reporting used to analyse how much the product contributes to company profits. If price quotes on a garment have been collected from other manufacturers than the selected production manufacturer, I would like be grateful to see some of these quotes as well.

Variants

ID *	The unique identifier of this style variant, typically a number or a HEX code. *(* May differ from the true ID of the variant.)*
Style ID *	The ID of the style from which this variant springs. *(* The same ID as given in the style table.)*
Name *	The name of this variant. *(* May differ from the actual name of the variant.)*

Staff

ID *	The unique identifier of an employee. *(* May differ from the true ID of the employee.)*
Responsibilities	The work tasks of the employee
Salary	The wage of the employee per season.
# of work hours	How many hours per season the employee works
Capacity	A tabular of e.g. how many patterns the pattern maker processes per season, or the number of suppliers one logistics coordinater can handle.

Billing

ID *	The unique ID of the bill, typically a number or a HEX code. *(* May differ from the true ID of the bill.)*
Supplier ID *	The identifier of the supplier billing the company. *(* The same ID as in the supplier table)*
Days of credit	The days of credit for the bill
Price discounts	The discount rate for the bill if days of credit are not exceeded.
Type	The type of bill, eg. based on a letter of credit, normal invoice, payment upon delivery, other (specify).

Suppliers

ID *	The unique identifier of the supplier, typically a number or a HEX code. *(* May differ from the true ID of the supplier.)*
Name *	The name of the supplier. *(* May differ from the actual name of the supplier.)*
Status	The status of the supplier: active, discarded, untestetl, inactive
Type	The manufacturing services of the supplier: FOB, CMT, other (specify).
$\mathbf{x_{error}}$	The error percentage on garments delivered by the supplier. All garments which do not match the standards of the salesman samples should be considered lost.
$\mathbf{x_{underdelivery}}$	The average percentage of underdelivery from the supplier. The supplier may have committed to a certain order size but deliver fewer items than ordered.
$\mathbf{x_{overdelivery}}$	The average percentage of overdelivery from the supplier. The supplier may have committed to a certain order size but deliver more items than ordered.
$\mathbf{x_{missing}}$	The average percentage of garments claimed to have been shipped from the supplier, but deficient upon delivery.
$\mathbf{x_{delay}}$	The average number of days a garment is delivered later than the promised delivery date.

Materials

ID *	The unique identifier of the material, typically a number or a HEX code. *(* May differ from the true ID of the material.)*
Supplier ID *	The ID of the supplier supplying the material. *(* The same ID as in the supplier table)*
Price per unit	The unit price of the material, e.g. meters of fabrics, number of buttons.
Type	The type of material, eg. fabric, button, zipper.
Description *	A description of the material, e.g. notes for handling of the material. *(* May be omitted if irrelevant.)*
Uniqueness	On a scale of 1-5, using the guidelines herunder, how easily can the supplier of the material be shifted? **1** The material can easily come from numerous other suppliers **2** The material is quite common but there is a limited number of suppliers. **3** The material has qualities and design elements desired, but these can be replaced by an equivalent yet not similar item from another supplier. **4** It is unlikely that the material can come from any other supplier, e.g. due to code of conduct in the business, or the supplier provides favourable trade relations. **5** The material cannot be found with any other supplier, may be due to the complexity of the material or copyrights.
Minimums	The minimum order of the material
Quantity discounts ID	Possible discounts or surcharges for the material depending on order quantity

Sales

ID *	The unique identifier of the sales summary, typically a number or a HEX code. *(* May differ from the true ID of the sales summary.)*
Variant ID *	The ID of the style variant sold. *(* The same ID as in the variants table)*
Size	The garment size sold
Quantity	The total quantity of the variant sold.

Ressources

Staff ID *	The ID of the staff working on a particular assignment. *(* The same ID as in the staff table.)*
Assignment ID	The ID of the assignment worked upon.
Time spent	The time spent (measured in hours) working on the assignment

Bill of Materials

Variant ID *	The ID of the variant using the material. *(* The same ID as in the variants table.)*
Material ID *	The ID of the material used. *(* The same ID as in the materials table.)*
Consumption	The quantity used for each item.
Unit	The unit of the material consumption.

Delay procedures

Delay	The delay, measured in days, linked together with a certain penalty or action
Penalty	The penalty for the delay, e.g. 2% discount of the total order
Max delay	The maximum delay accepted under the penalty rule
Importance	The importance of keeping within the delay span **1** Not too important **2** Normal **3** Important **4** Very important **5** Crucial

Appendix F

Sensitivity analysis

F.1 Testing fabric minimums

F1min = **0** F2min = **0** F3min = **0** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**0**	60	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€11336.00**					
New profit		**€26560.00**					

F1min = **50** F2min = **200** F3min = **100** $\hat{gmp}$ = **0.50,** λ = **10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**36**	60	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€12351.20**					
New profit		**€33040.00**					

F1min = **300** F2min = **400** F3min = **300** $\hat{gmp}$ = **0.50,** λ = **10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**18**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**108**	60	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€15126.80**					
New profit		**€36559.00**					

F1min = **700** F2min = **800** F3min = **800** $\hat{gmp}$ = **0.50,** λ = **10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**178**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**286**	60	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€26026.80**					
New profit		**€35497.00**					

F1min = **1000** F2min = **1200** F3min = **2000** $\hat{gmp}$ = **0.50,** λ = **10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**20**
B	170	€58.00	0.58	**170**	28	€16	**28**
C	450	€40.00	0.36	**450**	60	€17	**60**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€38432.00**					
New profit		**€29595.60**					

F1min = **2000** F2min = **2000** F3min = **5000** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**20**
B	170	€58.00	0.58	**170**	28	€16	**28**
C	450	€40.00	0.36	**450**	60	€17	**60**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€43952.00**					
New profit		**€24075.60**					

F.2 Testing revenues for mto and surplus lots

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€22.00	-0.88	**40**	20	€5	**10**
B	170	€18.00	-0.37	**-0**	28	€5	**0**
C	450	€12.00	-1.13	**0**	60	€8	**0**
D	490	€35.00	0.58	**490**	30	€10	**0**
New costs		**€8810.00**					
New profit		**€7226.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€43.00	0.04	**1**	20	€16	**10**
B	170	€31.00	0.21	**65**	28	€15	**0**
C	450	€25.00	-0.02	**179**	60	€16	**0**
D	490	€45.00	0.68	**490**	30	€28	**30**
New costs		**€13842.20**					
New profit		**€18529.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€50.00	0.17	**0**	20	€18	**0**
B	170	€56.00	0.56	**170**	28	€16	**0**
C	450	€35.00	0.27	**179**	60	€17	**0**
D	490	€50.00	0.71	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€28000.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€20	**0**
B	170	€58.00	0.58	**170**	28	€18	**0**
C	450	€40.00	0.36	**179**	60	€19	**0**
D	490	€55.00	0.73	**490**	30	€34	**30**
New costs		**€16383.80**					
New profit		**€33160.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€56.00	0.26	**0**	20	€52	**0**
B	170	€62.00	0.60	**170**	28	€58	**28**
C	450	€50.00	0.49	**450**	60	€70	**60**
D	490	€53.00	0.72	**490**	30	€55	**30**
New costs		**€22856.00**					
New profit		**€42558.20**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€92.00	0.55	**190**	20	€82	**20**
B	170	€88.00	0.72	**170**	28	€88	**28**
C	450	€80.00	0.68	**450**	60	€100	**60**
D	490	€85.00	0.83	**490**	30	€85	**30**
New costs		**€29408.00**					
New profit		**€92002.80**					

F.3 Testing $g\hat{m}p$

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.10,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.40,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.60,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.90,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**255**	30	€30	**0**
New costs		**€10419.00**					
New profit		**€31954.00**					

F.4 Testing λ

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€22856.00**					
New profit		**€32696.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**178**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16362.80**					
New profit		**€33040.00**					

F.5 Testing λ and $g\hat{m}p$ combined

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.10,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.40,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.60,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.90,** λ **= 0.5**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€22856.00**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.10,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.40,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€22856.00**					
New profit		**€32696.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.60,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€22856.00**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.90,** λ **= 1.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.10,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.40,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€22856.00**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.60,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.90,** λ **= 5.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**255**	30	€30	**10**
New costs		**€10419.00**					
New profit		**€32708.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.10,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.40,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.60,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.90,** λ **= 10.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**255**	30	€30	**0**
New costs		**€10419.00**					
New profit		**€31954.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.10,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.40,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.60,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**10**
New costs		**€16383.80**					
New profit		**€32708.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.90,** λ **= 15.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**178**	40	€17	**0**
D	490	€55.00	0.73	**255**	30	€30	**0**
New costs		**€10398.00**					
New profit		**€31954.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.10,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.40,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.50,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.60,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**10**
New costs		**€16383.80**					
New profit		**€32708.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.90,** λ **= 20.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**178**	40	€17	**0**
D	490	€55.00	0.73	**255**	30	€30	**0**
New costs		**€10398.00**					
New profit		**€31954.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.10,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**190**	20	€18	**10**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**450**	40	€17	**40**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€29408.00**					
New profit		**€36215.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.40,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**179**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16383.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.50,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**170**	28	€16	**0**
C	450	€40.00	0.36	**178**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**30**
New costs		**€16362.80**					
New profit		**€33040.00**					

F1min = **100** F2min = **300** F3min = **500** $\hat{gmp}$ **= 0.60,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**67**	28	€16	**0**
C	450	€40.00	0.36	**0**	40	€17	**0**
D	490	€55.00	0.73	**490**	30	€30	**10**
New costs		**€8802.20**					
New profit		**€26228.00**					

F1min = **100** F2min = **300** F3min = **500** $g\hat{m}p$ **= 0.90,** λ **= 80.0**

	Made-to-order				Surplus order		
Style	Demand	Revenue	gmp	**make**	Demand	Revenue	**make**
A	190	€52.00	0.20	**0**	20	€18	**0**
B	170	€58.00	0.58	**0**	28	€16	**0**
C	450	€40.00	0.36	**0**	40	€17	**0**
D	490	€55.00	0.73	**0**	30	€30	**0**
New costs			**€0.00**				
New profit			**€0.00**				

Bibliography

[1] Reeve, James M.: *Readings and Issues in Cost Management*, Second Edition, 2000, South-Western College Publishing, ISBN: 0-324-02298-0

[2] Birnbaum, David: *Birnbaum's Global Guide to Material Sourcing* 2005, The FashionIndex, Inc., ISBN: 0-9741011-3-3

[3] Birnbaum, David: *The Great Garment War*

[4] Bragg, Stephen M.: *Controller's Guide to Costing* 2005, John Wiley & Son's, Inc. ISBN: 0-471-71394-5

[5] Bukh, Per N. *Activity Based Costing - Dansk Økonomistyring under forvandling* 2004, Jurist- og Økonomforbundets forlag, ISBN: 87-574-1015-1

[6] Lyngaard, Peter: *Driftsøkonomi* 2002, Handelshøjsskolens Forlag, ISBN: 87-629-0198-2

[7] `http://www.mcgrawhill.ca/college/garrison5/student/olc/5mag_gloss_07.html`

[8] Federation of Danish Textile & Clothing: *Forecasting for the textile & clothing industry* 2007

[9] `http://instruct1.cit.cornell.edu/Courses/cuttingedge/glossary.html`

[10] Danmarks Statistik `www.dst.dk`

[11] Riegels Mechior, Marie & Olsen Rule, Nikolina: *Dansk mode - Historie, Design, Identitet* 2006 Danmarks Designskole Printcenter, ISBN: 87-985478-3-6

[12] Christopher, Martin; Lowson, Robert; Peck, Helen: *Creating agile supply chains in the fashion industry* 2004, International Journal of Retail & Distribution Management, Vol. 32, Number 8 pp. 367-376, ISSN 0959 0552

[13] R.P. Rollins, K. Porter, D. Little: *Modelling the changing apparel supply chain* International Journal of Clothing Science and Technology, Vol. 15 No. 2, 2003, ISSN 0955 6222

[14] Ian M. Taplin, Jonathan Winterton: *The European clothing industry - Metting the competitive challange* Journal of Fashion Marketing and Management, Vol. 8 No. 3, 2004

[15] Gary Gereffi: *International trade and industrial upgrading in the apparel commodity chain* Journal of International Economics, volume 48, Issue 1, June 1999

[16] Fu-Shiung Hsieh: *An evolutionary approach for self-organization of contract manufacturing supply chains* 0-7803-7087-2/01

[17] S.D. Mokashi, A.C.Kokossis: *Application of dispersion alogirthms to supply chain optimisation* Computers & Mechanical Engineering 27, 2003, ISSN 0098 1354

[18] Soundouss Bouhia, Frederick H. Abernathy: *Sceduling and ordering production policies in a Limited Capacity Manufacturing System - the Multiple Replenishment Products Case*

[19] Andrew Hughes: *ABC/ABM - activity-based costing and activity-based management.* Journal of Fashion Marketing and Management, 2005, 9, 1

[20] Sergio Maturana, Juan-Carlos Ferrer, Francisco Baranao: *Design and implementation of an optimization-based decision support system generator* European Journal of Operational Research 154, 2004

[21] Andrew J. Newman, Darshika Patel: *The marketing directions of two fashion retailers* European Journal of Marketing Vol. 38 No. 7, 2004

[22] Frederick H. Abernathy, Anthonyh Volpe, David Weil: *The Future of the Apparel and Textile Industries: Prospects and Choices for Public and Private Actors* Harvard Center for Textile and Apparel Research, Dec. 22 2005

[23] Vækstfonden: *Dansk Design - en god forretning?* `www.vf.dk`, 10. August 2007, pdf-document

[24] TEKO: *TEKO analysen 2005 - Mode og livstilsbranchen* `www.teko.dk`

[25] Danish Fahion Institute: '*Årsberetning 2005* `www.dafi.dk`, 10 August 2007, pdf-document

[26] Stig Ørskov: *Mens vi venter påerhvervslivet* 12 July 2005, DesignMatters no. 09

[27] Peter Doeringer, Sarah Crean: *Can fast fashion save the US apparel industry?* Socio-Economic Review(2006) 4, Advanced Access publication March 12, 2006

[28] Dansk Industri: *Guide til outsourcing og etablering* Oktober 2004, www.di.dk

[29] Peter Gibbon, Lotte Thomsen: *Scandinavian Clothing Retailers' Global Sourcing Patterns and Practices* CDR Working Paper 02.14, November 2002 http://www.diis.dk/graphics/CDR%5FPublications/cdr%5Fpublications/working%5Fp

[30] *The future of fast fashion.* Economist, 6/18/2005, Vol. 375 Issue 8431

[31] Amanda Craig, Charlese Jones, Martha Nieto: *ZARA: Fashion Follower, Industry Leader* Business of Fashion Case Study Competition, Philadelphia University April 2, 2004

[32] Richard M. Jones: *The Apparel Industry* Blackwell, 2006, 2nd. ed., ISBN: 9781405135993

[33] *Business environment rankings methodology* a330.g.akamai.net/7/330/25828/20060515192601/graphics.eiu.com/files/ad_pdfs/CF_PDF.pdf, 2007/09/26
methodology:
http://www.alacra.com/wdata/help/forecastmethodology.htm

[34] Morten Crone: *Designerduo kvalt i vækst* 2006/06/11, http://www.business.dk/article/20060711/nyhedsoversigt/107110292/

[35] David Tarp: *Tøjdesign og ledelse er en dårlig cocktail* 2006/08/07, http://www.business.dk/article/20060807/nyhedsoversigt/108070297/

[36] Wikipedia, http://en.wikipedia.org/wiki/Letter_of_credit

[37] *Wikipedia, Lagrarian Relaxation* http://en.wikipedia.org/wiki/Lagrangian_relaxation, 24/10-2007

[38] http://www.finfacts.com/irelandbusinessnews/publish/article_1011625.shtml

[39]