Analysis of the Material Demand Creation Process and the Availability of Material at the Right Time in a Make-to-Order Environment with a Global Supply Chain.

Study was done for

BMW Rosslyn

BMW (South Africa) (Pty) Ltd.

By

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25003331

Submitted In Partial Fulfilment Of The Requirements

For The Degree Of

Bachelors Of Industrial Engineering

In The

Faculty Of Engineering, Built Environment And Information Technology

University Of Pretoria

Mentor: Dr. P.J. Jacobs

October 2008

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The Final Year Project by Corli Leonard

on the subject of

“Analysis of the Material Demand Creation Process and the Availability of Material at the Right Time in a Make-to-Order Environment with a Global Supply Chain.”

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Yours sincerely,

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Abstract

Title: Analysis of the Material Demand Creation Process and the Availability of Material at the Right Time in a Make-to-Order Environment with a Global Supply Chain

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Keywords: air freight cost; demand stability; forecasts; global suppliers; data analysis model

In this study a data analysis model was built on excel to determine which options and part numbers are responsible for the high airfreight cost each month. This model could be maintained and used after completion of the study.

A project which analysed the demand stability history and forecasts of BMW Rosslyn was launched. This project focused mainly on the reasons for the demand changes between the ordering of the shipment at the start of the 9-week call-off period of goods ordered from global suppliers and 5-week call off period as well as between the 5-week call off period and the actual product that is built.

In this study a data analysis model was built on excel to determine which options and part numbers are responsible for the high airfreight cost each month. This model could be maintained and used after completion of the study.

The project’s aim was to identify these red areas and find alternatives and solutions to improve the production stability. The study included January 2008 up to October 2008 and had a cost saving potential of R 852413.60.

The data that must be collected from each month includes a list of the parts that was air freighted, the changes from the 9-week plan to the 5-week plan, as well as the 5-week plan until it is built.

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List of abbreviations and definitions:

SA Option (German: Sonderausstattung)

MTO Make-to-Order

MACRO: Automatic Data Processing Procedure in Excel

Chapter 1

INTRODUCTION AND BACKGROUND

In this chapter the author describes the history of BMW Rosslyn and gives a background to the project. When finished reading this chapter one should have a clear view of the deliverables, scope and the contribution this project has made.

1 INTRODUCTION AND BACKGROUND

1.1 History and Background to the Company:

Praetor Monteerders began assembling cars in 1968 in Pretoria, using BMW engines and drive trains fitted to the Hans Glas sheet metal pressed and shipped from Dingolfing in Germany, at its factory in Rosslyn. The cars coming off this initial production line were known as 1800 SA's – literally denoting South Africa. Brazil was the only other country where the Glas/BMW derivative ever went on sale.

In the early seventies, BMW AG bought shares in this company and shortly thereafter, the BMW 2500/2800 model hit the South African roads. In March 1974, BMW's new 5 Series was launched locally and in April 1975 BMW AG took over full shareholding and established BMW South Africa (Pty) Ltd. The 5 Series and then the new 7 Series launched in 1978, finally established BMW as a manufacturer of high performance luxury passenger cars in South Africa.

Location:

BMW-Rosslyn is based in Pretoria's industrial area namely Rosslyn. There are BMW plants worldwide to manufacture all the different models.

Figure 1: Air photo of Plant Rosslyn

Product:

Automobiles are classified as Complex Systems in the product type category. Rosslyn Plant's main production is the manufacturing of the incredible 3-series.

The BMW 3 Series consists of the following models: 320i; 323i; 325i; 330i; 335i (Coupe); 320d; 330d.

This iconic 3-series was rated World Car of the Year 2006. Vehicle performance, comfort and functionality were just some of the criteria that 46 international industry journalists assessed before awarding the BMW 3 Series 'World Car of the Year' status. Its athletic features and muscular lines also put the 3 Series on the podium in the 'World Car Design of the Year' category.

At BMW SA's Logistics department production is being planned and scheduled based on forecasts and history of demands. All processes are being monitored and areas of improvement are then identified and projects are then allocated to the industrial engineers that work in those specific areas.

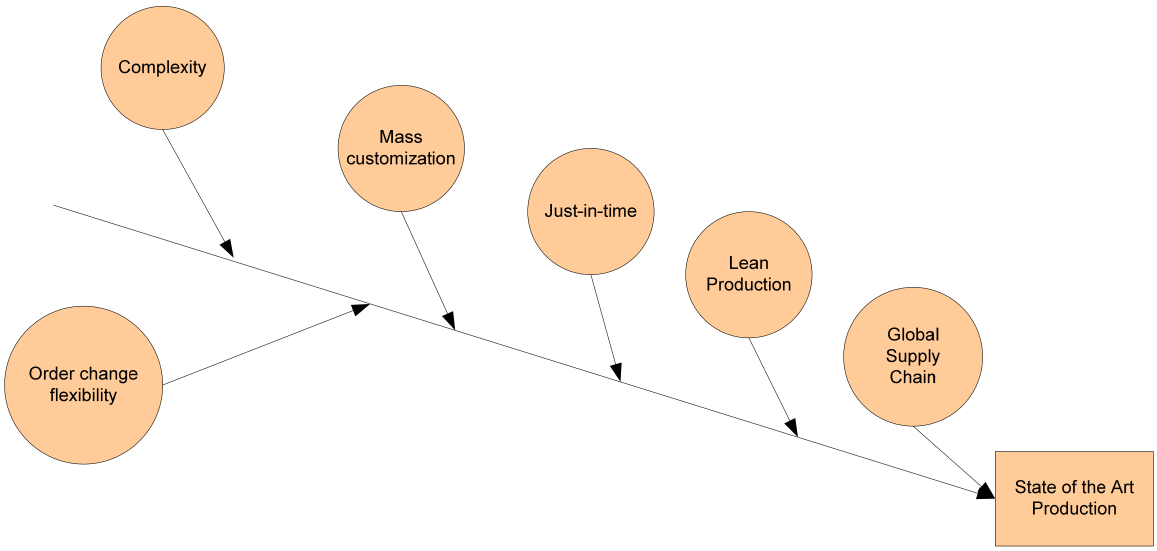


Figure 2: Aspect flexibility in the context of the production system

In the figure it can be seen that a number of factors contribute to a state of the art product namely the 3 series.

1.2 Background to the Project:

BMW SA Rosslyn is a make-to-order manufacturer which offers its end-user the option of full customization and flexibility to make changes to their order up until two weeks before the vehicle must be built. The problem that occurs because of this flexibility is that the demand changes rapidly from the first time the order of the forecasted material is being shipped (9weeks) until the actual vehicle is being built. The consequence is that some of the material needed to build certain types of the model might not be available on time and must be air freighted.

Figure3 will describe the levels of the newly manufactured 3 series at BMW Rosslyn. The 3 series is manufactured at Rosslyn for different markets. Each one of the markets has its own set of types which they order. A model or type consists of various options. Every set of options has a different set of material and parts requirement.

The model-mix changes in the long-term horizon and are caused by changing conditions and expectations of the markets resulting in changing delivery wishes. Within the short-term horizon, flexibility agreements allow changes in options.

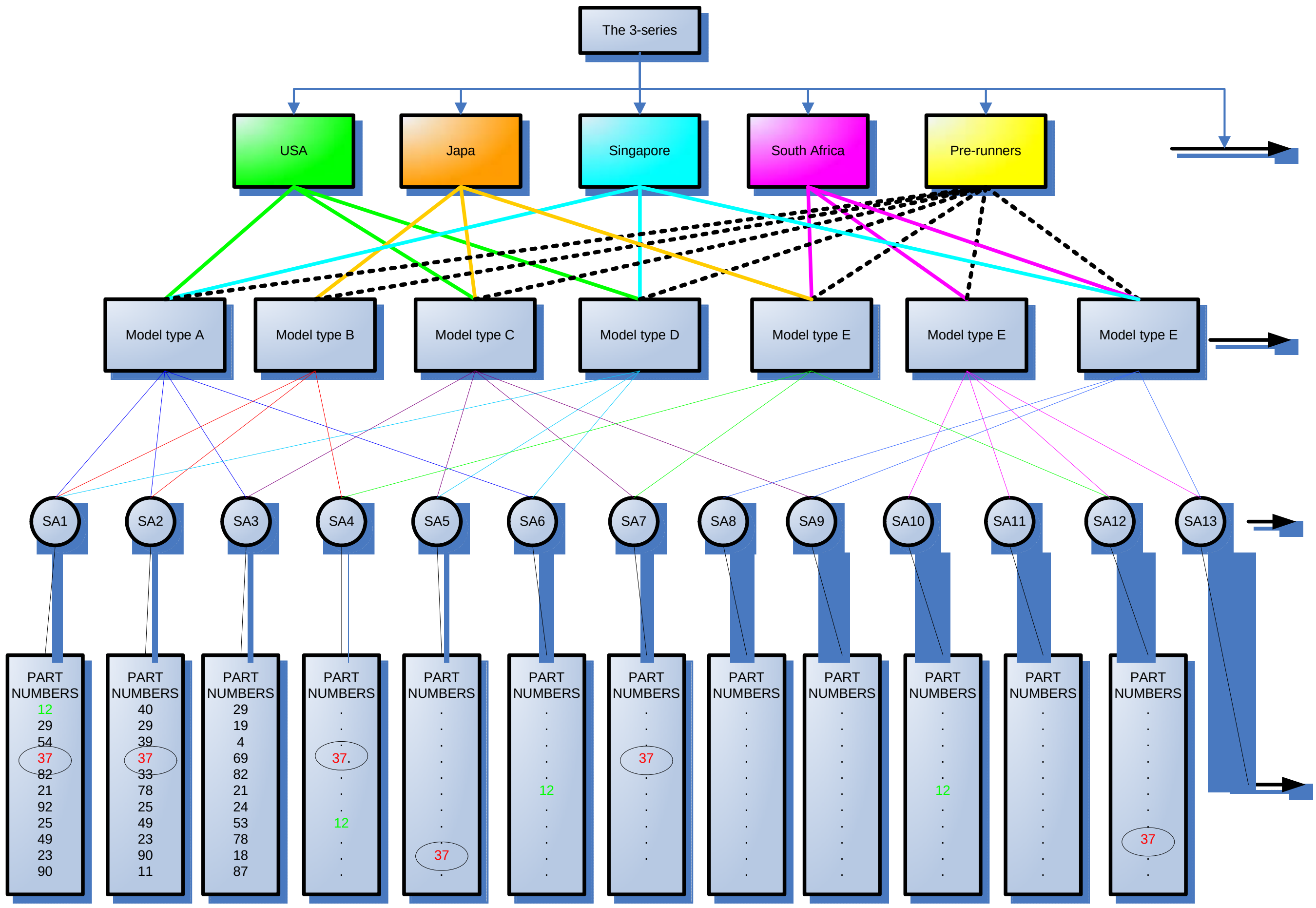


Figure 3: Description of different levels in the manufacturing of the product

The percentage of changes in demand that took place from the first time the shipment leaves for South Africa (9-weeks call- off period of goods ordered) until the actual product is being built as well as the cost wasted because of this incorrect order prognosis for the year of 2008 was determined. A detailed description of the call off period follows from figure4. These changes mainly occurred because of demand fluctuation. A project was launched to develop a program which makes it possible to update every month's demand and actual built models so that a pattern can be seen and to inform Germany if a problem occurs often and thus prevent it from happening again.

The main purpose of the project will be to analyse statistics of demand and order prognosis to determine how to be able to improve the production schedule and where the red areas are. This means that there will be looked at the history of parts that had to be air freighted and help them to create a plan to decrease these parts from being out of stock by confronting the cause of the problem.

With this analysis they will be able to highlight the cost of airfreight and packaging that will be saved, and production that won't be necessary to stop due to parts that are not ordered on time. Currently inbound logistic cost is 73% of which 8% is unnecessary airfreight.

The project focused mainly on demand creation, flexibility cost, make-to-order and customization. Demand management, statistics of demands and cost analysis techniques were used to analyse the problem.

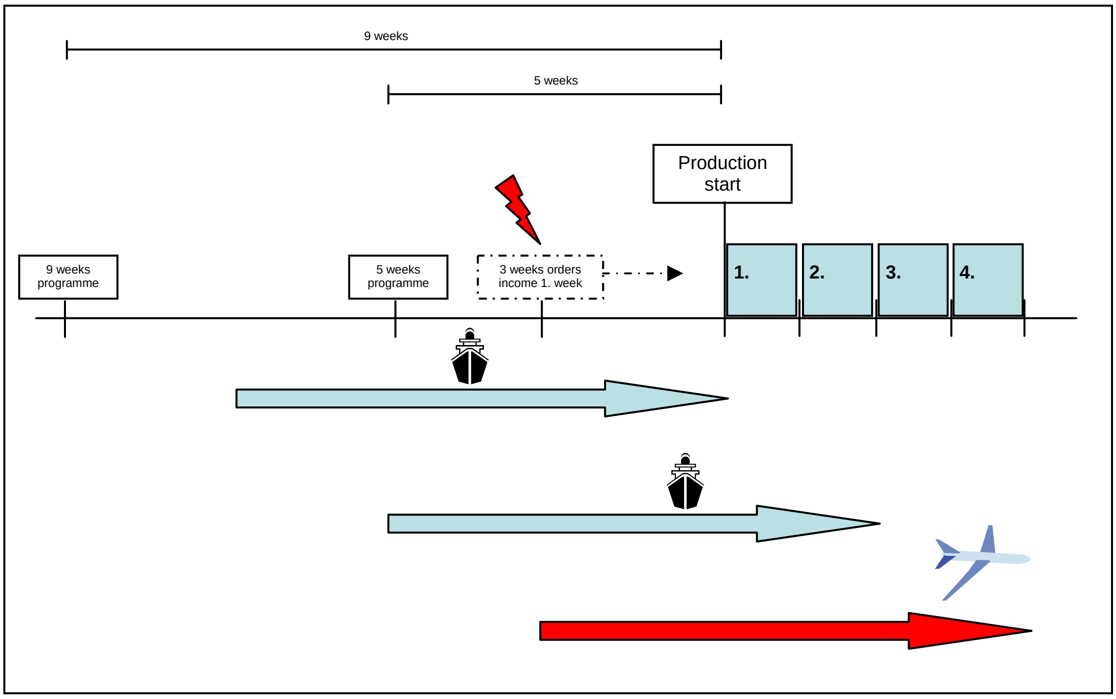


Figure 4: Breakdown of stages in call off period

As it can be seen from the figure 4: Nine weeks before production an order is placed for materials to be shipped based on demand forecasts. It takes a shipment 7 weeks to arrive in the harbour of South Africa. 5 weeks before production starts, another shipment leaves for SA with the material needed based on the new and changed demands. The changes are caused by different model mixes and changes in the market. These changes are called program changes. From the 5-week call-off period there are still order changes which cause the material demand to change again. Until two weeks before the actual production has to start, customers may still change some of the options of their orders. If the material is unavailable and it is not on the next shipment which will arrive after two more weeks, the material/parts have to be air freighted in.

1.3 Project Deliverables

The aim of this project is to analyse the production plan of BMW in order to improve the forecast of demand. This manifests in three areas namely:

Cost Reduction

The aim of the project is to reduce the 8% unnecessary airfreight. To be able to decrease this airfreight it must be determined which parts will be needed additionally if the demand changes from one option to another option. Some options differ a lot from one another and because of demand changes some parts are not in safety stock and must be air freighted. Parts that are air freighted also need other packaging than the parts which are shipped and this is more expensive because it is not transported in bulk.

The cost of airfreight for 2008 up to October was R 4153832. The potential cost that could be saved if the data analysis model that is proposed later in the document is implemented is R852413.60. This decreases the airfreight by 21%.

Plant Stability

When there is insufficient safety stock of a certain part the line have to stop until the specific part becomes available. Some parts that were ordered are not used and must be sent back or it becomes obsolete and can’t be sent back or used anymore. These costs can be reduced if forecasts of demand are more accurate.

Supply Chain Stability

The lack of accurate forecast figures causes the supply chain to change because the safety stock is insufficient and must be air freighted. The objective of this project is to try and stabilize the supply chain.

After completion of this project the following outcomes have be achieved:

1. Know where possible red areas are and how to treat them
2. Better forecasting of demand changes
3. Managing of demand fluctuation must be enhanced

The first three objectives result in the following deliverables:

- Decreased airfreight cost
- Cost reduction (21%)
- Plant Stability
- Supply Chain Stability

The material planners of BMW Rosslyn will be trained to plan materials according to the new solution.

1.4 Scope of the Project

The focus of the project will be to analyse and investigate the demand changes from 9 weeks to 5 weeks and 5 weeks to actually built models. It must be determined what the effect on forecasting and ordering of specific parts will be and to determine a strategy to counter this. The reasons for primary demand changes were analysed and alternatives and solutions have been found for better planning and to improve stability. The problem areas were discovered by analysing historic/ (previous) demand changes and airfreight history of parts. A database for the firm to maintain was developed as well.

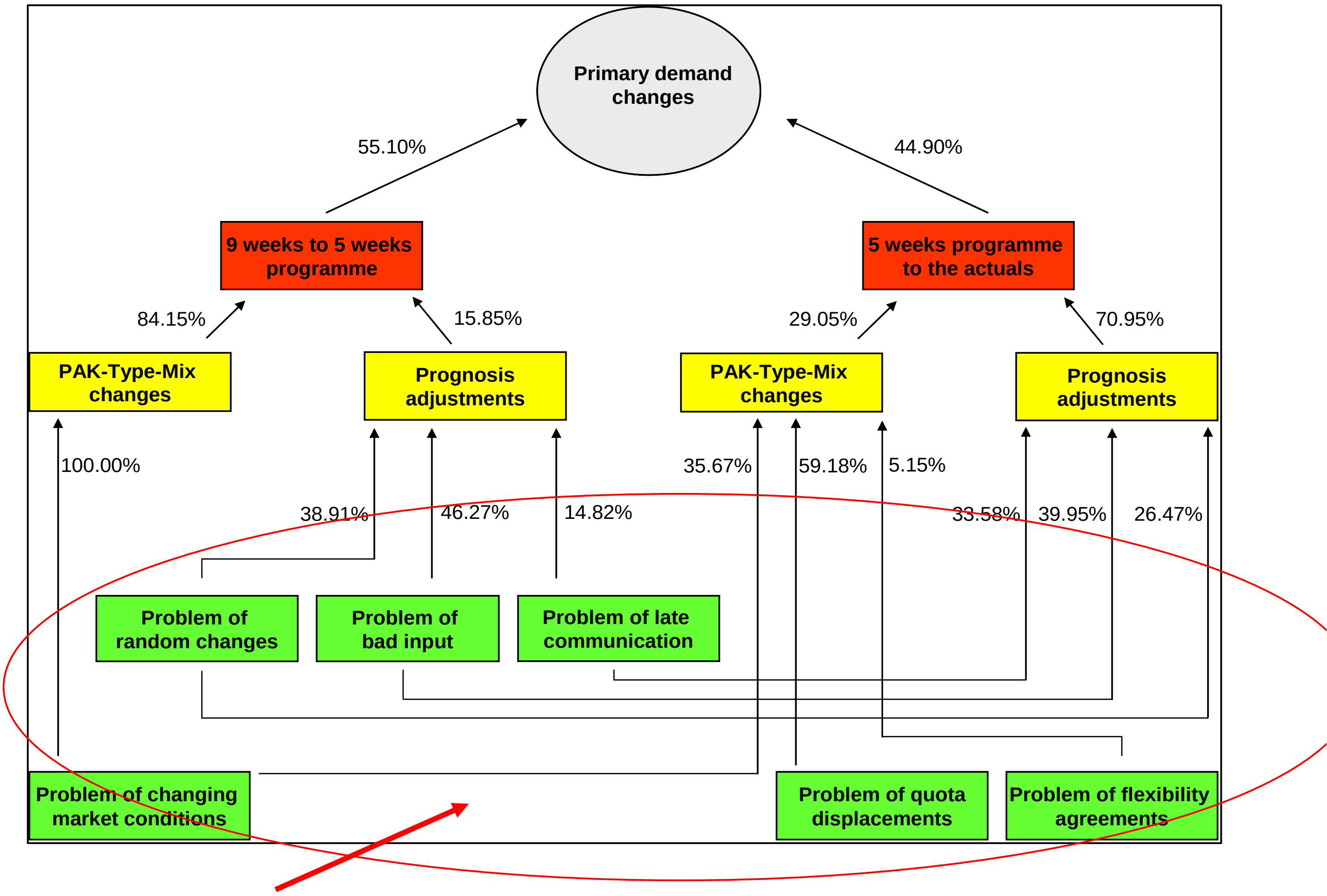


Figure 5: Reasons for changes and adjustments that are focused on.

By analysing the demand changes and actually built cars the probabilities as in figure 5 were achieved. The changes in the programmes can be divided into two parts: the PAK-Type-Mix changes and the Prognosis adjustments. The PAK-Type-Mix changes happen when there is a change in the market conditions. Prognosis adjustments are caused when there are random changes, bad input or late communication.

1.5 Approach to the Project and Contribution

A thorough analysis of the background on how BMW and other organisations in the same industry function and operate was conducted by the author. This analysis revealed interesting information and also exposed a place for improvement because there were no solutions to this problem yet.

The problem was turned into an opportunity of great improvement as well as a stepping stone for further investigations.

The project made a great contribution to the production planning because the author developed a data analysis model that indicates where the problem areas are, which options cause the most air freight and should be investigated. The data model can be maintained and updated by the material planners after the completion of the project.

It can be seen from the data model that from January up to October 2008 the potential cost that could have been saved if the model had been implemented was R 852 413.60.

Chapter 2

LITERATURE STUDY

In this chapter the author conducted a study on relevant literature of the problem to get a better understanding of the environment and to find alternative solutions and implement them in the data analysis model.

2 LITERATURE STUDY:

A study of the background of the project environment was conducted to get to know the reasons behind the problem. Other companies have faced problems that are likely to the current problem of BMW and a study on how they overcame their problems was done. This literature study should analyse the current state and the developments of the questions of demand creation, production flexibility, make-to-order and customization in the automotive sector.

For the purpose of the introduction of these topics the different views existing in literature were collected and compared in order to provide detailed information about the complexity and the aspects of these topics.

A literature study is done by making use of the following techniques and resources:

- Library
- Internet
- Interviews
- Observations

2.1 Demand Creation:

A combined forecasting model for uncertain demands based on Rough Set (RS) and Radical Basic Function (RBF) network were presented. First, RBF network was introduced to work on the historical data and extrapolate future demands. Then attributes reduction of the RS was applied to analyze the datasheet and draw the kernel index set from it. The forecasting results were obtained with a combination of the above two methods. The combined model was tested with real historical data collected from a large firm in the automobile industry, and it produces more precise results than the RBF model.

In a turbulent environment with fluctuating markets, demand forecasts are critical to the supplier, manufacturer and retailer of the supply chain. It is also vital for balancing available resources and optimizing production scheduling and thus determining the quantities that should be purchased, produced and distributed. Accurate demand forecasts lead to efficient operations and high levels of customer service. Traditional forecasting techniques are generally based on extrapolation of future demands through an analysis of past periods, which works well for products with regular demands. However, when demand varies with environmental factors, they fail.[2]

A new model that considers not only long-period and short-period demand forecasting, but also qualitative and quantitative approaches were presented in the paper, *Adaptive Make-to-Order Strategy in Distributed Manufacturing Supply Chains*.[2]. In the combined model, enterprises can choose either of the sub models according to their needs. By comparing it with the RBF network model, it is found that the forecasting results improve greatly. In one word, it provides a feasible framework of demand forecasting for the enterprises of the supply chain.

2.2 Make-to-order

In order to reduce inventory and increase the level of customization, some manufacturers have changed their production systems to manufacture a product only after it is ordered and this is called a make-to-order system.

Outsourcing of production activities has been caused by globalization. In case of BMW Rosslyn the production of the 3 series has been outsourced from Germany to South Africa. This trend creates a new organization paradigm called networked or virtual enterprises. It also causes challenging opportunities in terms of supply chain management. The location of these kinds of complex manufacturing networks leads to a decentralized independent work environment. In a make-to-order supply network it is of vital essence that they quickly react to forceful market conditions because of the location of suppliers and thus higher average lateness.

When make-to-order manufacturing systems are capacity constrained with strictly set due dates and heavy delay penalties, they can be effectively managed by selective acceptance of orders, in particular when the system encounters heavy congestion. In the journal of Optimal Control of Make-to-order Manufacturing systems via selected Order Acceptance [2] the rule of popular order acceptance is demonstrated. The optimal control of a manufacturing system under diverse environments and how the main performance measures of the manufacturing system are affected by it were demonstrated and analyzed. A simulated hypothetical manufacturing system was used as a test sample in this study. Coordination of activities across a network of suppliers becomes crucial to quickly respond to dynamic environments. The supply chain in these kinds of environments plays a very important role because of the decentralized locations. If the demand for a certain product changes after an order of parts is already being shipped, a second shipment with the new parts that are needed must be shipped. If it is already too late for the assembly of those specific products, the parts must be air freighted and thus result in high costs. It is therefore very important for make-to-order supply networks to buffer coordination inefficiencies since the flow of materials is triggered by dynamic customer orders.

This paper (Adaptive Make-to-Order Strategy in Distributed Manufacturing Supply Chains)[3] analyses an adaptive MTO coordination mechanism in a multi-product manufacturing supply chain (like BMW Rosslyn which manufactures various types of the 3 series).

With the help of simulation results, it was found that the proposed mechanism could reduce the cost of the total system as compared with stochastic programming. The demand fill rate of the system, which is one of the weaknesses of traditional MTO systems, can also be improved. How the study was done: the system was formulated as a mathematical model which represents the adaptive MTO coordination mechanism. A stochastic order-up-to policy was then described because under distributed and uncertain environments, forecast of the demand can only be made by making use of order-up-to policies for inventory replenishments. If not, the risk that they might be holding excessive inventory will be very high, particularly if a product have a short product life cycle.

The conclusion of the paper was that product life cycles are getting shorter, which makes the adoption of production strategies inevitable in the responsive era. The main implication of this paper is to quantify the benefits of introduction of flexibility and adaptability in the MTO production environment. Without flexibility and adaptability, suppliers in the simulation study cannot be responsive to the actual real-time situations.

2.3 Flexibility cost

In the automotive industry manufacturers produce make-to-order products and the variety and options that are associated with the end-product continue to increase. The reason for this increase is the pressure to compete in the market and to offer full customization to their customers. The big question however now is: what will this flexibility cost the company?

A study of the cost of flexibility in the automotive industry was conducted by Johannes Van Biesebroeck at the University of Toronto [4]. It was found that in the past, firms have incurred high productivity penalties when they offered more variety in their plants. The question of what actions these firms have taken to control this productivity penalty as well as the cost associated with it was answered. A number of statistical models which showed the effect of flexibility on productivity were estimated for a sample that included most assembly plants in North America from 1994 to 2004.

Table I The number of models sold and/or produced in North America has increased substantially over time

			Sample period	
	1974	1984	1994	2004
Models for sale in North America	185	228	273	320
Models for sale in United States	133	195	238	282
Car models	96	140	164	167
Car variations	–	–	468[a]	503
Light truck models	37	55	74	115
Light truck variations	–	–	558[a]	1,805
Models produced in North America	90	125	139	165
Assembly plants in North America	68	76	68	64

Note: [a]1996 – not available
Source: Ward's Communications (1975-2005)

Table 1: Number of models sold and/produced in North America

The number of different models available for sale in the automobile industry has increased vividly over time, particularly in the previous 20 years. The number of competitors has also increased drastically and to stay at the top of the market, firms differentiate their products from their competitors' to temper price competition and together with it the grinding down of profit margins. From a revenue perspective it makes brilliant sense but there are unfortunately also cost implications. When producing a broader range of platforms, models, body styles, or chassis configurations, a considerable productivity penalty must be paid.

Table II Productivity penalty associated with production of greater variety

	Dependent variable: hpv				
	Platforms (1)	Models (2)	Chassis configurations (3)	Body styles (4)	Configurations + styles (5)
Variety	2.522 *** (0.564)	1.612 *** (0.299)	0.564 *** (0.135)	0.437 *** (0.158)	0.353 *** (0.082)
Time	− 0.961 *** (0.136)	− 0.946 *** (0.133)	− 0.932 *** (0.135)	−0.966 *** (0.136)	− 0.945 *** (0.135)
Variety × time	−0.239 (0.147)	− 0.334 *** (0.077)	−0.067 (0.043)	− 0.091 * (0.048)	−0.055 ** (0.024)
Observations	860	860	860	860	860
R^2	0.539	0.552	0.541	0.532	0.540
Productivity penalty (hpv) associated with producing one more variety in					
1994	3 h 43′	3h 17′	54′	54′	38′
2004	1 h 20′	− 3′	14′	− 1′	5′

Notes: Estimation by least squares on the entire sample of North American assembly plants. Controls include the logarithm of production capacity (scale), dummies for the vehicle segment of a plant's output, country (Canada or Mexico) and foreign ownership dummies, and a dummy for the pre-1998 period as the dependent variable was defined somewhat differently. Standard errors in parentheses; *significant at the 10 percent level; **5 percent; ***1 percent

Table 2: Productivity Penalty

Activities that reduce the productivity penalty associated with variety can be adopted by firms; the negative aspect is that these be likely to lower baseline productivity. The incremental cost of variety is reduced, but it comes at the price of higher input requirements when few varieties are produced. Flexibility technology that characterizes the production process at some modern plants has drastically reduced the productivity penalty associated with variety, this technology tends to have lower scale economies as well. Whether the optimal strategy for any given plant is full flexibility, depends essentially on its current and future product mix and extent of operation.

If the firm adopt some of the activities complimentary to producing variety – insourcing and flexibility – the penalty at the margin has been shown to reduce. The disadvantage is that the baseline number of hours required to assemble a vehicle is increased.

As manufacturers in various industries change toward primarily make-to-order production to optimize their service towards their customers' needs, escalating product mix flexibility appears as a crucial strategy to provide sufficient market responsiveness. The problem that is faced now is that the implications of the increased flexibility on overall system performance are still widely unknown. In Manufacturing & Service Operations Management [5], analytical models were developed as well as an optimization-based simulation tool to study the impact of growing flexibility on shortages, production changeability, component inventories, and order variability induced at suppliers in common multi-plant multi-product make-to-order manufacturing systems.

Their results showed that partial flexibility leads to a significant increase in production changeability, and consequently in higher component inventory levels and upstream order variability. A modest increase in flexibility yields most of the sales benefits but at the same time production variability is reduced as more flexibility is added to the system. When component inventories are expensive, it may be justified to investment in additional flexibility.

In an entirely make-to-order system, no final goods are kept in inventory. The changeability in consumer demands justify that those components with long lead times are kept in inventory. This helps to ensure timely delivery.

Manufacturing flexibility is becoming a fundamental production objective, along with cost, quality, and delivery time. Current production systems face quick changes in market conditions and they need to adapt in this environment. The supply chain and industrial globalization give an important role for assembly systems. Placed at the end of the value chain, assembly systems must face those quick changes successfully to reach the expected performance. The key performance indicators are normally based on cost, quality, and delivery time objectives. Reducing costs and improving quality are almost universal goals. Delivery time is typically determined by customer demand in the supply chain, planning from make-to-stock to make-to-order, and aspiring to reach a just-in-time manufacturing system. Closely related to the rest of production objectives and the overall performance of the system, flexibility must be integrated in the system for successful decision-making in operations. [6]

2.4 Customer Satisfaction:

On-time-delivery

It is a policy of BMW that cars will be provided on time. On Time Delivery means cars produced in Plant Rosslyn leave the plant early or on-time. This ensures that cars are delivered to the intended customers on their promised dates. The achievement of on-time-delivery is the result of stable production volume as well as a steady improvement in the number of cars built ‘Right First Time’. This can be attributed to an improved build quality and a sharpened focus on these important targets. This provides the foundation on which must be build to achieve the 'Green' target of 95%.

Customization

When a manufacturing system offers a customization production mode, quality assurance becomes a critical factor. The most important problem that a firm is faced with is how to maintain stable product quality and meet the customer's individualized requirements constantly. A quality management system model of customization which is based on customer satisfaction is set up, collaborative quality design, production process quality management, application and service quality management and quality evaluation etc., the key functions in the model, are analyzed in detail. More over the evaluation method of customization product quality is studied. The quality management prototype system of individualized customization based customer satisfaction is developed.[7](Xingyu Jiang, 2007)

Enterprise quality strategy is rapidly becoming customer satisfaction in the 21st century [8](S. Martin, 2000). The single customer has become the firm's primary focus with the development of society and economy. Individualization in all areas of life is an uninterrupted trend that enterprises are facing. The answer to meeting the customer's individual requirements is individualized customization [9,10]

When a firm has a network manufacturing platform with the goal of customer satisfaction, it can apply a modern management concept and advanced manufacturing technologies to acquire individualized customization. This can be achieved through product structure and its related process reconfiguration that will meet the customer's individualized requirements and produce a product that is standardized and diversified. This customized product will generate profits for the enterprise. [10]

The most critical and difficult problem is how to maintain stable product quality and keep meeting the customer's individualized requirements. Through the research on individualized customization quality assurance, quality management system model for individualized customization based-customer satisfaction one can study this problem. Each and every part, especially the support technologies for the system are analysed and studied to meet the customer requirements constantly and steadily in product lifecycle, moreover a new evaluation method of customization product quality is presented. This can significantly assure realizing customer satisfaction over the life of a product. Based on these, the system is hoped to play an important support role of research and implementation of individualized customization. (Xingyu Jiang) [7]

Chapter 3

PROBLEM STATEMENT

After this chapter has been read the reader must have a clear understanding of how the problem was identified, what the negative effects of the problem are and which solutions currently available are.

3 PROBLEM STATEMENT:

3.1 Problem Identification:

It was seen from the literature study that in a make-to-order manufacturing environment multiple problems may occur, some may have solutions and others not yet. The problem was broken down into the following fishbone diagram to illustrate the factors that are applicable clearly.

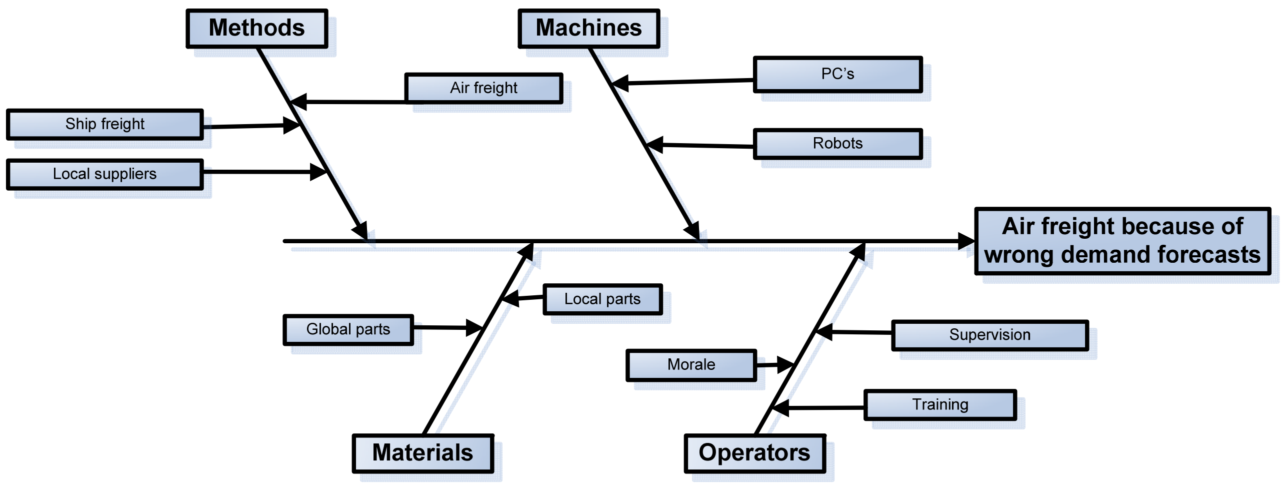


Figure 6: Fishbone diagram of problem

The literature study made it possible to identify the problem in terms of:

- Creation of demand
- Cost of flexibility and Customer satisfaction

Material demands creation:

One of the most important inputs of programme planning is an accurate prognosis which is visually shown in figure 7.

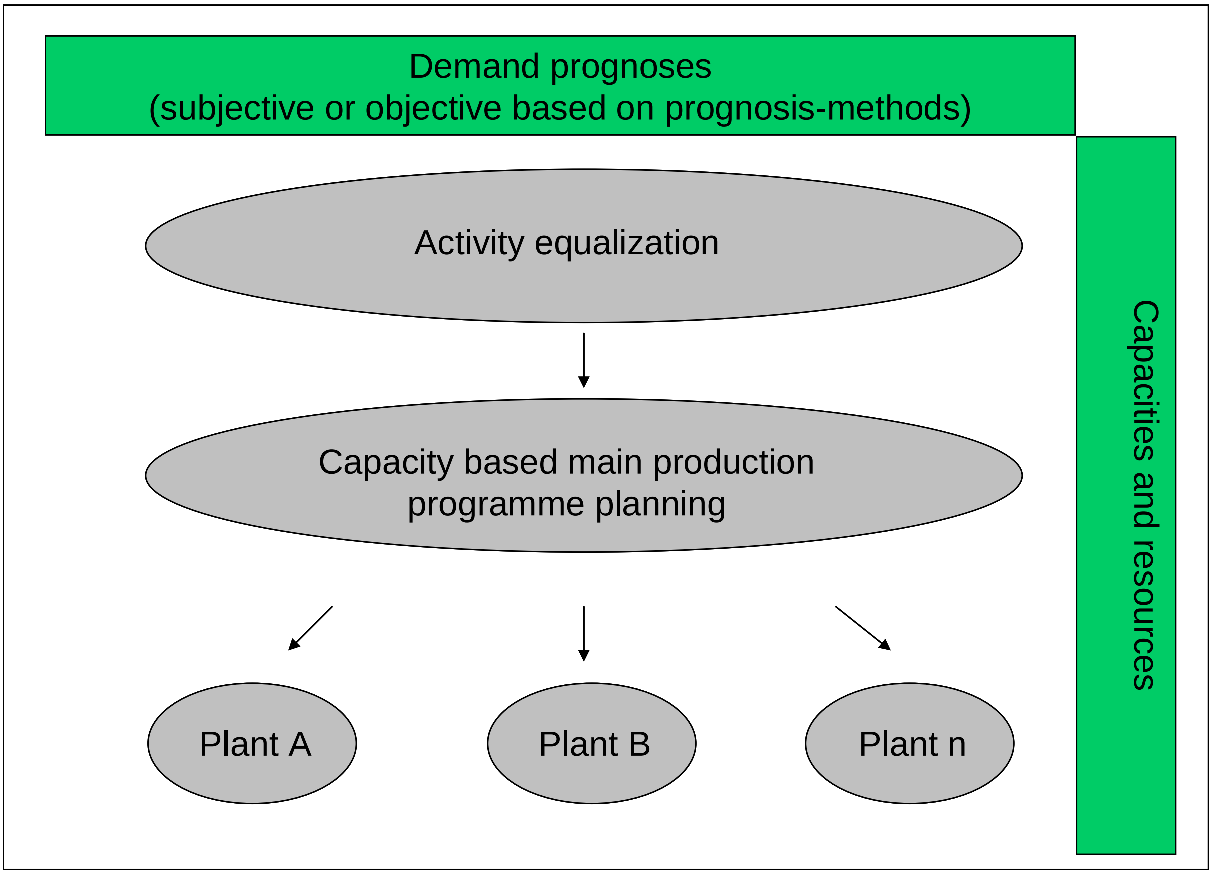


Figure 7: Sequence production programme creation

From figure 7 one can see that the correct demand prognoses is the most important step in programme planning, after this comes the activity equalization which is the longest-dated stage of the planning where the revenue and cost decisions regarding production output are done. The targets in terms of sales and profit are considered by the demand prognoses after which a plan of the intended production is done.

After the activity equalization, the capacity based main production programme planning is done. Concrete orders and short-term prognoses with high accuracy are inputs for this stage. The problem that accurs here is that all the planning is done simmultaneously for all the plants and when the actual orders must be built the demand differs at some of the plants because of various reasons.

The programme execution in the last step of the production network and each plant's production steering and control department has to convert the programme to weekly and daily packages in order to ensure the correct parts supply. This means that if the demand prognoses was wrong from the start of the process, the weekly and daily packages will also be incorrect and the wrong parts will be ordered and supplied.

Flexibility requirements:

The question of how important flexibility is for the customer as well as the cost for the company to maintain this flexibility are very important. From the customer's point of view one needs to know what influences the customer's buy decision and what the competition offers. If one looks at the following picture it can easily be seen how important it is to offer diversity and be flexible.

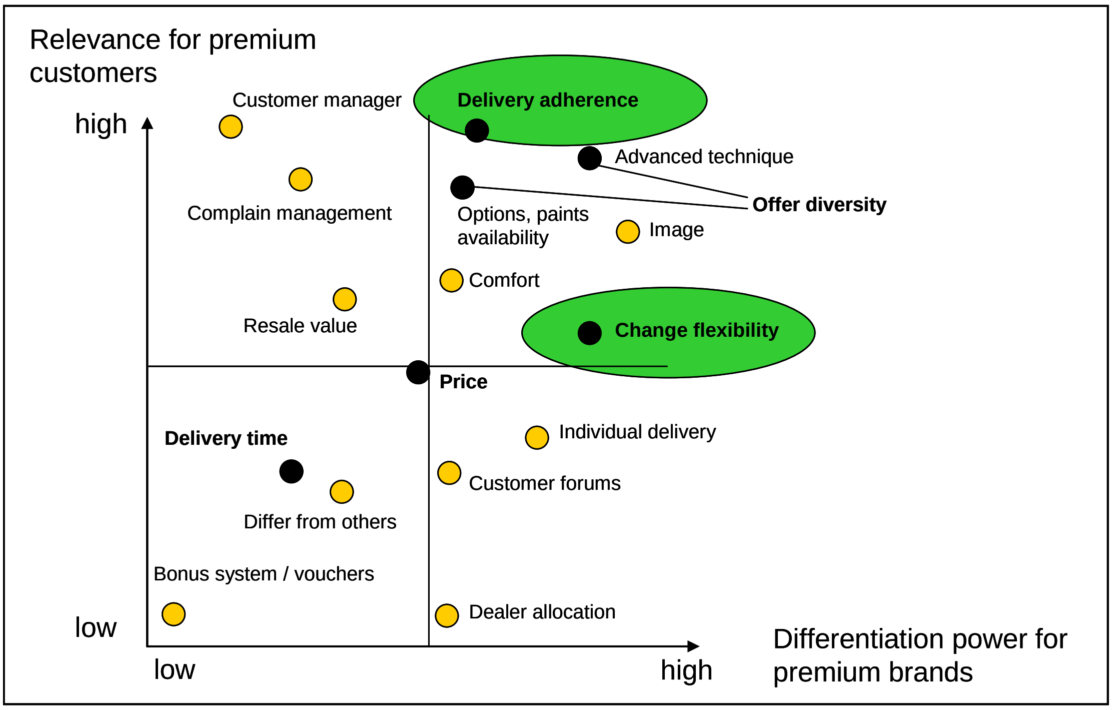


Figure 8: Aspects of the buy decision

If one looks at it from the manufacturer's point of view one will find that the manufacturer also gets benefits if it follows a flexible production approach.

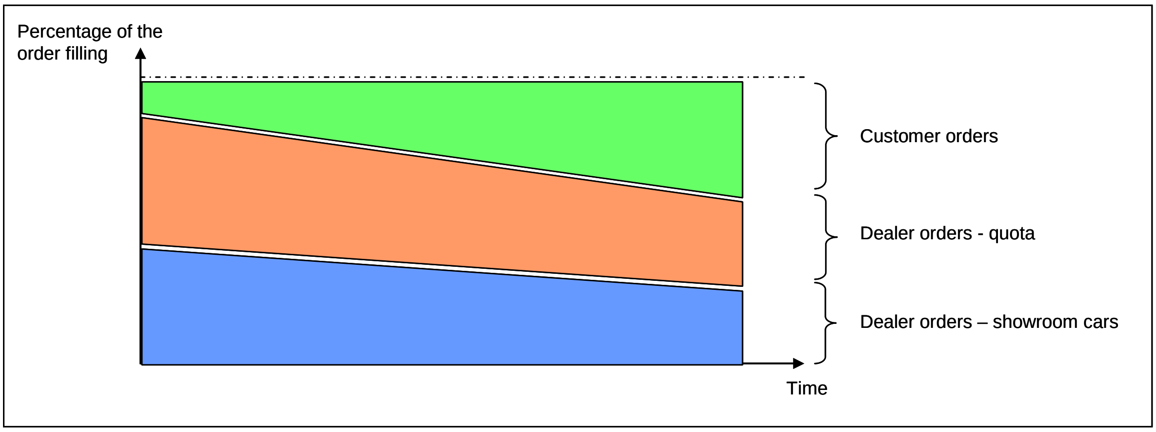


Figure 9: Order distribution against the time aspect

Even when no orders are available yet(as at time zero on the figure 9), order change flexibility also exists because virtual orders are used to block production capacity until the quatas are filled by dealers or customers within the process of the programme planning. This means that there are still time to change the configuration of a certain order if the market changes.

3.2 Negative Effects of the Problem:

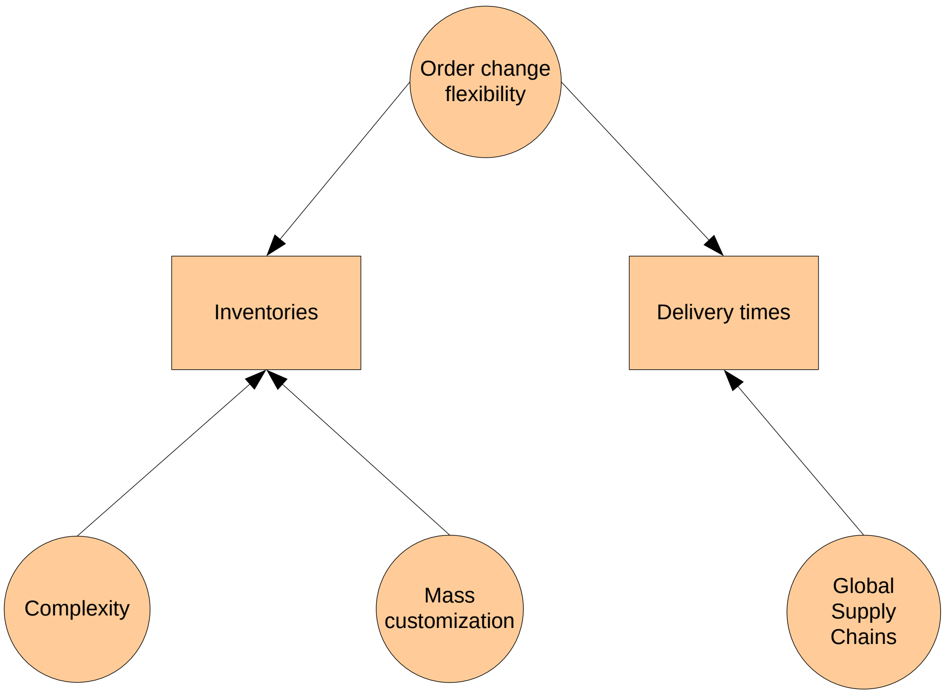


Figure 10: Area of conflict of the aspect flexibility

The greatest effects of this problem of rapidly changing demand are high air freight cost and financial losses because of customer dissatisfaction when the product is not delivered on time.

The characteristic of flexibility and mass customisation leads to the problem of the absolute necessity of higher inventory levels. Global supply chains leads to a very high delivery time (figure 10). This shows the importance of better forecasting to prevent part shortages which implies high airfreight cost and late deliveries of the product.

Figure 11 shows how much the options (SA's) change from week 9 to week 5 and then to the actual building of the product.

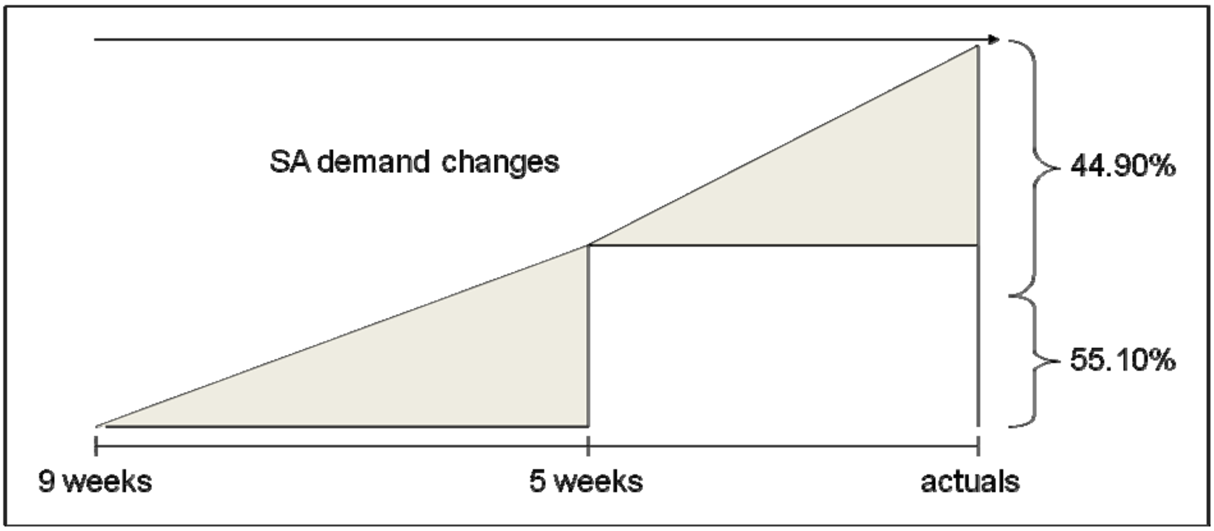


Figure 11: SA demand changes

3.3 *Current Solutions:*

The big question is whether there is a solution to this problem? Unfortunately there are currently no solutions to solve this problem and a project was launched to develop a program that will not only determine the demand changes of a fixed period versus the actual built models for that period, but will also be able to be maintained and will help to determine where the red areas are. This model must be able to compare monthly airfreight parts with each other and notify the user if a problem occurs in more than three consecutive months.

In order to offer a great variety and to meet customer demand and keep up the competition, the company needs to offer complex products. The product can be customized by the customer in unlimited opportunities.

The just-in-time concept can be divided into three components namely: an integrated information processing, the definition of manufacturing segments and a demand synchronic parts supply. This means that the success depends on the prognosis of the product's demand, and the concept is mainly applied for parts with short delivery times from the supplier. The problem is that is it can only be possible for local suppliers.

Chapter 4

SOLUTION TO THE PROBLEM

In this chapter the author explains the relevant data that is available to work with as well as the methodology that was followed when designing the data analysis model.

4 SOLUTION TO THE PROBLEM:

4.1 Data Available

A thorough investigation yielded various kinds of data. All this data had to be sorted through to see which of it is relevant and can be converted into useable information to build the model. The following data was selected to be used in the model later in the project:

Monthly air freighted parts:

Plnr	Part Nr	Part Description	Qty	Date	Purchase Order
128	7077127-05	CLIP MOLDING ROOF	5,000	2008/02/04	S01060908
128	7077127-05	CLIP MOLDING ROOF	5,000	2008/02/04	S01060908
000	7800621-01	EXT/TRX SCREW M8X30	30	2008/02/05	S01060911
000	7800622-01	EXT/TRX SCREW M6X60	4	2008/02/04	S01060911
128	6776068-01	ASSY DSC-MODULE MK60E5 RH	7	2008/02/10	S01070678

Line	Airfreight Cost	AETC Nr	AETC Date	RC
10	55.1	44254	2006/12/04	MP
10	55.1	44254	2006/12/04	MP
90	2.9	47864	2008/01/09	PD
80	2.9	47863	2008/01/09	PD

10	55.1	47702	2007/11/27	EE

Description	Cost-Cen	Remarks	Remarks 2
STANDARD AIRFREIGHT	ZA-T-12	48-HRS	Standard Airfreight
STANDARD AIRFREIGHT	ZA-T-12	48-HRS	Standard Airfreight
STANDARD AIRFREIGHT	ZA-T-4	48-HRS	Standard Airfreight
STANDARD AIRFREIGHT	ZA-T-4	48-HRS	Standard Airfreight
FLASHING PARTS ONLY	ZA-T-12	48-HRS	FLASHING ONLY

Kolli Nr	Invoice Wght	Volumetric Wght	Bruto Wght
O01T0882	11	19	10
O01T0881	11	19	10
N3468790	1	0	1
N3468797	1	0	1
N3587927	19	4	19

The Rosslyn plant produces cars for the below listed markets. For internal control- and steering purposes the mentioned PAK-numbers are used.

PAK	Market
00004	USA
00210	Japan
00780	Singapore
01601	New Zealand
02167	Australia
02786	South Africa
04142	Hong Kong
04825	Taiwan
06995	Pre-runners
11412	Hot country (for different markets)

Various options are available to be selected from; and listed is an example of some the options (SA's):

SA-code	Description
S0 169	EU3 exhaust emission norm
S0 205	Automatic transmission
S0 217	Active Steering
S0 226	Sports suspension settings
S0 240	Leather steering wheel
S0 249	Multi-function for steering wheel
S0 255	Sports leather steering wheel
S0 2XA	Sports leather steering wheel with gearshift paddles and multifunction
S0 354	Green stripe windscreen
S0 358	Climate comfort windscreen
S0 3AC	Trailer tow hitch

In Germany all the demand forecasting and planning are done on a database called KAPRO-web. Access was gained to work on this programme and extract data from it to be used in the model:

A screenshot of some of the data that was gained from KAPRO –web and then exported to excel is showed on the following figure.

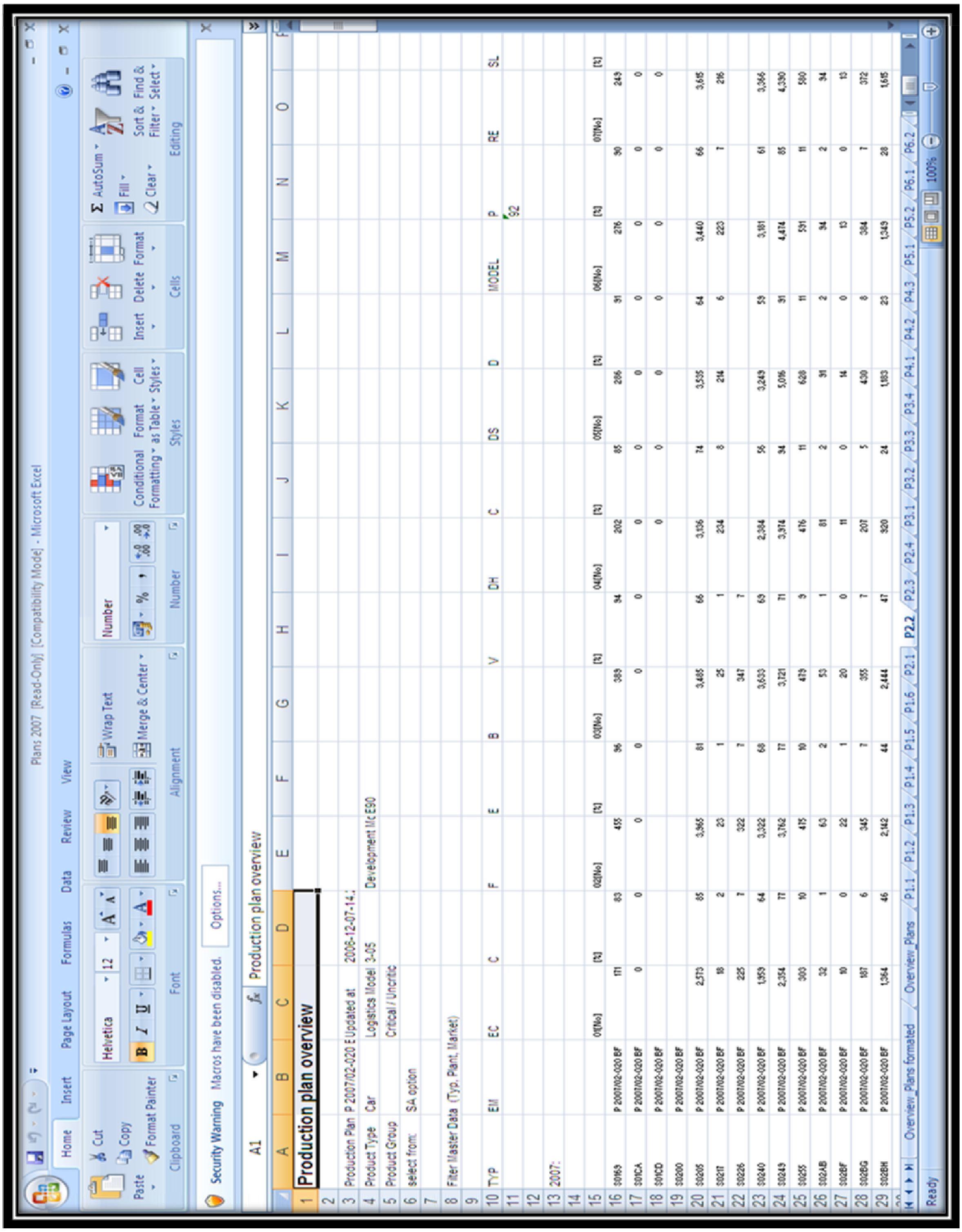


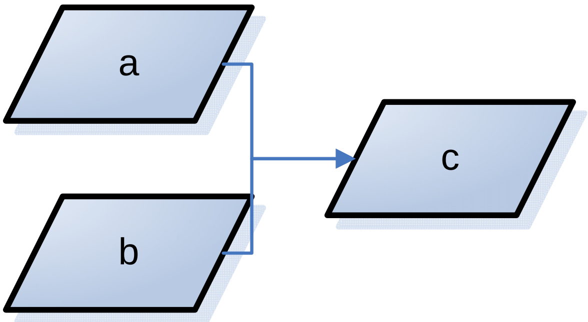
Figure 12: Production Plan exported to excel

4.2 Methodology:

A database in excel which will update every month's demand changes versus the actual built models had been developed and must be maintained. This data can be analysed further to be able to increase the overall profitability and productivity of the company.

a = forecasted demand
b = actually built cars
c = difference
d = top 10 air freighted parts (cost)
e = cost saving potential

The difference between the forecast and actual model can be determined from the production plan and give you c.



An example of the difference in the units from week 5 to actual model is showed in the figure:

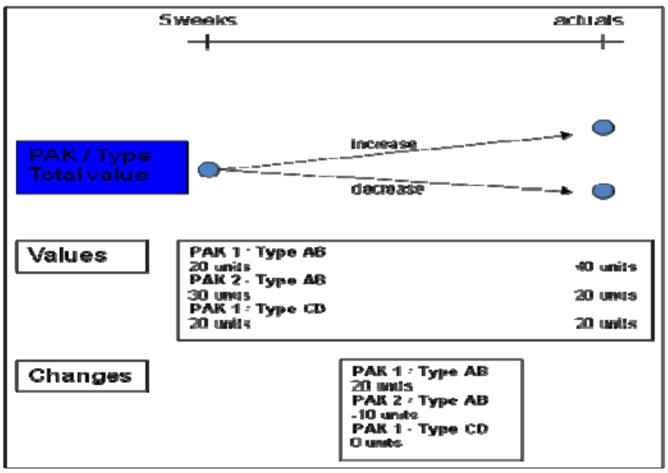


Figure 11: Unit changes

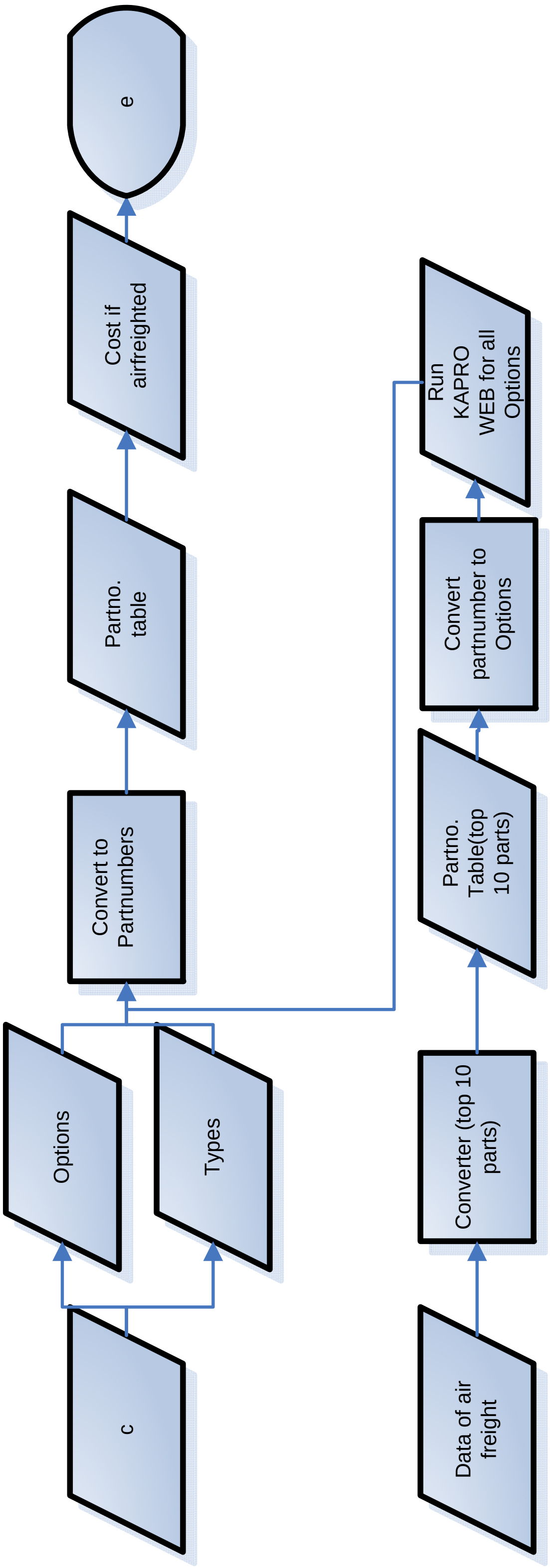


Figure 13: Preliminary model planning

After the difference between the forecast and actual units is determined, the units are divided into options (SA's) and types. Every option and type is then converted into a list of part numbers. The part number can then be linked to a certain cost if air freighted.

Every month a list of all the air freight is drawn up by the material planners and can be used in the model. The top 10 parts can be listed according to the highest contribution to the air freight. These part numbers are then linked to options and types to determine whether the part number is often a problem. If the problem occurred in three or more consecutive months, the part must be listed as a red area and must be further investigated to prevent it from happening again.

The model must be maintained in order to keep the history of parts and to be able to forecast demands better in the future.

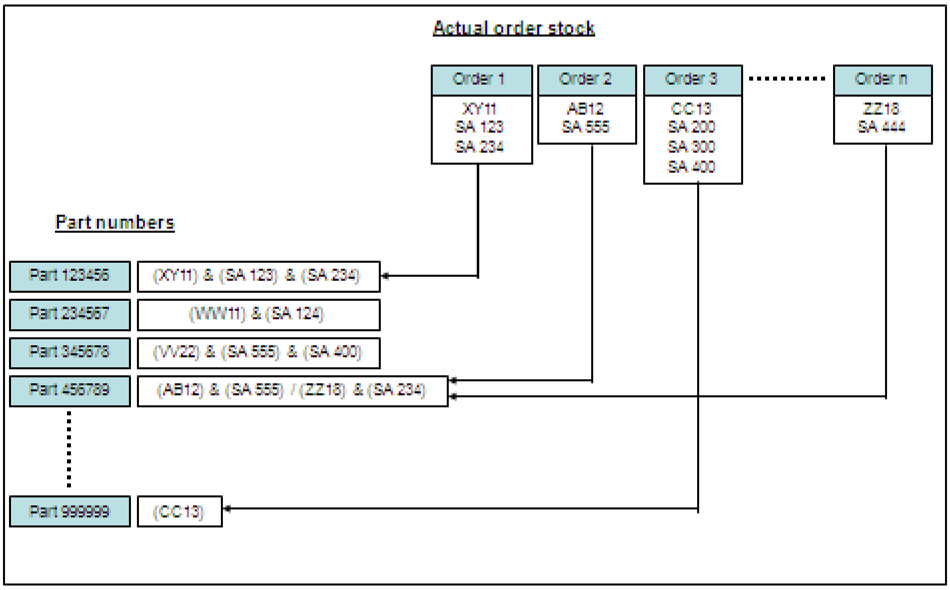
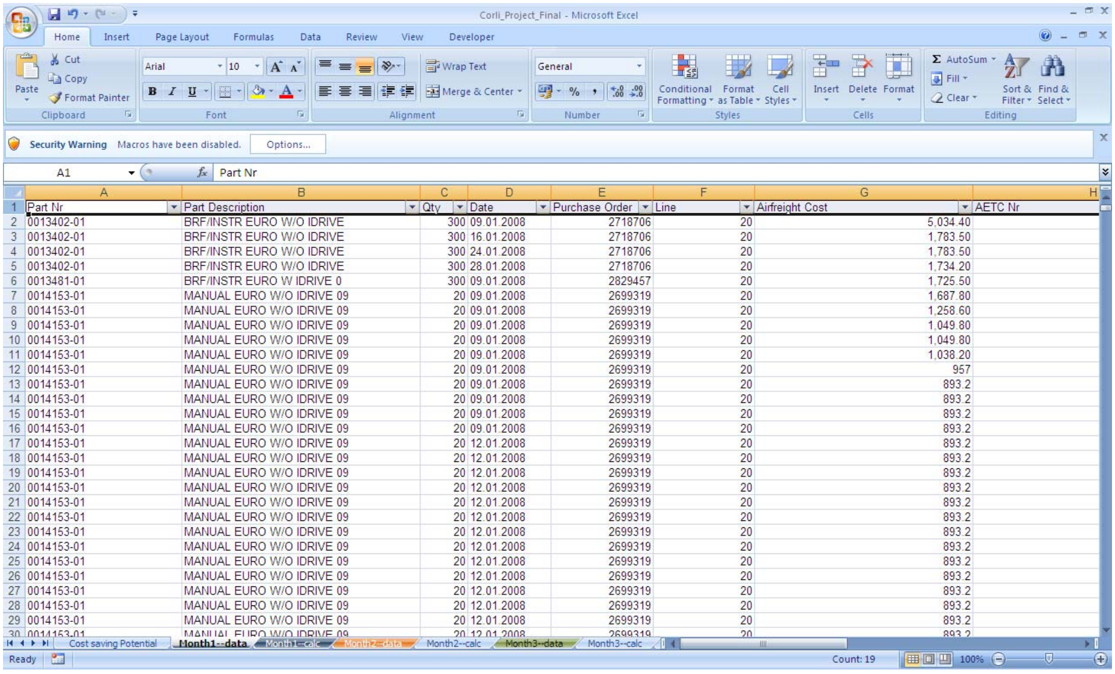


Figure 13: Part numbers that are linked to options and types

The figure is showed to illustrate how a part number can be linked to more than one option and/or type.

4.3 Data Analysis Model:

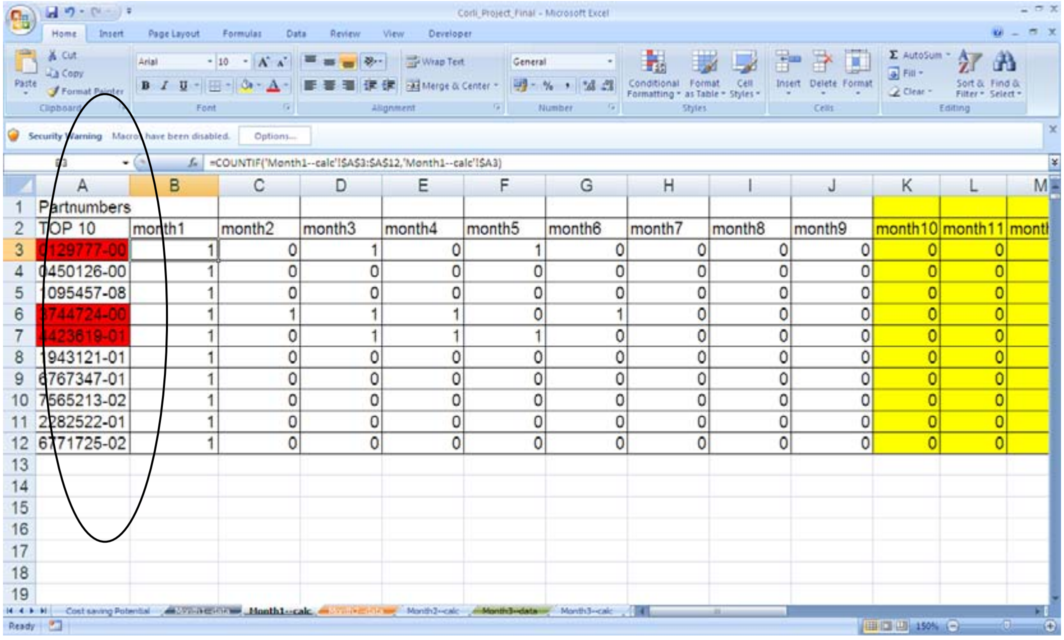
The Material Planner has a list of monthly airfreight, this can be save directly in the data model.



Part Nr	Part Description	Qty	Date	Purchase Order	Line	Airfreight Cost	AETC Nr
0013402-01	BRF/INSTR EURO W/O IDRIVE	300	09.01.2008	2718706	20	5,034.40	
0013402-01	BRF/INSTR EURO W/O IDRIVE	300	16.01.2008	2718706	20	1,783.50	
0013402-01	BRF/INSTR EURO W/O IDRIVE	300	24.01.2008	2718706	20	1,783.50	
0013402-01	BRF/INSTR EURO W/O IDRIVE	300	28.01.2008	2718706	20	1,734.20	
0013481-01	BRF/INSTR EURO W IDRIVE 0	300	09.01.2008	2829457	20	1,725.50	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	1,687.80	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	1,258.60	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	1,049.80	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	1,049.80	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	1,038.20	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	957	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	09.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	
0014153-01	MANUAL EURO W/O IDRIVE 09	20	12.01.2008	2699319	20	893.2	

Figure 15: Monthly airfreight (January 2008)

The airfreight cost is then used to filter the part numbers to get the top 10 part numbers to investigate them further.

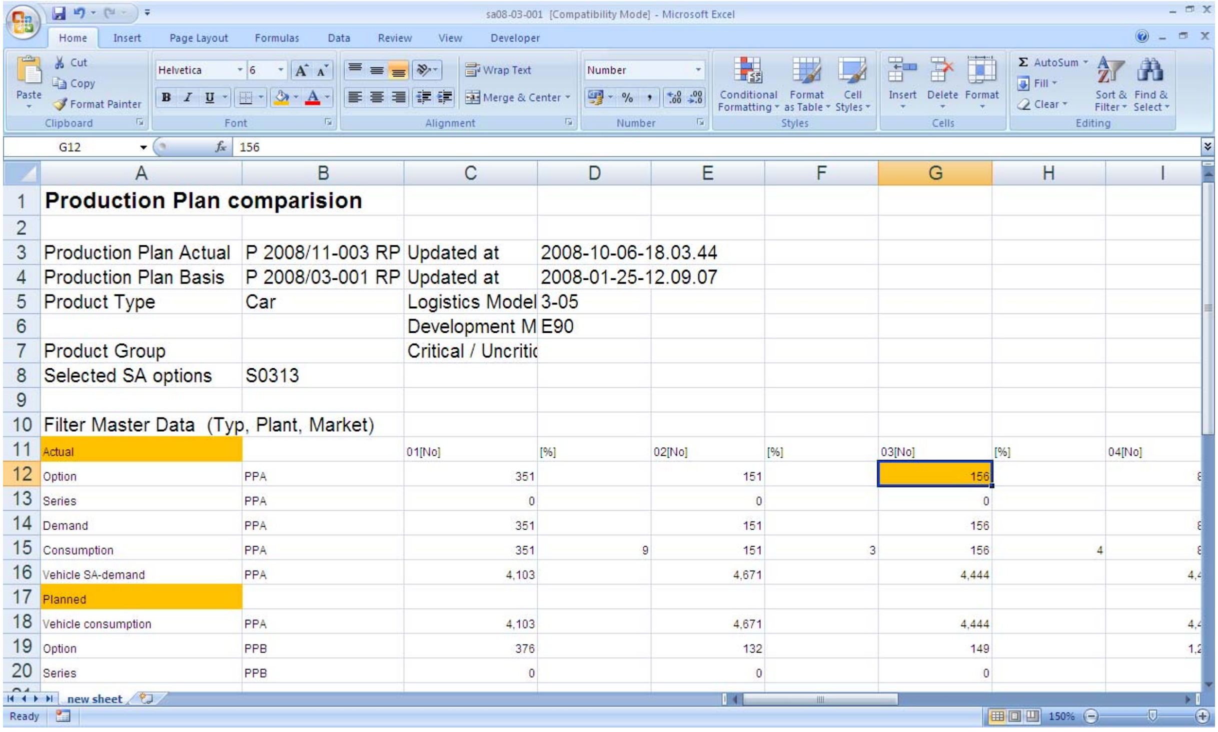


	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Partnumbers												
2	TOP 10	month1	month2	month3	month4	month5	month6	month7	month8	month9	month10	month11	montl
3	0129777-00	1	0	1	0	1	0	0	0	0	0	0	
4	0450126-00	1	0	0	0	0	0	0	0	0	0	0	
5	1095457-08	1	0	0	0	0	0	0	0	0	0	0	
6	3744724-00	1	1	1	1	0	1	0	0	0	0	0	
7	4423619-01	1	0	1	1	1	0	0	0	0	0	0	
8	1943121-01	1	0	0	0	0	0	0	0	0	0	0	
9	6767347-01	1	0	0	0	0	0	0	0	0	0	0	
10	7565213-02	1	0	0	0	0	0	0	0	0	0	0	
11	2282522-01	1	0	0	0	0	0	0	0	0	0	0	
12	6771725-02	1	0	0	0	0	0	0	0	0	0	0	

Figure 16: Top 10 Parts

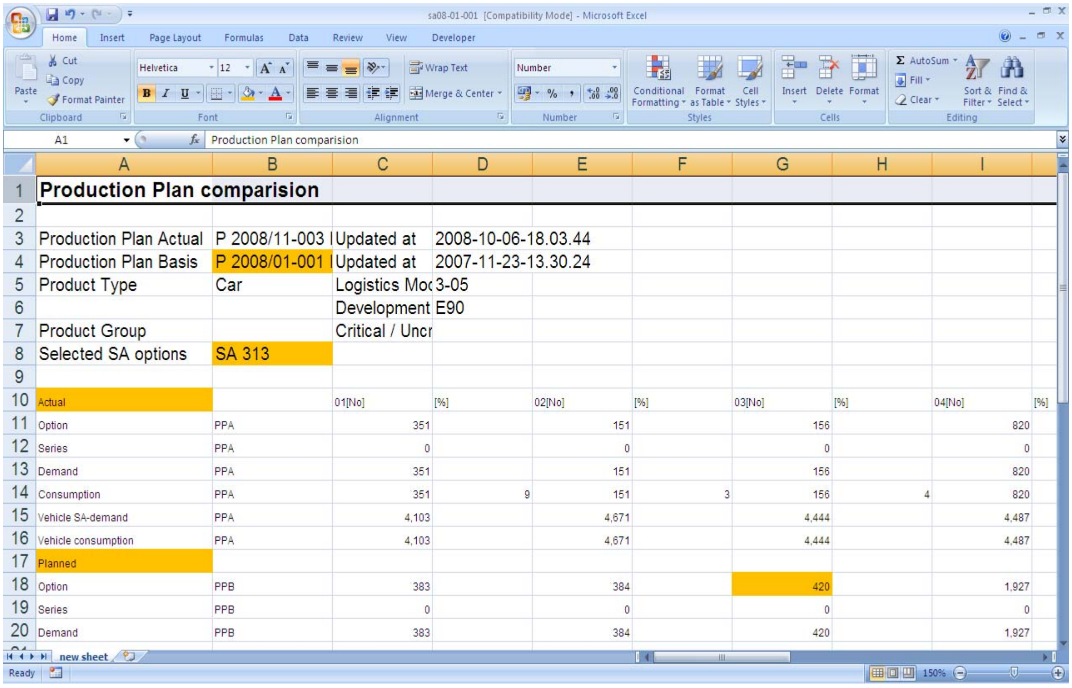
These two steps are repeated for all twelve months of the year. With the help of the vlookup function one can now search for the number of times a part number was air freighted in the year. If it was more than twice, it becomes a red part number.

All of the top 10 part numbers are then converted into the options in which they appear. These options must now be run on KAPRO web for the actual month as well as for two months before (planned). The differences between the planned and actual options are then determined and the option which caused the most changes are used in further calculations.



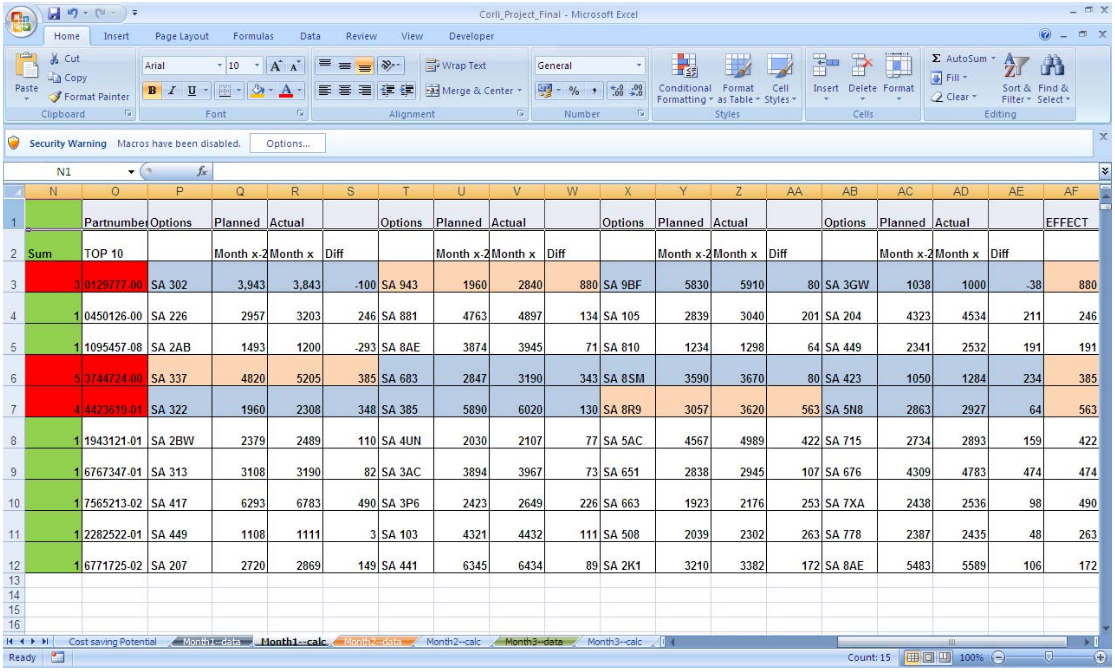
	A	B	C	D	E	F	G	H	I
1	**Production Plan comparision**								
2									
3	Production Plan Actual	P 2008/11-003 RP	Updated at	2008-10-06-18.03.44					
4	Production Plan Basis	P 2008/03-001 RP	Updated at	2008-01-25-12.09.07					
5	Product Type	Car	Logistics Model	3-05					
6			Development M	E90					
7	Product Group		Critical / Uncritic						
8	Selected SA options	S0313							
9									
10	Filter Master Data (Typ, Plant, Market)								
11	Actual		01[No]	[%]	02[No]	[%]	03[No]	[%]	04[No]
12	Option	PPA	351		151		156		8
13	Series	PPA	0		0		0		
14	Demand	PPA	351		151		156		8
15	Consumption	PPA	351	9	151	3	156	4	8
16	Vehicle SA-demand	PPA	4,103		4,671		4,444		4,4
17	Planned								
18	Vehicle consumption	PPA	4,103		4,671		4,444		4,4
19	Option	PPB	376		132		149		1,2
20	Series	PPB	0		0		0		

Figure 17: Data from KAPRO Web of Month3 and SA 313 (Actual)



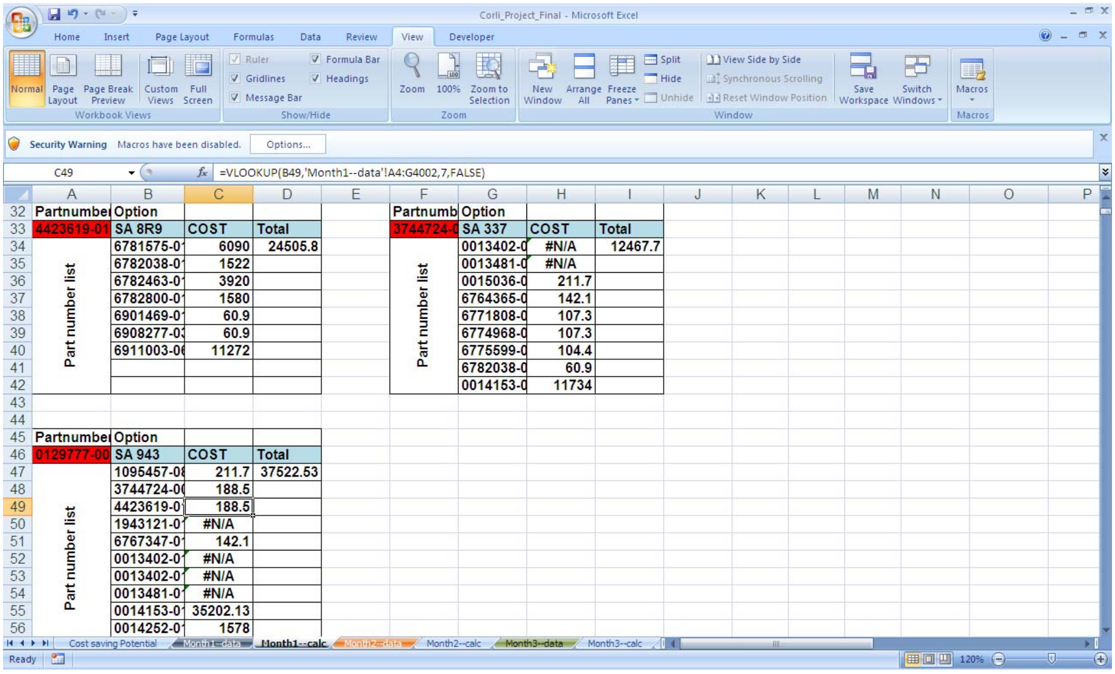
	A	B	C	D	E	F	G	H	I	
1	**Production Plan comparision**									
2										
3	Production Plan Actual	P 2008/11-003 I	Updated at	2008-10-06-18.03.44						
4	Production Plan Basis	P 2008/01-001 I	Updated at	2007-11-23-13.30.24						
5	Product Type	Car	Logistics Moc	3-05						
6			Development	E90						
7	Product Group		Critical / Uncr							
8	Selected SA options	SA 313								
9										
10	Actual		01[No]	[%]	02[No]	[%]	03[No]	[%]	04[No]	[%]
11	Option	PPA	351		151		156		820	
12	Series	PPA	0		0		0		0	
13	Demand	PPA	351		151		156		820	
14	Consumption	PPA	351	9	151	3	156	4	820	
15	Vehicle SA-demand	PPA	4,103		4,671		4,444		4,487	
16	Vehicle consumption	PPA	4,103		4,671		4,444		4,487	
17	Planned									
18	Option	PPB	383		384		420		1,927	
19	Series	PPB	0		0		0		0	
20	Demand	PPB	383		384		420		1,927	

Figure 18: Data from KAPRO Web of Month1 and planned for Month3 and SA 313 (Planned)



N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
	Partnumber	Options	Planned	Actual		Options	Planned	Actual		Options	Planned	Actual		Options	Planned	Actual		EFFECT
Sum	TOP 10		Month x-2	Month x	Diff		Month x-2	Month x	Diff		Month x-2	Month x	Diff		Month x-2	Month x	Diff	
3	0129777-00	SA 302	3,943	3,843	-100	SA 943	1960	2840	880	SA 9BF	5830	5910	80	SA 3GW	1038	1000	-38	880
1	0450126-00	SA 226	2957	3203	246	SA 881	4763	4897	134	SA 105	2839	3040	201	SA 204	4323	4534	211	246
1	1095457-08	SA 2AB	1493	1200	-293	SA 8AE	3874	3945	71	SA 810	1234	1298	64	SA 449	2341	2532	191	191
5	3744724-00	SA 337	4820	5205	385	SA 683	2847	3190	343	SA 8SM	3590	3670	80	SA 423	1050	1284	234	385
4	4423619-01	SA 322	1960	2308	348	SA 385	5890	6020	130	SA 8R9	3057	3620	563	SA 5N8	2863	2927	64	563
1	1943121-01	SA 2BW	2379	2489	110	SA 4UN	2030	2107	77	SA 5AC	4567	4989	422	SA 715	2734	2893	159	422
1	6767347-01	SA 313	3108	3190	82	SA 3AC	3894	3967	73	SA 651	2838	2945	107	SA 676	4309	4783	474	474
1	7565213-02	SA 417	6293	6783	490	SA 3P6	2423	2649	226	SA 663	1923	2176	253	SA 7XA	2438	2536	98	490
1	2282522-01	SA 449	1108	1111	3	SA 103	4321	4432	111	SA 508	2039	2302	263	SA 778	2387	2435	48	263
1	6771725-02	SA 207	2720	2869	149	SA 441	6345	6434	89	SA 2K1	3210	3382	172	SA 8AE	5483	5589	106	172

Figure 19: Processed data from options for month1



Partnumber	Option	COST	Total
4423619-01	SA 8R9	COST	Total
Part number list	6781575-0	6090	24505.8
	6782038-0	1522	
	6782463-0	3920	
	6782800-0	1580	
	6901469-0	60.9	
	6908277-0	60.9	
	6911003-0	11272	

Partnumb	Option		
3744724-0	SA 337	COST	Total
Part number list	0013402-0	#N/A	12467.7
	0013481-0	#N/A	
	0015036-0	211.7	
	6764365-0	142.1	
	6771808-0	107.3	
	6774968-0	107.3	
	6775599-0	104.4	
	6782038-0	60.9	
	0014153-0	11734	

Partnumber	Option		
0129777-00	SA 943	COST	Total
Part number list	1095457-0	211.7	37522.53
	3744724-0	188.5	
	4423619-0	188.5	
	1943121-0	#N/A	
	6767347-0	142.1	
	0013402-0	#N/A	
	0013402-0	#N/A	
	0013481-0	#N/A	
	0014153-0	35202.13	
	0014252-0	1578	

Figure 20: Cost of airfreight for red options

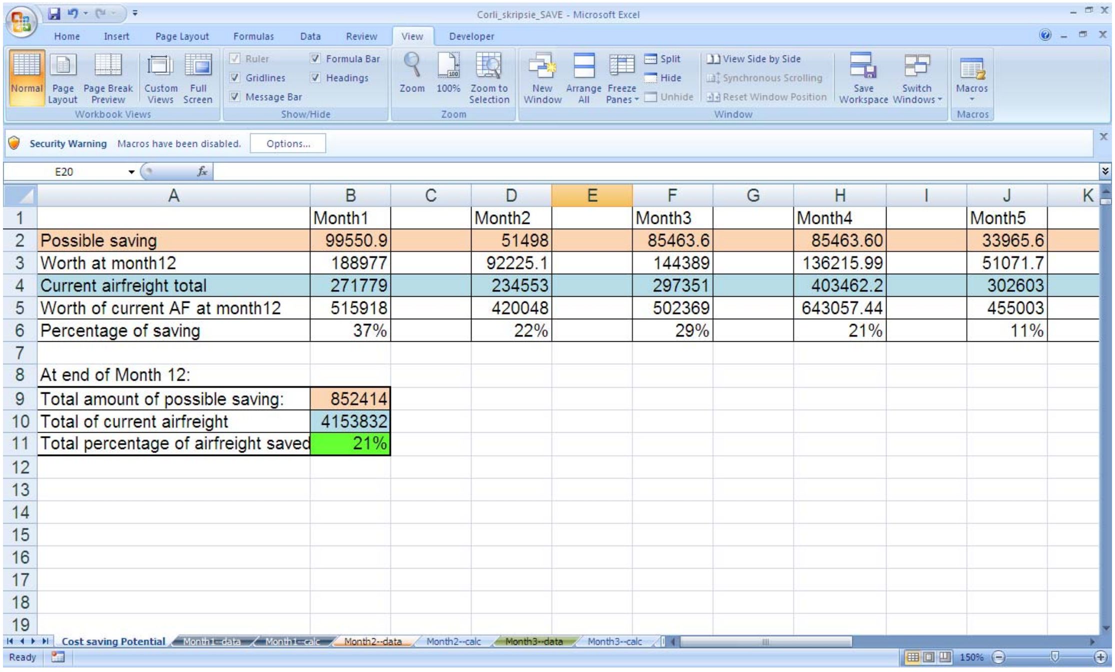
Chapter 5

RESULTS

The results that were obtained from the data analysis model is described in more detail in this chapter.

5 RESULTS:

5.1 Cost Saving Potential



	A	B	C	D	E	F	G	H	I	J
1		Month1		Month2		Month3		Month4		Month5
2	Possible saving	99550.9		51498		85463.6		85463.60		33965.6
3	Worth at month12	188977		92225.1		144389		136215.99		51071.7
4	Current airfreight total	271779		234553		297351		403462.2		302603
5	Worth of current AF at month12	515918		420048		502369		643057.44		455003
6	Percentage of saving	37%		22%		29%		21%		11%
7										
8	At end of Month 12:									
9	Total amount of possible saving:	852414								
10	Total of current airfreight	4153832								
11	Total percentage of airfreight saved	21%								

Figure 21: The potential cost saving if model is implemented.

Each month’s possible saving was determined and its future value at the end of month 12 was calculated. The total airfreight cost of each month was also determined and at the end of month 12 it could be said that:

- The total amount spent on airfreight is: R 4 153 832
- The total potential cost saving: R 852 141
- The total percentage of airfreight saved: 21%

Chapter 6

CONCLUSION AND RECOMMENDATIONS

This chapter concludes the project and describes the recommendations made by the author.

6 CONCLUSION AND RECOMMENDATIONS:

6.1 Conclusion:

From the information obtained from the data analysis model one can easily see which options the red areas are and this can be possible savings if it is managed well enough. The following recommendations are possibilities to manage these options. From the literature study the author had conducted the following recommendations can be made. In future this can become a new project to investigate exactly which method to use or a combination of them.

Each month has its own list of options that is a problem and can be investigated further to see for which market it was due and find out exactly what the reason for it was.

6.2 Recommendations:

6.2.1 Method 1

Extension of the frozen horizon

The first method and also the most radical possibility is to extend the frozen horizon of the production in order to get the opportunity to react to demand changes with regular sea freight shipments. Figure 22 shows the principal:

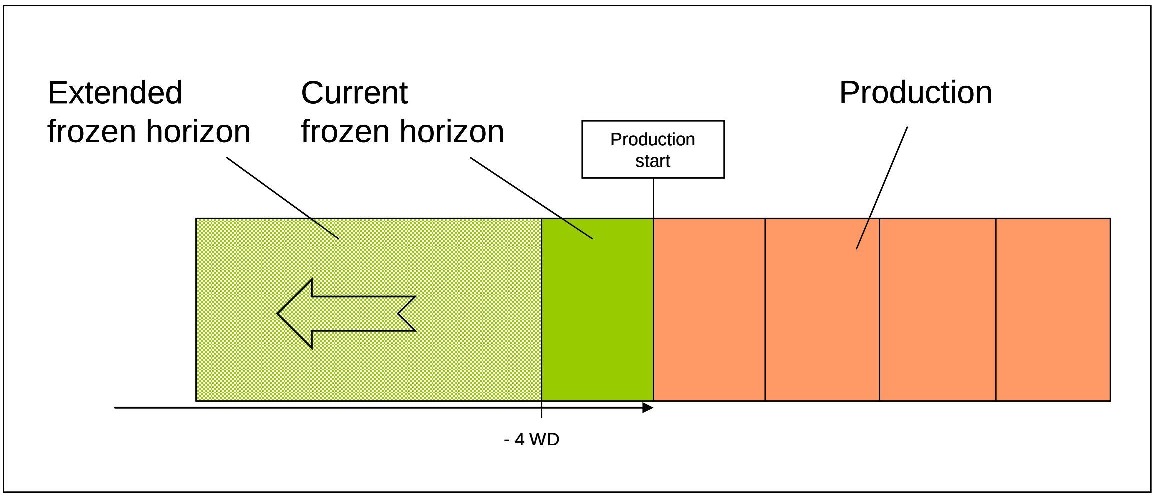


Figure 22: Process change method 1 – Extension of the frozen horizon

Before the implementation of this method it has to be proved if the saved costs are higher than the lost benefits.

6.2.2 Method 2

Extension of the frozen horizon for certain options

A medium radical possibility illustrates the second method that would disable changes of certain options by assigning them to an extended frozen horizon. This method would allow changes of the other options in the same dimension like it is done in the current process. The options with the extended frozen horizon cannot be changed after the fixing of the 5 weeks programme. Figure 5 shows the principal:

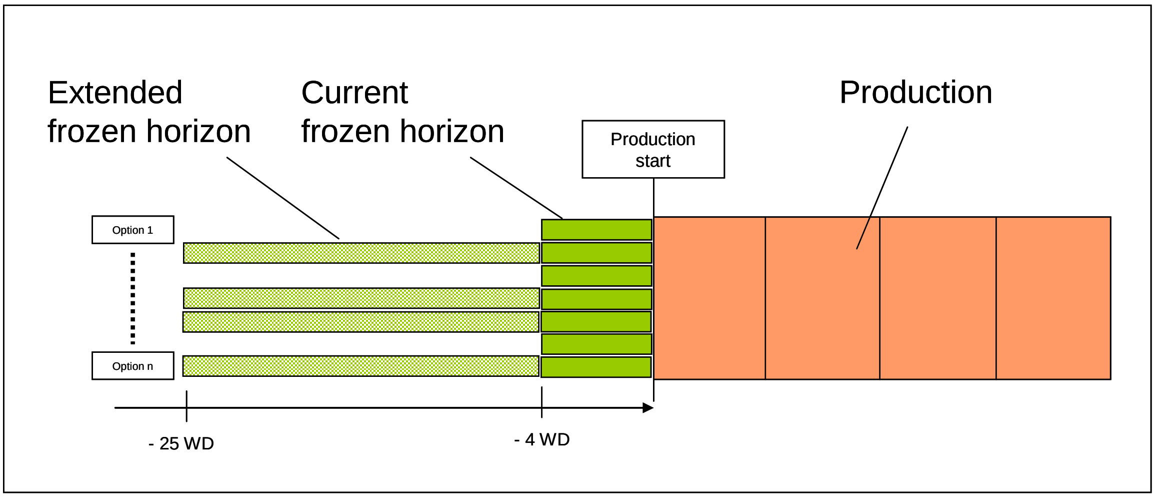


Figure 23: Process change method 2 – Extension of the frozen horizon II

This investigation tends to result in the assignment of options that cause low costs and are important for the dealer for the re-configuration, to the group of options with short frozen horizon. In contrast options that lead to high costs and are not often used for re-configurations will get the long frozen horizon.

6.2.3 Method 3

Introduction of rules and regulations

Method 3 illustrates a complete different approach, the changes at the demands creation process are not done in terms of the extension of the frozen horizons; instead a body of rules and regulations is defined to limit the changes done by the markets and dealers in order to set incentives. These incentives should avoid the observed influences of bad input and late communication which illustrate in total more than a quarter of the whole problem of the primary demand changes. Figure 6 shows the principal of method 3:

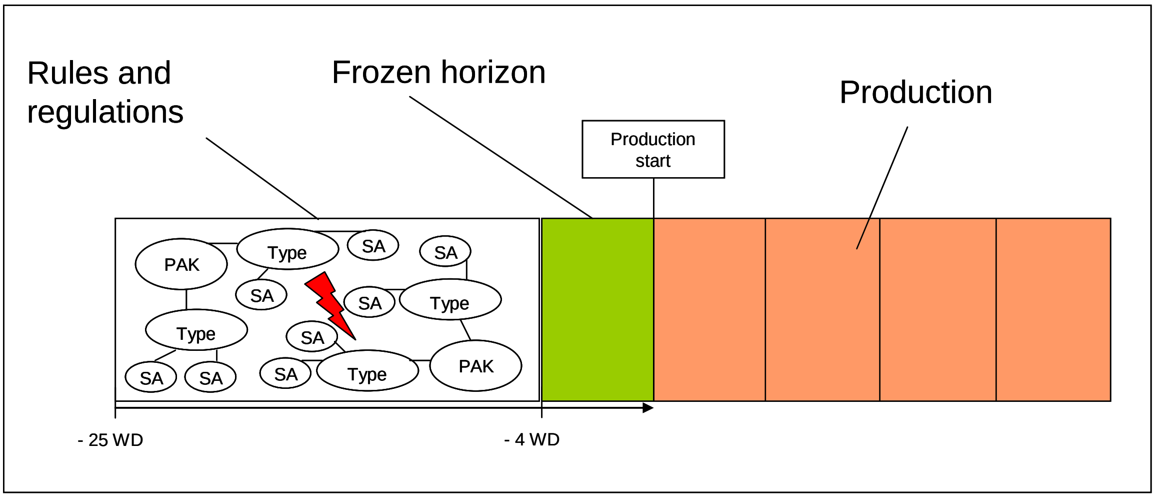


Figure 24: Process change method 3 - Introduction of rules and regulations

The third method illustrates a trade-off between the current state of the process and the first and second method. Method 3 tries to leave the frozen horizon and the vast spectrum of opportunities of order changes like they are by steering the changes to a zero-sum situation. The body of rules and regulations should ensure that if changes in the orders are done these changes equalize each other in total. The question of how to regulate in detail can revert to several tools and targets. [12]

Chapter 7

7 LIST OF REFERENCES:

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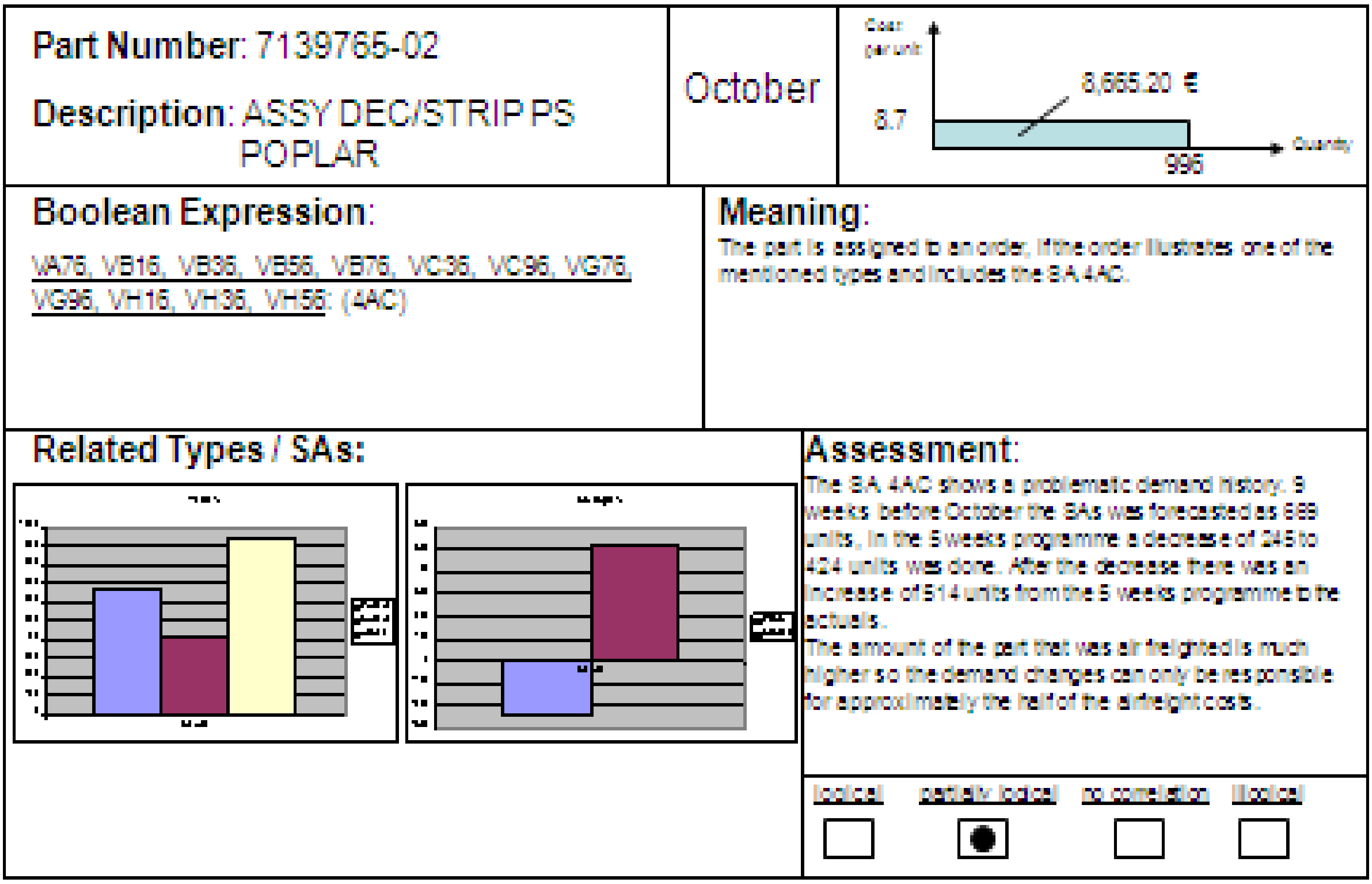
Chapter 8

8 APPENDICES:

Appendix A: Data of individual part that was air freighted in



Part Number: 7139765-02

Description: ASSY DEC/STRIP PS POPLAR

October

Cost per unit

8,665.20 €

8.7

996

Quantity

Boolean Expression:

VA76, VB16, VB36, VB56, VB76, VC36, VC96, VG76, VG96, VH16, VH36, VH56: (4AC)

Meaning:

The part is assigned to an order, if the order illustrates one of the mentioned types and includes the SA 4AC.

Related Types / SAs:

Assessment:

The SA 4AC shows a problematic demand history. 9 weeks before October the SAs was forecasted as 669 units. In the 5 weeks programme a decrease of 245 to 424 units was done. After the decrease there was an increase of 514 units from the 5 weeks programme to the actuals.

The amount of the part that was air freighted is much higher so the demand changes can only be responsible for approximately the half of the airfreight costs.

logical ☐ partially logical ● no correlation ☐ illogical ☐

SA-code	Description
S0 169	EU3 exhaust emission norm
S0 205	Automatic transmission
S0 217	Active Steering
S0 226	Sports suspension settings
S0 240	Leather steering wheel
S0 249	Multi-function for steering wheel
S0 255	Sports leather steering wheel
S0 2AB	Light-alloy wheel ellipsoid spoke 162
S0 2BF	Light-alloy wheel double spoke 154
S0 2BG	Light-alloy wheel double spoke 161
S0 2BH	Light alloy wheels double spoke 156
S0 2BW	Light alloy wheels double spoke 268
S0 2CX	Light-alloy wheels star spoke 155
S0 2CY	Light-alloy wheels star spoke 158
S0 2CZ	Light-alloy wheels star spoke 159
S0 2HB	Light-alloy wheels radial spoke 160
S0 2M0	Individual light alloy wheels V-Spoke 152 I, 18"
S0 2ME	M light-allow wheels double spoke 194 M
S0 2MF	M light-alloy wheels star spoke 193 M
S0 2PA	Locking wheel bolt
S0 2VB	Tyre pressure monitor
S0 2XA	Sports leather steering wheel with gearshift paddles and multifunction
S0 302	Alarm system
S0 313	Exterior mirror package
S0 319	Integrated universal remote control
S0 320	Model designation, deletion
S0 322	Comfort access system
S0 337	M Sports package
S0 354	Green stripe windscreen
S0 358	Climate comfort windscreen

S0 3AC	Trailer tow hitch
S0 3AP	Windscreen with grey shade band
S0 403	Glas roof
S0 415	Sunblind for rear window
S0 417	Sunblinds for rear side windows
S0 418	Luggage compartment package
S0 423	Floor mats, Velours
S0 428	Warning triangle
S0 430	Interior and exterior mirrors with automatic anti-dazzle function
S0 431	Interior mirror with automatic anti-dazzle function
S0 441	Smoker´s package
S0 449	Toll interior mirror for Japan
S0 459	Seat adjustment electric
S0 465	Through-loading system
S0 470	Child seat ISOFIX attachment
S0 481	Sports seats
S0 488	Lumbar support
S0 493	Storage compartment package
S0 494	Seat heating
S0 497	Centre armrest in rear
S0 4AB	Fine-wood trim burled walnut
S0 4AC	Fine-wood trim poplar grain
S0 4AD	Interior trim aluminium, finely brushed lengthwise
S0 4AE	Armrest fron, retractable
S0 4MG	Interior trim finishers aluminium glacier silver
S0 4NA	Interior mirror with digital compass
S0 4UA	Semi-electr. adj. both front seats
S0 4UN	Through-loading feature with integrated storage compartment
S0 502	Headlight washer system
S0 507	Park Distance Control
S0 508	Park Distance Control

S0 520	Foglights
S0 521	Rain sensor
S0 522	Xenon light
S0 524	Adaptive Headlights
S0 534	Automatic air conditioning
S0 540	Cruise control
S0 541	Active cruise control
S0 544	Cruise control with braking function
S0 548	Speedometer with kilometer reading
S0 563	Interior lights package
S0 5AB	Brake force Display, deletion
S0 5AC	High-beam assistant
S0 5DC	Folding rear-seat headrests
S0 5DS	Luggage-compartment emergency release
S0 5GA	Preparation anti-theft alarm system
S0 601	TV-Function
S0 602	On-board monitor with TV
S0 606	Navigation system business
S0 607	Teleservice preparation
S0 609	Navigation system professional
S0 620	Voice control
S0 633	Preparation for mobile phone Business with Bluetooth interface
S0 639	Complete preparation cellular phone USA/CND
S0 640	Car telephone preparation
S0 644	Preparation for mobile phone with Bluetooth interface
S0 645	Radio control US
S0 646	Car telephone preparation Japan
S0 651	MD player
S0 653	High Definition Radio
S0 654	DAB tuner
S0 655	Satellite tuner
S0 663	Radio BMW Professional

S0 672	CD changer
S0 676	HiFi loudspeaker system
S0 677	HiFi system Professional
S0 693	Preparation for satellite tuner
S0 694	Preparation for CD changer
S0 6AB	Control teleservices
S0 6FL	USB-/Audio interface
S0 6UD	Language Version Russian
S0 704	M sports suspension
S0 710	M leather steering wheel
S0 715	M Aerodynamics package
S0 735	Basic package
S0 752	Individual audio system
S0 760	Individual high-gloss Satin Chrome
S0 761	Individual sun protection glazing
S0 775	Individual roof-lining
S0 778	Door sills with BMW Individual designation
S0 7AP	Dynamic and advantage package
S0 7R7	Innovation package
S0 7RP	Advantage package
S0 7RR	Dynamic package
S0 7RS	Comfort package
S0 7SN	Navigation system business with cell preparation bluetooth
S0 7SP	Navigation system professional with cell preparation bluetooth
S0 7XA	M leather steering wheel with gearshift paddles and multifunctions
S0 807	Japanese version
S0 810	Australian version
S0 818	Battery master switch
S0 823	Hot-climate version
S0 833	Singapore version

S0 838	Canadian version
S0 842	Cold climate version
S0 845	Acoustic seat-belt warning
S0 850	Additional fuel tank filling
S0 851	Language version German
S0 852	Language version Japanese
S0 853	Language version English
S0 854	Language version French
S0 855	Language version Italian
S0 856	Language version Spanish
S0 863	Europe dealer directory
S0 864	Overseas / dealer directory
S0 866	Language version simplified Chinese
S0 867	Language version Korean
S0 868	Language version Dutch
S0 874	Radio-frequency 434 MHz
S0 876	Radio frequency 315 MHz
S0 877	Deletion Cross-over operation
S0 879	German owner’s handbook / service booklet
S0 880	English owner's handbook / service booklet
S0 881	French owner's handbook / service booklet
S0 883	Spanish owner's handbook / service booklet
S0 884	Italian owner's handbook / service booklet
S0 885	Swedish owner's handbook / service booklet
S0 886	Dutch owner's handbook / service booklet
S0 887	Arabian owner's handbook / service booklet
S0 888	Danish owner's handbook / service booklet
S0 889	Portuguese owner's handbook / service booklet
S0 892	Chinese simplified
S0 896	Daytime lights function
S0 8AE	Greek owner’s handbook / service booklet
S0 8AF	Korean owner’s handbook / service booklet
S0 8LH	Country control 04142

S0 8S7	Fleet cars without TV function
S0 8SD	Underride guard countries
S0 8SL	Preparation for trailer tow hitch
S0 8SM	Vin, visible from outside
S0 925	Shipment protection package
S0 938	Managed via ZS individual series
S0 948	Core model package V5-KA
S0 953	Taiwan package
S0 957	HK package
S0 962	Number plate holder front
S0 977	Exclusive line
S0 992	Number plate attachment management
S0 9AA	Protection car body shell
S0 9AB	External skin protection, deletion
S0 9BE	Motivation package
S0 9BF	Navigation package

In a discussion with the manager of the Material Planning department the following SAs are identified as not relevant for the parts stage and because of this not included in the analysis:

SA-code	Description
S0 1CA	Selection of COP relevant vehicles
S0 612	BMW Assist
S0 616	BMW Online
S0 6AA	BMW Tele Services
S0 6UE	Anti-theft security system for navigation DVD
S0 6UH	Traffic information
S0 825	Radio control Oceania
S0 840	High speed synchronisation
S0 861	Change of coding data set
S0 8LS	Country control 00780
S0 8S2	Coding of alarm signal

S0 8S3	Automatic lock when driving away
S0 8SX	Provider assignation for telemetric and online services
S0 983	Model year, export
S0 984	Coding service interval
S0 986	Deadline check