Rearrangement and Development of the Procurement of Supply Parts with Focus on the Reduction of Delivery Times by the Suppliers of Flender Ltd., Adaptation of Stock Level and According Cost Reduction within the Supply Chain

Gruppen-Diplomarbeit

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Diplomarbeit

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Themensteller:	Flender Power Transmission Tianjin Co., Ltd. P. R. China	**Ausgabe der Arbeit:**	31. Mai 2002
Betreuer:	Herr Chen	**Abgabetermin:**	31. August 2002

Kurzthema: (*Formulierung, die auf das Zeugnis übernommen werden kann.*)

"Development of the procurement management with focus on quality with Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China."

Inhaltliche Anforderungen/Zielstellung:

- Analysis of current and potential supply sources focusing on DIN-/norm parts.
- Development and implementation of a reference model für evaluation of suppliers.
- Development of communication channels used between Flender and its suppliers for exchange of procurement needs.
- Development of suppliers.
- Implementation of a reference model for quantity oriented procurement.

Als Teil A zur Gruppendiplomarbeit (mit Herrn Falk Ueberschär, L2/98) zum gemeinsamen Hauptthema:

Rearrangement and development of the procurement of supply parts with focus on the reduction of delivery times by the suppliers of Flender Ltd., adaptation of stock level and according cost reduction within the supply chain with the company Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.

Konsultationen: nach Vereinbarung mit dem betreuenden Hochschullehrer

Bemerkung: Die Diplomarbeit wird in englischer Sprache angefertigt.

Wildau, den 15.05.2002

Hochschullehrer	Vorsitzender des Prüfungsausschusses	Student

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Betreuer:	Herr Chen	**Abgabetermin:**	31. August 2002

Kurzthema: (*Formulierung, die auf das Zeugnis übernommen werden kann.*)

"Development of the process chain focused on the reduction of delivery times with Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China."

Inhaltliche Anforderungen/Zielstellung:

- Analysis of main final product structure, information flow, material flow, quality management.
- Identification of weak points and succeeding potential for optimization within the logistics and process chain based on DIN-/norm, inner geared and other parts.
- Development of a reference model for the planning of supply requirements concerning supply quantities and times.
- Analysis of problems with project oriented procurement, e. g. forecast probability and disadvantages.

Als Teil B zur Gruppendiplomarbeit (mit Herrn Jörg Büchting, W1/98) zum gemeinsamen Hauptthema:

Rearrangement and development of the procurement of supply parts with focus on the reduction of delivery times by the suppliers of Flender Ltd., adaptation of stock level and according cost reduction within the supply chain with the company Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.

Konsultationen: nach Vereinbarung mit dem betreuenden Hochschullehrer

Bemerkung: Die Diplomarbeit wird in englischer Sprache angefertigt.

Wildau, den 15.05.2002

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I) Subject

Joint Subject of the Diploma Thesis:
“Rearrangement and development of the procurement of supply parts with focus on the reduction of delivery times by the suppliers of Flender Ltd., adaptation of stock level and according cost reduction within the supply chain with the company Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.”

Theme of Part A:
(Jörg Büchting)
“Development of the procurement management with focus on quality with Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.”

Theme of Part B:
(Falk Ueberschär)
“Development of the process chain focused on the reduction of delivery times with Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.”

II) Bibliographic Description and Section

Ueberschär, Falk and Büchting, Jörg

Rearrangement and development of the procurement of supply parts with focus on the reduction of delivery times by the suppliers of Flender Ltd., adaptation of stock level and according cost reduction within the supply chain with the company Flender Power Transmission (Tianjin) Co., Ltd. in the P. R. China.

Diploma Thesis, University of Applied Sciences Wildau 2002,
Including 180 pages, 30 diagrams, 50 tables, 49 bibliographical references, 3 annexes.

Aim:

Rearrangement of the current logistics and purchase processes at a German based Wholly Foreign Owned Enterprise in the P.R. China. The producer of gear units for the Chinese Market faces strong competition due to his long delivery times for final products and an inefficient procurement management. One of the main topics of this thesis in the context of the rearrangement of procurement and local sourcing is the establishment of a Buying Center.

Content:

- Analysis of the product portfolio, information flow, material flow, as well as quality management.
- Identification of weak points and succeeding potential for optimization within the supply chain based on DIN-/norm supply parts.
- Development of a reference model for the search and evaluation of suppliers within the P.R. China, especially in regard to DIN/norm supply parts.
- Development of a reference model for the planning of supply requirements concerning supply quantities and times as well as the establishment of communication channel between Flender Tianjin and its suppliers.
- Implementation of a reference model for quantity oriented procurement and
- Analysis of problems with project oriented procurement, e.g. forecast probability and disadvantages.

III) Declaration of Independence (Selbständigkeitserklärung)

Wir erklären hiermit, daß wir die vorliegende Diplomarbeit selbständig angefertigt und nur die angegebenen Quellen und Hilfsmittel verwendet haben.

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Die Abschnitte 2.3., 2.7., 3.1., 3.2., 3.3., 4.1., 4.2., 5.2. [Part A] wurden von Jörg Büchting und die Abschnitte 2.1., 2.2., 2.4., 2.5., 2.6., 3.4., 3.5., 4.3., 5.1., 5.3. [Part B] wurden von Falk Ueberschär angefertigt.
Die Einleitungen zu den einzelnen Kapiteln sowie Kapitel 1 (chapter 1) und Kapitel 6 (chapter 6) wurden gemeinsam erarbeitet.

Die Arbeit hat in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen.

Wildau, den 24.07.2002 Jörg Büchting Falk Ueberschär

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List of Abbreviations and Formula Symbols

A	expected cost for non-quality (Taguchi's loss function)
α_{Cyc}	α-Service level (per cycle)
α_{Per}	α-Service level (per period)
ASP	absolute savings potential
avg.	average
β	β-Service level
B	balanced scrap costs (Taguchi)
BEDA	Beichen Economic Development Area (Tianjin)
C	medium-term cyclical fluctuations (economic cycle) of a time series
c	acceptance number (single sampling)
cons.	consignment
CIP	Continuous Improvement Program
C_{ord}	order costs for one order
CS3	Client Server 3 (the ERP system used at FTJ)
C_w	Warehousing costs per unit of quantity / of time
δ	resulting deviation from target value in case of balanced scrap costs
d	number of faulty parts
DHL	Name of a logistics express service company
DIN	Deutsches Institut für Normung e.V.
DP	data processing
E	expected value
e_t	forecast error
EDI	Electronic Data Interchange
EFQM	European Foundation for Quality Management
ERP	Enterprise Resource Planning
ExW	Ex Works (INCO-TERM)
FSG	Flender Standardgetriebe (English: Flender standard gear unit)
FTJ	Flender-Tianjin (= Flender Power Transmission (Tianjin) Co., Ltd.)
FTJ-logistics	Logistics department of Flender-Tianjin
FZG	Flender Zahnradgetriebe (engl.: Flender gear unit)
γ	γ-Service level
GDP	Gross Domestic Product
GmbH	Gesellschaft mit beschränkter Haftung (English: PLC)

List of Abbreviations and Formula Symbols (continuation)

HF	half finished
I	irregular fluctuations (irregular component) of a time series
ISO	International Organization for Standardization
JV	Joint Venture
K	average consequence cost
L(Y)	loss function
l_c	critical level
L_{PA}	maximum noise level
LTL	Lower Tolerance Limit
m	expectancy value
max.	maximum
MGM	Material Group Management
min.	minimum
N	Quantity of a lot (sampling plans)
n	random number of chosen parts (single sampling); all possibilities
OEM	Original Equipment Manufacturer
OF	order frequency
p	process average; probability (of an event)
p.	page
p_t	prognosis result
pp.	ongoing pages
PPC	Production Planning and Control (German abbreviation: PPS)
P.R. China	People's Republic of China
P.R.C.	People's Republic of China
q	Re-order quantity
q_o	optimal re-order quantity
qty.	quantity
r	rejection number (double sampling)
RMB	RenMinBi (current exchange rate: 1.0 € = 7.5 RMB)
RQP	responsible quality person
RSP	relative savings potential
S	replenishment stock quantity;
s	buffer stock
σ	mean deviation sigma

List of Abbreviations and Formula Symbols (continuation)

SCM	Supply Chain Management
sh.	share
sp	sourcing priority
SPGN	supply part group name
δ	deviation from target value (Taguchi's loss function)
T	long-term trend of a time series
t	time interval of the length t (stockkeeping policies); period
t_D	delivery time
TA	technical appendix (attachment of a customer contract)
t_f	firm control period
t_{rp}	firm re-order period
U.S.A.	United States of America
UTL	Upper Tolerance Limit
v	variance
VAP	Value-Adding-Partnership
VAT	value-added tax
WFOE	Wholly Foreign Owned Enterprise
x	demand (requirement) per unit of time; average demand
x_i	event with the characteristic i
x_{RL}	re-order level
x_{RPQ}	replenishment quantity
Y	dimension (Taguchi's loss function)
y_t	actual observed result of a time series

1. Introduction to the Problem

On May 5th, 1899 Alfred F. Flender founded a company for the manufacturing and sales of wooden pulleys in Düsseldorf (Germany). With its long history of over 100 years the name **Flender** stands for quality when you say 'Made in Germany'. The company produces high quality gear units and gear boxes using special Flender designed and produced inner geared parts.

By the year 1986, the Flender-group established their first contacts with Chinese customers via local agents. Since the opening of its 'wall' towards the western world in 1979, the P.R. China has continually strengthened its position on the world market. With 1.3 billion inhabitants, the P.R. China achieved a GDP of about 9.58 trillion RMB in 2001 with a current a growth rate of over 7%. In economic terms the P.R. China ranks sixth in the world and foreign investments for the P.R. China play a mayor role in the development process and have reached US$46 billion[1].

For Flender, with its subsidiaries around the world[2] (here 'Flender-group'), it had been a logical step to be present, explore and invest in this market. In 1997 the Flender-group established a production plant at the 'Beichen Economic Development Area' in Tianjin (Flender Power Transmission Co., Ltd. here "FTJ"). FTJ is a Wholly Foreign Owned Enterprise (WFOE). This allows the company to act individually without any local partner, as it is necessary in a Joint Venture.

Tianjin City is one of the major industrial cities in the P.R. China. In 2001, its GDP increased 12%, ranking top in the country. Tianjin is second place, after Shanghai, regarding its gross value of industrial output, which reached 285.8 billion RMB in 2000.[3]

The plant of FTJ was planned and build as an extended workbench of Flender-Germany. The idea behind it was to produce goods with lower labor costs. It is fairly well known that the procurement, treatment and production of certain goods in the P.R. China can be done at reduced cost levels compared to German production facilities. Therefore Flender-group has decided to use FTJ as a production site for casting products. From the FTJ financial year

1 Chinaweek, 1st February 2002, p. 69, the figures account for the year 2001

2 Flender-group is currently present on every continent. Flender-China with 89mil€ turnover is ranking second in the Flender-group behind Flender-Germany with 334mill€ turnover in the year 2001. In the last financial year the Flender-group has manufactured a total of 42,000 gear units and geared boxes.

3 see Information Office of Tianjin Municipal Government: "The record of actual events in Tianjin-2002", 2002

1998/99 on, the focus of the assembly shifted towards final gear boxes[4], a change which brought Flender-China closer to the local market requirements in Asia.

Regarding market price level for gear units, diagram 1.-1 shows that FTJ holds a strong position compared to its competitors in the P.R. China:

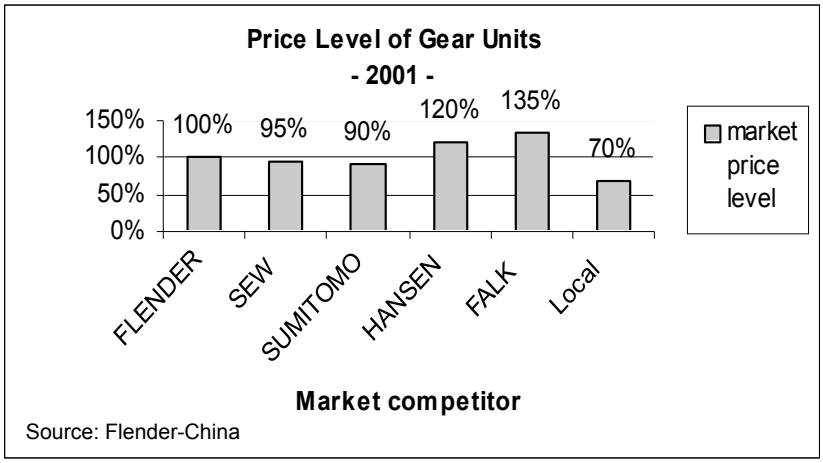

Diagram 1.–1: Price level of gear units in the P.R. China

Besides the price, another major concern for customers is on-time delivery on a specified date. In this case, Flender-China and FTJ are currently not able to satisfy the requirements of local customers for the delivery of final products. The current situation is different from the promised delivery time at Flender-Germany. So far Flender-China can keep and satisfy its customer only through project orientation procurement[5]. The result of the market survey in diagram 1.-2 carried out by Flender-China shows the current delivery time for gear units of FTJ compared to its strongest competitors.

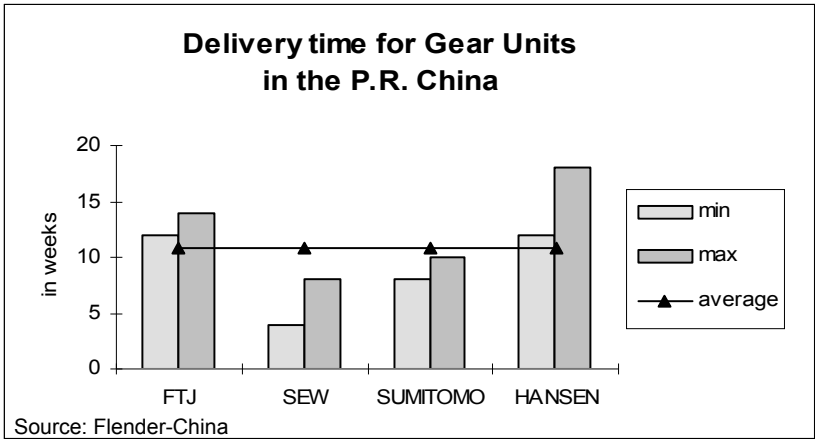

Diagram 1.–2: Delivery time of FTJ and its competitors

The two competitors with a faster delivery time, SEW and Sumitomo, have a local production facility such as FTJ. According to customer orders the competitor Hansen is still sourcing all final gear units from Europe. In addition to these main competitors for FZG, Flender-China faces up to 200 competitors for some of the final products of the Flender product range.

4 FTJ still produces finished casting products for Flender-Germany. The final decision to continue with production or to totally focus on the assembly of gear units and boxes is still not made by the board of directors.

5 Flender customers often plan and order the required quantity of gear units and gear boxes months in advance. This makes it possible to prepare the partlist for final assembly and to order the required supply parts from Flender-Germany and also from local suppliers.

Despite the high quality of all Flender products, Flender-China fears growing competition from each of its competitors on the Chinese market. With a decrease of current delivery time, an improved customer service and increased production output, FTJ would be able to keep or increase its market share. According to its biggest competitor SEW, FTJ faces three main challenges on the market of the P.R.C.:

1. Prolongation of the guarantee period for final products from 12 (FTJ) to 18 months,
2. Reduced delivery time of c. 6 weeks (SEW) compared with c. 13 weeks (FTJ) and
3. A functioning and flexible 24h after-sales service (currently not offered by FTJ).

The challenge of longer guarantee periods is mainly a question of product quality offered by FTJ, but a reduced delivery time and a 24h after-sales service depend on a great part on the availability of the respective supply parts. In a growing market like mainland China the price of a product is not the most important selling argument[6] as the focus of the customer rather lies on quick delivery time, high quality and an effective after sales service. Now, FTJ has to tackle all three challenges, otherwise it will steadily fall back in comparison with its biggest competitor SEW. For not doing so the current procurement strategies have to be reviewed.

The decision to open up a production plant in Tianjin had been a strategic decision spearheading a globalization process for the Flender-group. Unfortunately, the Flender-group lost its first strong efforts to adapt to the market situation in the P.R. China. This loss can easily be seen by the relatively low involvement of all organizational units and in the slow updating of processes throughout the whole company. The well-known guiding motto “think global - act local” and its commitment to the Chinese market needs to be newly reiterated within the Flender-group. The main effort should be on production, procurement and logistics processes, which should be standardized and should receive global support throughout the Flender-group.

The final products of FTJ can be roughly divided into two groups a) finished gear units, which are only assembled in FTJ, and b) casting parts, made of delivered raw castings. Casting parts can again be told apart into 1) housings and 2) HF-parts.

There has been an enormous shift of importance from finishing of castings, with 80% of total turnover of FTJ in 1998/99, to gear units counting now for 80% of total turnover in the financial year 2001/02. As the Chinese market for gear units continues to grow strongly, FTJ is now focusing mainly on the manufacturing of gear units.

Without any change over the years, about 70% of all supply parts for the assembly of gear units come from Flender-Germany. The supply parts from Germany can be grouped into: (1) DIN/norm parts, (2) inner geared parts and (3) other parts. 30% of the parts for the assembly of

6 This fact has been realized during a talk with an important customer of FTJ in Beijing.

gear units are produced internally at FTJ, sourcing raw material and unfinished parts from local suppliers. For castings it can be stated that from the beginning on the great majority of supply parts have been sourced locally in the P.R. China, with only a small percentage share coming from Flender-Germany, which has been further decreased over the years in favor of local supply.

For the shift of sourcing from German to local Chinese supplier, FTJ currently further develops its procurement management. Past quality problems with supplied parts and structural problems in the P.R. China have still impeded FTJ from sourcing supply parts locally. The benefit analysis, the search for new suppliers and the development of local sourcing for DIN/norm parts, should currently be the main focus within the company. For inner geared parts, which are relatively high value parts and which are more difficult to produce than DIN/norm parts, it is unsure as to whether there are Chinese suppliers able to provide the required quality. Hence there will be no shift to local suppliers in the near future. Other parts for the assembly of Flender gear units are not actively taken into consideration at the moment.

So the **first main field of problems** for FTJ is the procurement of supply parts from Germany. Currently about 70% of all transports are realized by ship. This kind of transportation can reduce the transport costs, but results in a longer total transport time. For FTJ the supply of parts from Germany takes about 42 calendar days[7], including four weeks on sea. For urgent consignments airborne transport with a transport time of up to 9.5 days is used leading to high transport costs.

It has long been known by merchants all over the world, that long replacement times are the general reason for big and thereby expensive stocks. “With the invention of the telegraph in 1837, the information flow could be speeded up tremendously for the first time in history - even over very long distances. Before the telegraph, Australian companies had to carry large stocks because the only way to order from England was to send a letter by sea. But once the first telegraph connection between Australia and England opened, businesses such as Prince, Ogg and Co, a soft-goods firm in Sydney, were able to cut their stocks by more than half.”[8]

This small historical story leads to the **second main field of problem** with FTJ: the discontinues and partly disrupted information flow or even the lack of any information, for example lack of statistical data for the production output, lack of clear goals and even lack of success indicators.

As the information flow is not properly managed at FTJ, but needed to control the complex material flow, there often is either an prolongation of supply time or an increase of transport

7 42 days is the average transport time from ExW Flender-Penig to FTJ via sea. The indicated transport times for airborne transport and DHL services are also based on the relation ExW Flender-Penig and arrival at FTJ.

8 see The Economist: “A survey of the real-time economy”, p. 4, 2nd February 2002

costs or both, an unclear stock level and an unclear stock content, which has to be assured physically by the stockkeeper. As both problem areas are interconnected with each other a solution has to consider both in the current context of the situation.

According to these problems, this thesis covers three main topics:

- Analysis and reorganization of the procurement process of supply parts from Germany,
- Reduction of material cost and supply time at a high quality level with contracting local supplier,
- Reorganization of the internal and external information flow.

To reach a competitive level of delivery time of its final products, FTJ has to optimize its processes. The aim of this thesis is to provide detailed improvement suggestions based on the potential for the reduction of supply time and the requirements of the customers.

Chapter 2 will analyze the current situation at FTJ with focus on procurement and production output quantities. The current situation at Flender demands the search for new suppliers in the P.R. China. Feasibility, potential cost savings and requirements for new local supplier will be the topic of chapter 3. Chapter 4 will focus on how to set internal quality standards and logistic requirements for suppliers and how to implement and communicate changes. Chapter 5 gives recommendations and feedback for the rearrangement of the procurement management at FTJ that includes the introduction and improvement of a Quantity Oriented Procurement.

2. Current Management of Procurement

Until today, every delivery of supply parts for the assembly at FTJ starts with the receipt of a customer order, which has been sent to FTJ from Flender-Sales offices all over the P.R. China.

For Flender-Sales in Beijing, where the main sales and marketing department of the Flender-group in the P.R. China is located, two options are possible for arranging the customer orders. Either final products are purchased directly from Germany or the order is placed with FTJ. Currently, procurement of final products directly from Flender-Germany can lead to shorter lead-times than sourcing the same final product from FTJ since in FTJ the time for final assembly of the supply parts needs to be added to the transportation time of the supply parts from Germany.

The Flender-group, and especially Flender-Beijing, does not place enough effort for the support of FTJ. This can be seen by the provision of sales forecast which is not adapted to needs of FTJ. The information process between FTJ and Flender-Beijing as the sales department in Beijing can therefore be called 'disturbed'. Until today, only a few steps have been implemented to improve the overall relation between both parties. One major step is the 'weekly Monday meeting' where sales and marketing managers from Flender-Beijing meet at the logistics department in FTJ, in order to exchange current delivery times for supply parts procured from Germany.

Chapter 2 analyzes the current situation of procurement and logistics at FTJ. This includes an ABC analysis of FZG supply parts. Further analyzes include the cost structure of the current Procurement Management, of the information flow and of the quality management at FTJ to provide a starting point for reorganization and suggestions for improvement that will contribute to this thesis.

2.1. Analysis of Main Products [Part B]

2.1.1. Products Produced at Flender-Tianjin

The products produced at Flender-Tianjin[9] constitute a certain section of the whole product range of the Flender-group. As mentioned before there are a) gear units and b) finished castings. FTJ currently focuses on the FZG type of gear units as in this product group lays the greatest potential for rearrangement of procurement. As within the product group of gear units FZG supply parts count for the majority of different parts used this thesis will especially focus on FZG gear units. Finished castings will not be taken into consideration.

There exist four types of gear units which are produced at FTJ: CAVEX, FZG (FSG[10]), MOTOX and PALMOIL. The following table 2.1.-1 gives an overview:

9 There exists only one production site of the Flender Power Transmission (Tianjin) Co., Ltd.

10 FZG is sometimes abbreviated as 'FSG'.

Table 2.1.-1: Product groups and final products at Flender-Tianjin

Gear Unit Group	Final Products	Ratio Range	Used Part Lists	Description
CAVEX	CRW160, CG19, CG26-112, CG26-135	medium (21.5 to 47.14)	c. 1	Worm helical gear unit (for escalators, elevators)
FZG	Series H/B, others[11]	great (1.25/5 to 450)	c. 400[12]	Flender gear unit (e.g. conveyor drives)
MOTOX CLP[13] (MOTOX N)	No indication	No indication	No indication	Helical gear units (for slow-running machine applications)
PALMOIL	H3SH10, H3SH11, H3SH12, H3SH13	Small (56, etc.)	> 10[14]	Gear unit with split housing (for slow-running machine applications which need great power)

Of the CAVEX final products 55% are currently used for the production of FZG or PALMOIL with the rest being sold to German customers. CAVEX, MOTOX and PALMOIL are not directly analyzed in this thesis, since this would go beyond the time available. It has to be added that MOTOX is under special management responsibility within the Flender-group and PALMOIL is totally separated throughout the procurement and production process at FTJ, because it belongs financially 100% to Flender-Germany.

2.1.2. The Structure of the Main Products

As the exact structure of each finished final product differs, the explanations given here are based on FZG gear units. In order to deliver a gear unit, which is adapted to the customer needs, the customer has to choose (1) the type of gear unit, which can be ‘Helical gear unit’ or ‘bevel-helical gear unit’, (2) the number of stages, (3) the input shaft design, (4) the mounting position and (5) the size of the housing. The greatest difference between gear units originates from the chosen type.

For efficient customization of its gear units, FTJ uses a modular construction system, which has led to a reduction of the variety of supply parts required for production.

By that all gear units consist of the same construction elements, but according to the customer need the number of construction elements and the specific type of certain supply part varies.

11 Other series are up to now only produced in small number of pieces and are hence not considered.

12 In the financial year 2000/01: c. 300.

13 In June 2002 there has been a change from MOTOX CLP to MOTOX N. MOTOX CLP will not be produced any more.

14 There have only been used about 10 part lists since May 1999.

In general, a gear unit consists of ‘casting parts’ and of ‘inner parts’. The following ‘casting parts’ are necessary: one housing, or sometimes multiple housings like for a PALMOIL, the approximate number of covers for the housing(s) and added parts for the housing(s). All other parts are called ‘inner parts’ and can be grouped into DIN/norm parts, inner geared parts and other parts.

2.1.3. Definition of DIN and Norm Parts

DIN-parts are parts, which are standardized by a DIN-standard valid within Germany. Usually these parts are widely used for industrial products, e.g. screws, nuts, etc.
Norm[15] parts are understood as parts standardized by a Flender factory standard. These standards deal with parts, standardized by Flender and its employees according to a certain product, e.g. a dipstick. Norm parts are not compulsory included in a DIN-standard, but can be derived from the later.

2.1.4. Definition of Inner Geared Parts

Inner geared parts are all parts within a gear unit, which show a running gearing, e.g. a helical wheel or a bevel wheel.

2.1.5. Other Parts

Other parts are understood to be parts, which are neither DIN/norm parts nor inner geared parts.

2.1.6. Importance and Role of Raw Material

In fact FTJ has no need of real raw material, like steel logs, etc., but nonetheless there are ‘supply parts’ which arrive unfinished at FTJ and hence are called ‘raw material’. It has to be distinguished between unfinished raw material, which are in fact sourced casting products, and ‘half finished raw material’, which are made out of unfinished raw material being housing and parts. The later are for example used for the assembly of gear units.

2.1.7. ABC Analysis of FZG Supply Parts

In regard to the capital tied-up, the necessary monitoring efforts and the warehouse strategy of FTJ it is very important to figure out which supply parts for FZG gear units are the most important according to their value, hence their purchase price, and their quantity. An ABC analysis is a standard option to answer this question. This subchapter surveys the results of the

15 In this thesis the term *norm* is used instead of the term *standard* since the former is used throughout the Flender-group.

ABC analysis realized a) for all supply parts and b) for DIN/norm supply parts (as sub set of all supply parts) of FZG gear units[16].

In the beginning the quantity share of each ABC type in relation to the sum of the ordered supply parts has to be defined[17]. It is defined that type A supply parts represent up to 20%, type B supply parts up to 25% and type C supply parts the remaining quantity share, hence at least 55%[18]. The existence of different models per supply part group[19] makes it necessary to consider each single supply part model separately for the analysis.

Normally ABC types can be defined by two criteria: value and replacement period. As currently all supply parts for FZG gear units are sourced from the same supplier and as no indication for differences in the replacement period has been available, only the value criterion has been used.

The **goal** for the realization of a ABC analysis was to **find out the respective value limits** for which the sum of the quantity shares of all models within each part type match the above stated quantity shares[20].

Results of the ABC Analysis of All Supply Parts

The following table 2.1.-2 shows the results for all supply parts:

Table 2.1.-2: ABC analysis of all supplied parts for FZG gear units at FTJ

Type	Supply part value >=	Quantity of ordered supply parts	Quantity share	Value (RMB)	Value share
A	33.58 RMB	25,743	19.99%	14,259,590.99	96.34%
B	4.62 RMB	31,933	24.80%	458,945.75	3.10%
C	0.00 RMB	71,106	55.21%	82,856.42	0.56%
Total		**128,782**	**100.00%**	**14,801,393.16**	**100.00%**

The result of the ABC analysis is astonishing: 19.99% of all supplied parts represent a value share of 96.3% if an A-part has to have at least a value of 33.58 RMB. In comparison with a standard result of an ABC analysis, where A-parts represent 70% – 75% and B-parts 20% – 25% of the total value, the **value share of A-parts is far too high** and the value shares of B- and C-parts are accordingly far too low revealing a very high value concentration for A-parts.

16 based on data from 1st of July 2001 up to 31st of January 2002

17 This step should not be mixed up with the definition of ABC types.

18 see Weber, Rainer: “Zeitgemäße Materialwirtschaft mit Lagerhaltung”, p. 43

19 For a SPGN like for example ADAPTER FLANGE different models, with for example different length, etc., represented by different part codes, like for example ‘01527958761762’, ‘01527958761906’, etc., and different prices can be found.

20 There have been no definitions of value limits of supply parts for the realization of an ABC analysis available at FTJ.

Hence a search for local Chinese suppliers should start with A-parts if no further analysis data is available. The concentrated search for these supply parts will very quickly show clear financial gains, which can than be used to finance continuous efforts for the remaining B- and C-parts. It has also to be stated that it will be easier to find new suppliers if whole supply part group names - and the respective order quantities - are ordered at once, but the models of the same SPGN are within different (A, B, C) types.

By regrouping the results of the ABC analysis the problem can be solved like indicated in table 2.1.-3:

Table 2.1.-3: Example results of the ABC analysis of all parts after regrouping the original results by SPGN[21]

No.[22]	Group Name	Ordered Quantity	Ordered Value	A-Share	B-Share	C-Share
1	GEAR WHEEL	1,368	4,545,733.18 RMB	100%	0%	0%
2	PINION SHAFT	1,351	1,482,124.54 RMB	100%	0%	0%
53	FLANGE	90	17,247.76 RMB	90%	10%	0%
78	PARALLEL KEY	4,430	44,673.20 RMB	10.98%	45.12%	43.90%

According to table 2.1.-3 all models of supply parts of the GEAR WHEEL have been identified as A-parts, because each model has at least a purchase price of RMB 33.58, whereas for the FLANGE only 90% of all models are A-parts and 10% are B-parts. Now, with the additional indication of order value and order quantity, it is easy to decide that, at first all SPGNs with an A-share of 100% will be placed with new suppliers starting with the highest value in a descending manner and followed by SPGNs with the next highest A-share and B-share, etc. In the example the order for supplier search would be: (1) GEAR WHEEL, (2) PINION SHAFT, (3) FLANGE and (4) PARALLEL KEY.

Results of the ABC Analysis of DIN/norm Parts

The same ABC analysis has also been carried out for all DIN/norm parts included in these supplied parts showing a similar result in table 2.1.-4:

21 see annex 1

22 Indicates the ranking within the total result of the ABC analysis of 106 SPGN with no. 1 representing the most important SPGN.

Table 2.1.-4: ABC analysis of DIN/norm supply parts for FZG gear units at FTJ

Type	Supply Part Value (RMB) >=	Qty. of Ordered Supply Parts	Quantity share of all parts	Quantity Share of DIN/norm Parts	Value (RMB)	Value Share of All Parts	Value Share of DIN/norm Parts
A	14.79 RMB	21,041	16.33%	19.91%	3,903,354.07	26.37%	94.75%
B	2.75 RMB	26,333	20.45%	24.91%	176,775.91	1.19%	4.29%
C	0.00 RMB	58,331	45.29%	55.18%	39,482.74	0.27%	0.96%
Total		105,705	82.07%	100.00%	4,119,612.72	27.83%	100.00%

With 94.75% of the total value DIN/norm parts also show a very high value concentration for A-parts. There are two interesting results:

- A lower value limit for A-parts of only 14.79 RMB (44% of the value limit for type A for all parts) and for B-parts of only 2.75 RMB (59.5% respectively) and
- All DIN/norm parts embody 82% of the quantity of all parts but only 28% of the value. That means DIN/norm parts represent high quantities, but on average only small values.

The following table 2.1.-5 underlines once again the statement of DIN/norm parts as low value parts.

Table 2.1.-5: Example results of the ABC analysis of DIN/norm parts after regrouping the original results by SPGN[23]

No.[24]	Group name	Ordered qty.	Ordered value	A-share	B-share	C-share
1	BACKSTOP	106	212,022.66 RMB	100%	0%	0%
2	FAN COWL	200	171,491.24 RMB	100%	0%	0%
25	ANGLE	448	11,960.20 RMB	60%	40%	0%
48	SET SCREW	521	480.39 RMB	0%	6.25%	93.75%

It can easily be seen that the most important group name BACKSTOP represents only a small value, either if compared directly in total with the GEAR WHEEL or by average value per supply part, where one GEAR WHEEL costs on average RMB 3,323 but one BACKSTOP only costs RMB 2,000. Only 49 of the total 106 group names comprise at least one DIN/norm supply part model.

23 see annex 2

24 Indicates the ranking within the total result of the ABC analysis of 49 group names with no. 1 representing the most important supply part group name.

2.2. Past Development of Output [Part B]

For turnover of FTJ usable statistical data is only available from October 2000 on. Diagram 2.2.-1 shows that the turnover of FTJ is quite volatile with seasonal peaks, e.g. in March. There is also a peak in August 2001, but still no statistical data is available to determine its nature. The current trend for turnover at FTJ for the 20 months available is an average increase of about 129 thousand RMB per month.

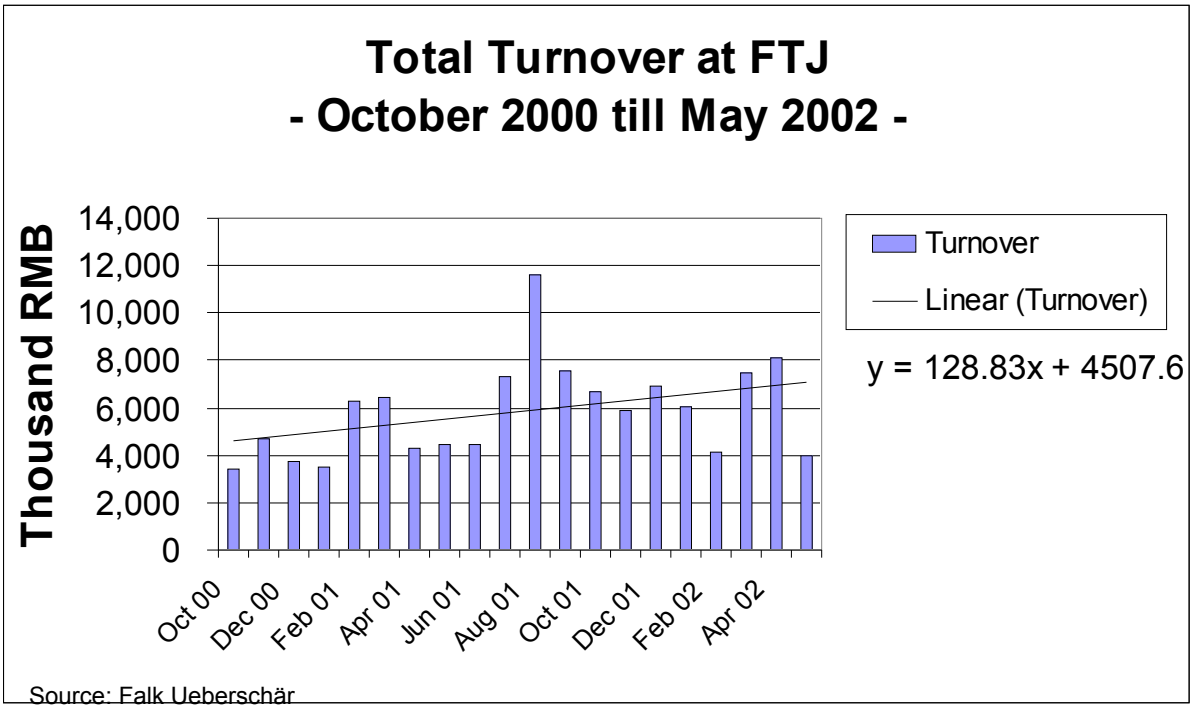

Diagram 2.2.-1: Development of total turnover at FTJ

Based on data of the logistics department the diagram 2.2.-2 shows the turnover per final product in the financial year 2000/01. According to the total turnover realized the most important final products are CAVEX gear units (32.5% of total turnover), with 'CRW160 and CG19', FZG gear units (19.8%) and PALMOIL gear units (17.2%). From the shown monthly turnover change and the fact that a product is only produced if ordered by the customer, it can be concluded that there is a high fluctuation in customer demand throughout the year for final products. With regard to the quite volatile total turnover it can be assumed that there is either a strong seasonal influence according to the demand for the majority of the final products or the Chinese customers have fluctuating requirements or different suppliers, and are swiftly switching from one product type to another without foreseeable regularity.

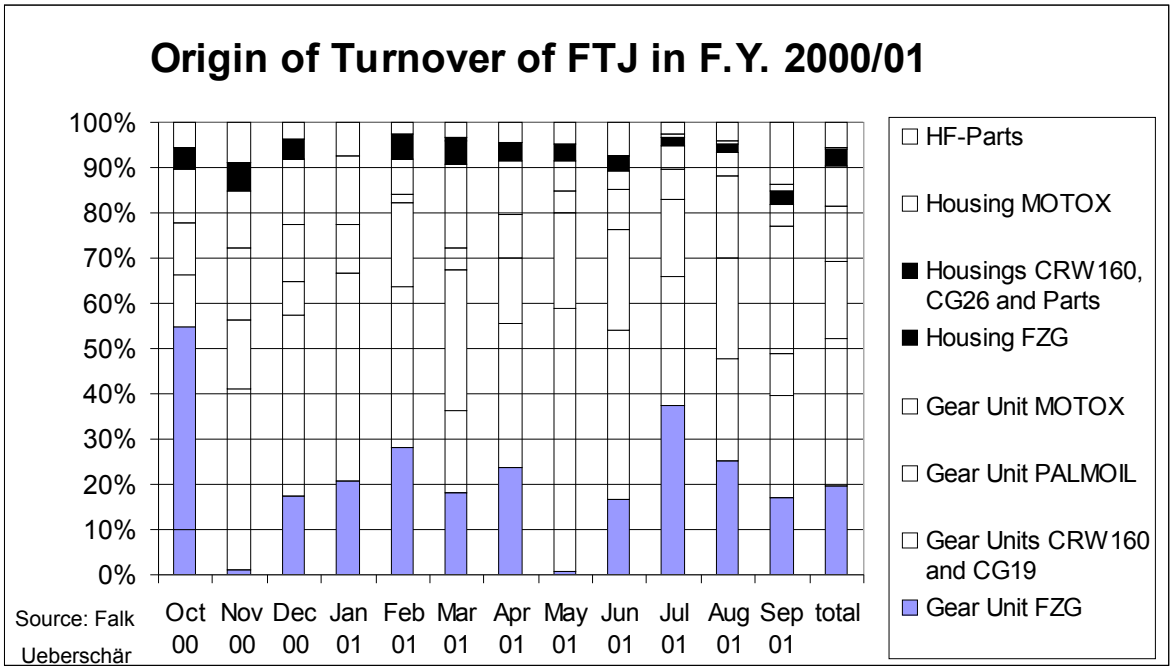

Diagram 2.2.-2: Origin of turnover according to final products

2.3. Analysis of Supply Sources [Part A]

This chapter will analyze the current sources for supply of material that are necessary for further corporate processes. The procurement is part of the corporate external supply, which includes the supply of goods, services and power. The procurement in a company has the responsibility of a goal oriented planning and realization of approval and contraction of suppliers. This field of activities is called **Procurement Management**[25]. This chapter as well as the entire thesis deals with the problem of supply of goods or material that are part of a final product as it has been described in chapter 2.1.2. The procurement purpose in today's supply chain includes the objective of a supply market oriented guidance of the company. This system uses the term of Procurement Marketing[26]. If the supply of goods from suppliers is described, this paper will use the term Procurement Management, which in most cases includes the approach of supply marketed oriented procurement.

With its long history, the Flender-group has established relations to a broad range of suppliers in Germany and across Europe. The delivered supply parts reach a high quality standard, which is the basis for the high quality of all Flender products. This effort results in the establishment of long and durable win-win relations with Flender's suppliers.

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25 The term of *Procurement Management* is analogous to *Procurement Marketing*. As far as the logistical component plays a major part the term *Supply Chain Management* is used; see Koppelmann, Udo: "Beschaffungsmarketing", p. 5

26 see Koppelmann, Udo: "Beschaffungsmarketing", p. 5

At first, during the beginning of business relations of Flender in the P.R. China in the year 1989, all the finished goods (completely assembled gear units) and spare parts for service have been purchased directly from the Flender plants in Germany. Today, FTJ exists as a single assembling facility for final products of MOTOX, FZG, PALMOIL and CAVEX in the P. R. China. The manufacturing depth at FTJ is therefore rather small, i.e. is limited to the treatment of local supplied castings.

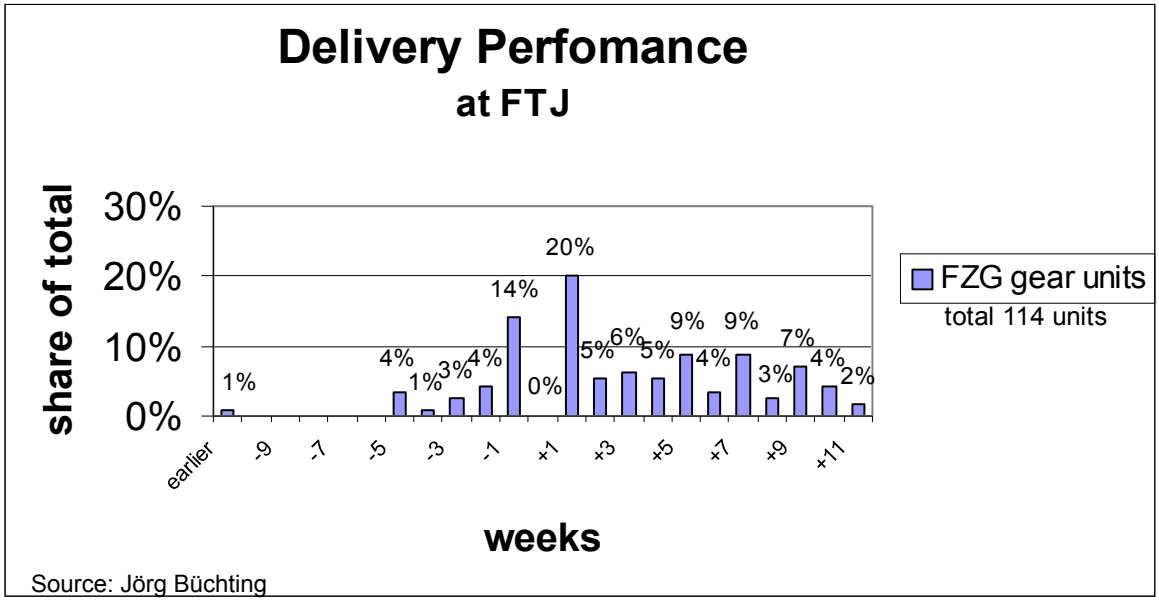

Diagram 2.3-1: Deviation from the customer wish date promised in the customer contract.

The procurement of single supply parts for the assembling process is project oriented, i.e. based on customer orders. The procurement process starts with local customer orders sent by the sales department to the logistics department of FTJ. Stock management at FTJ has limited resources. Every purchase order for FZG parts is separately arranged at Flender-Penig. Based on the technical appendix[27] and according to the established FZG part list, every ordered item will be sent from Flender-Penig to FTJ.

The following diagram 2.3.-1 shows the deviation from the customer wish date stipulated in the contract with Flender-Sales-China:
This diagram is created and regularly updated at the logistics department of FTJ. The respective calculation includes the following data[28]:

27 The so-called technical appendix contains the clearly defined customer requirements for the ordered product. Flender-Sales has to carefully prepare the technical appendix with the customer to avoid later product changes which may lead to a longer delivery time.

28 Due to missing data certain dates of the overall delivery process had to be estimated. The estimated figures are based on the average of well-known data.

- Customer wish date stipulated in contract
- Average time for preparation of order placing at FTJ
- Average time for order placing at Flender-Penig
- Delivery date from ExW-Flender-Penig to FTJ
- Average stocking time before production at FTJ
- Production time at FTJ
- Average stocking time after production at FTJ
- Average time for preparation of dispatch at FTJ and
- ExW-date for dispatch at FTJ to the customer.

Flender-Sales-China signs contracts with its customers with an average delivery time of 118 days. The diagram 2.3.-1 shows that FTJ has a deviation of delivery time in regard to the date signed in contract as early as 5 weeks before and up to 11 weeks after the customer wish date.

In most cases and for regular customer orders the order placing process starts with the down payment by the Flender customer. The average down payment for this case is 28% of the order value in the contract. It has to be remarked that for FTJ the period allowed for payment to Flender-Penig is 60 days after delivery ExW at Penig to FTJ.

The feedback and confirmation on the Ex Work date of Flender-Penig is one main weak point within the overall purchasing process since there appears on average a delay of on to two weeks. Unfortunately in several cases Flender-Penig confirms up to 3 changes of the Ex Work date.

The before mentioned case includes all shipped orders from Flender-Penig to FTJ via sea- and air-transport. As a high percentage share of incoming goods have been transported by air, the statistic above looks brighter due to the acceptation of higher transportation costs.

All calculations have an exactness of one week. The analysis of this statistic indicates quite clearly that none of the customer orders has been exactly sent on their defined wished date in the contract. The statistic also shows a broad mean variation within the Gauss graph. A problem point in regard to that is that some figures are based on average dates.

One explanation for the broad mean variation is an uncontrolled process with several undefined influences within the supply chain. A recommendation for the improvement of the overall situation and for the achievement of a more stable process that leads to higher customer satisfaction will be discussed in chapter 4 of this paper.

In regard to supply sources, it has already been stated that about 70% of all supply parts for the assembly of gear units originate from Flender-Germany, whereas 30% are produced internally

in FTJ. Only a small percentage share of casting products is delivered by Flender-Wittgensdorf and has to be further decreased to optimize and standardize the SCM of FTJ.

The diagram 2.3.-2 shows the location of the suppliers of FTJ in Germany and in the P.R. China as well as the total value share of ordered supply parts sourced in both countries for the financial year 2001/02.

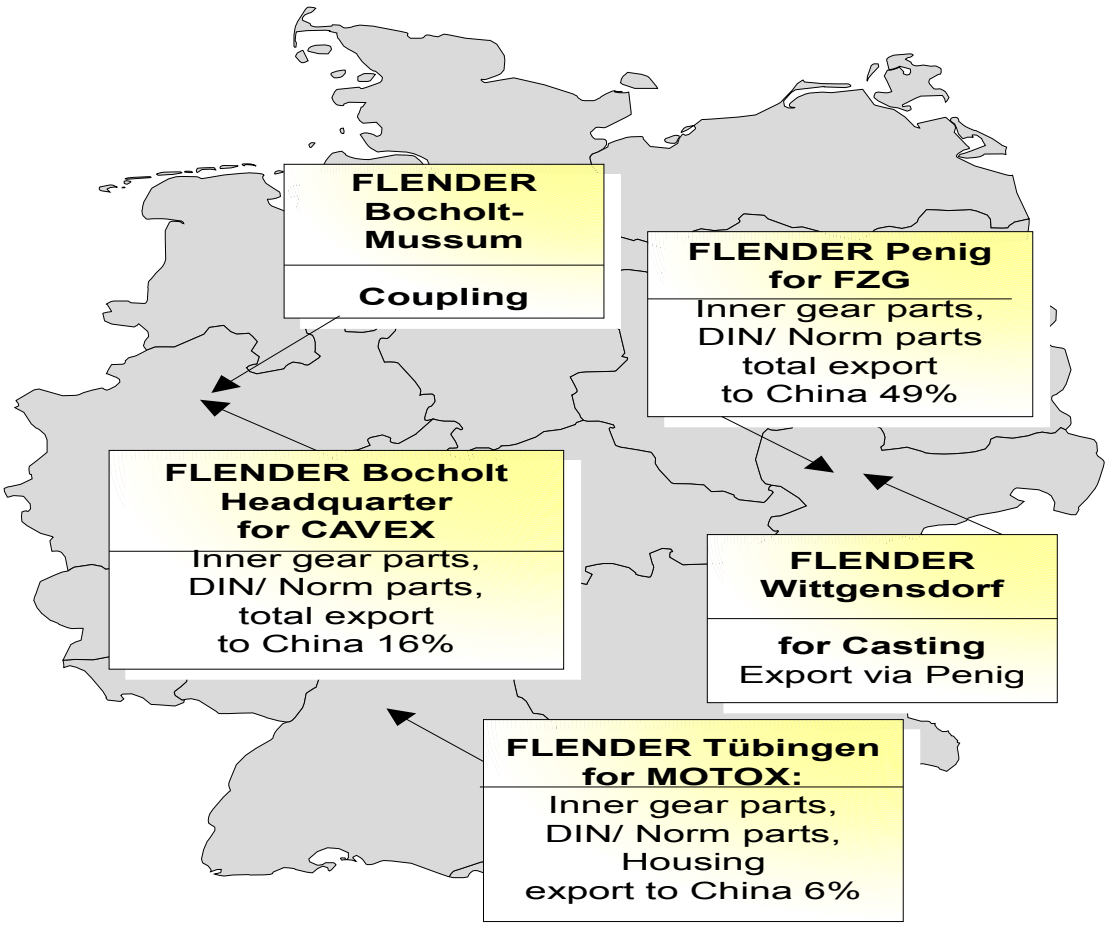

Diagram 2.3.-2: Location FTJ's suppliers in Germany & P.R.C. and the total value share of ordered supply parts sourced (valid for the financial year 2001/2002).

2.3.1. Sourcing Abroad

Flender-Germany has four production sites. The most important is in Bocholt located in the federal state of North Rhine-Westphalia. It serves as headquarter for the Flender-group and is the productions site for CAVEX gear units. Near Bocholt, a rather smaller production plant exists for the production of coupling parts. A third production site of the Flender-group is located in Tübingen, in the federal state of Baden-Württemberg. Flender-Tübingen is responsible for the production of the whole MOTOX product range. A fairly new FZG production facility is Flender-Penig in the federal state of Saxony established in the year 1990.

The Flender plants Penig, Bocholt and Tübingen in Germany are production facilities for completely finished gear units. Beside these sites in Germany and FTJ in the P.R. China, the Flender-group has several production and manufacturing plants around the world. Flender is known for its own designed inner geared parts. These parts are mainly produced at Flender plants. All other parts for assembly such as DIN/norm parts are sourced from suppliers in Germany and Europe.

To reduce the working and organizational effort at Flender-Penig, FTJ has established direct relationships with Flender-group suppliers of DIN/norm parts. This step has just been done in the last months and is already been carried out. The supplied goods are purchased direct at the supplier in Germany and are then transported via an agent to FTJ. The transport starts when an economical quantity of supply parts for transport is available, i.e. normally the shipping company tries to load a complete 20` or 40` container.

For FTJ, the contract for procurement of goods at Flender-Germany is based on an agreement contract. This means that FTJ is working independently, but with support from Flender-Germany which is stated as regular supplier. There is not written agreement that FTJ has to procure supply parts from its parent company.

2.3.2. Local Sourcing Within the P.R. China

The P.R. China holds a leading position for sourcing strategies of supply parts. It also offers many possibilities for setting up international production networks[29]. FTJ is recognizing these opportunities and takes activities regarding local procurement.

At the moment the concept of local sourcing is partly difficult to realize. Especially the procurement of high quality industrial products is so far not unproblematic. The overall demand for high quality products in the P.R.C. forces the market to move away from low quality mass products. The P.R. China will become a producer of relatively high technology and high quality oriented products.

Since the start of production in the year 1997 in Tianjin, FTJ has continuously looked for suppliers, mainly for casting products. So far several companies have been evaluated as possible supplier.

Today, FTJ sources mainly casting products as well as shafts for its gear units locally. Casting products are needed for housings and covers. Locally sourced supply parts are mainly cast iron parts of GG20, GG25, and GG40.

29 Delegation of German Industry & Commerce in China, German-Chinese BusinessForum, Number 6, December 2000, p. 6

Regarding the transport of supplied parts, FTJ has so far only sourced within the regional area of Tianjin and Beijing. Concerning the efficiency and cost of sourcing from suppliers in and around Tianjin mayor problems or cost factors have lately occurred.

In general and in particular for FTJ the local procurement in the P.R. China has various advantages, but does also lead to many difficulties. One of the main problems for companies like FTJ is the establishment of suppliers, which deliver a high quality standard. FTJ tries to manufacture high quality products according to the internal Flender quality standard.

In the near future, the goals of FTJ are to procure all DIN/norm supply parts in the P.R. China. To achieve this goal much effort has to be put in the search, evaluation and development of new and also even suppliers in the P.R. China.

Local suppliers in mainland China are defined as 'state owned companies' or privat Chinese companies. Private, or privatized state owned companies, have invested a vast amount of money into the modernization of production equipment.

There are a growing number of considerable foreign companies in the P.R. China with production plants all over the country. Most of them are situated at the flourishing eastern provinces of the P. R. China. FTJ has business contacts to both parties: local Chinese and foreign companies, most of them Japanese and Korean, JV or WFOE.

The increasing strength and appearance among different suppliers in the P.R. China makes it difficult to select the best supplier. For example new companies with state of the art technology may not be rated as a core supplier in Germany. One of the main reason will be that the business environment does not keep up with the high internal standard. That makes it difficult to evaluate local suppliers. Current core suppliers will have to simultaneous keep up with this high management and quality standard. The evolution of the companies is influenced by outside factors. A local A-rated supplier may still show a serious lack of competencies, for example in the management of his logistics leading to long delivery times.

2.3.3. Quantity and History of Supply

FTJ is located in one of the north eastern provinces of the P.R. China. This region is known for its heavy duty industry, such as casting and steel production. A broad range of companies can be found in many provinces. Tianjin is one of the main cities well-known for its industrial knowledge mainly due to its nearby international harbor, which exists since 1949. The ability to accommodate the world's biggest container ships makes Tianjin a competitive location to the Port of Shanghai. With close contacts to supplier companies in and around Tianjin, FTJ has chosen the BEDA (Beichen Economic Development Area) as the ideal production site. All current suppliers are located in the Tianjin as well as the nearby Beijing area.

The procurement of parts at FTJ is divided into four main groups. Supply parts from Flender-Penig include:

- Housings
- Inner Geared Parts
- DIN/norm Parts
- Other parts

Supply parts from the P.R. China include:

- Casting products: housings and HF-parts
- DIN/norm parts
- Other parts

Within mainland China the procurement of casting products is the main focus of FTJ and has been carried out for several years. The potential procurement of other supply parts could up to now not be realized. This mainly results from missing relationships to potential suppliers as well as the low quality of the delivered supply parts. As each Flender product has its own characteristics due to different customer needs, about 10 casting suppliers for FZG and MOTOX housings have been under contract within FTJ. The first evaluation and supplier contracting had been carried out five years ago with the establishment of FTJ. The situation at the supplier market may have changed. New opportunities (quality standard, production output) offer the possibility to improve the procurement process. The search for new suppliers will be expounded in chapter 3.

In some cases, FTJ has approved and established relations with more than one supplier. Which orders are assigned to a certain supplier mostly depends on the order quantity as some suppliers only deliver higher order quantities. The lack of the sufficient order volume or quantity for certain supply parts lead to a higher working effort, higher part price and unstable process at FTJ in comparison to its competitors. Today's procurement and supplier situation at FTJ is listed in table 2.3.-1.

Flender-China and FTJ both organize their procurement according to each received single or project customer order. Almost no stockkeeping in advance takes place. The output of FTJ matches with the number of procured parts. An additional 10% supply parts will be added to the order to avoid a shortage of material due to quality failures. Any remaining supply parts are put into stock until needed for assembly of a gear unit.

Table 2.3.-1: Procurement and supplier information

Gear Unit		Drawing No. Casting Type	Supplier 1	Location of Supplier 1	Supplier 2[30]	Location of Supplier 2
FZG		8 (Housing size-H2/B3)	NWS	Tianjin		
FZG		2 (Housing size-H2/B3)	NWS	Tianjin	MT. No.1	Tianjin
FZG		1	NWS	Tianjin	WLD	BaoDing (Hebei)
FZG		3	NWS	Tianjin	SanDa	Tianjin
FZG		8	WLD	BaoDing (Hebei)		
FZG		2	MT No.1	Tianjin		
PALMOIL		3	NWS	Tianjin		
PALMOIL		1	NWS	Tianjin	MT. No.1	Tianjin
CAVEX	CRW 169	1 Housing 1 Cover	NWS	Tianjin		
	CG 26	2	WLD	BaoDing (Hebei)		
	CG 21-80	2	HJX			
	CG 45	1	WLD	BaoDing (Hebei)		
	CG 35	1	WLD	BaoDing (Hebei)		

The average production output for FZG gear units, housings and parts in the past two financial years is shown in table 2.3.-2 below:

Table 2.3.-2: Production output for FZG gear units, housings and parts

Financial Year	Avg. Monthly Output of Gear Units	Housings	Parts
2000/01	39	120	--
2001/02	52	109	268

The production output for FZG housings includes the output for Flender-Penig less the internally used products.

2.4. Material Flow within the Procurement Process [Part B]

In Germany and the P.R. China exist different packaging sizes, which can all be found at FTJ resulting in extra reloads amongst the packaging. This becomes obvious in the receipt of goods during the checking process when additional empty palettes are needed. There are also problems regarding stocking, because different palette sizes consume different space and are hence often not properly stocked. The table 2.4.-1 gives an overview of the used types of palettes and boxes at FTJ.

30 In some cases FTJ approves a second supplier to assure the delivery of important parts.

Table 2.4.-1: Used palettes and boxes at FTJ

Incoming packaging		**Within FTJ**	**Outgoing packaging**	
From	**Size (mm)**	**Size (mm)**	**To**	**Size (mm)**
Germany: - Bocholt	800x1000	800 x 1000	Germany[32]	760 x 1200
- Penig, Tübingen	800x1200	800 x 1200		from NWS
- Tübingen	800x1200x640	760 x 1200	P.R. China	according to product
P.R. China	760x1200[31]	800 x 1300	Singapore	according to product
	800x1300	470x630x410		
		470x770x470		
		470x400x170		
		250x165x75		

It becomes clear that with four different types of palettes in use at FTJ and additional four types of boxes FTJ lacks a standard palette size. The problem is worsened by the fact that palettes and boxes are often in a very bad shape, with open spikes and broken planks preventing a correct storage of supply parts and jeopardizing employee's health.

2.4.1. Material Flow from Suppliers to Flender-Tianjin

For supply from German suppliers there are two possible transport ways: transport *by ship* and *by air*. For transport of supply parts sourced from Flender-Germany the transport company *WM Sea Air Transport GmbH* is responsible. For transport by sea the company uses a consolidation warehouse in Duisburg[33] (Germany) to group all supply parts, which arrive from Bocholt, Tübingen and Penig. Once per week a 20'-container, which is most commonly used, or a 40'-container is used to transport all supply parts via the Port of Hamburg four weeks over sea to the Port of Tianjin.

At the Port of Tianjin ten working days are needed for customs clearance and to reload the goods from the ship on the truck. The transport from the Port of Tianjin to FTJ[34] takes about four hours. So the total transport time from ExW Flender-Germany to FTJ is about 42 days assuming an average time of 4 days from ExW in Germany to the Port of Hamburg via Duisburg.

In case of air-transport the diagram 2.4.-1 shows that only 5 to 9.5 days are needed, depending on the used airport and the carrier. In case of urgent delivery the time for customs clearance can be shortend to two days. However this is not always possible.

31 Mainly used by the most important Chinese supplier NWS.

32 Only HF-parts and housings are sent to Germany, but not gear units.

33 Nonetheless FZG supply parts from Flender-Penig are transported to Chemnitz and it could not be settled out if they are shipped from Chemnitz to Duisburg or directly to the Port of Hamburg.

34 organized by *M+R Forwarding (China) Ltd.*, a shipping agent, under contract of *WM Sea Air Transport GmbH*

Currently the supply from local Chinese suppliers is no problem as it takes only up to three hours of total transport time from the most far-away suppliers[35]. Depending on the orders placed there arrive about 100 up to 200 consignments from local Chinese suppliers per month.

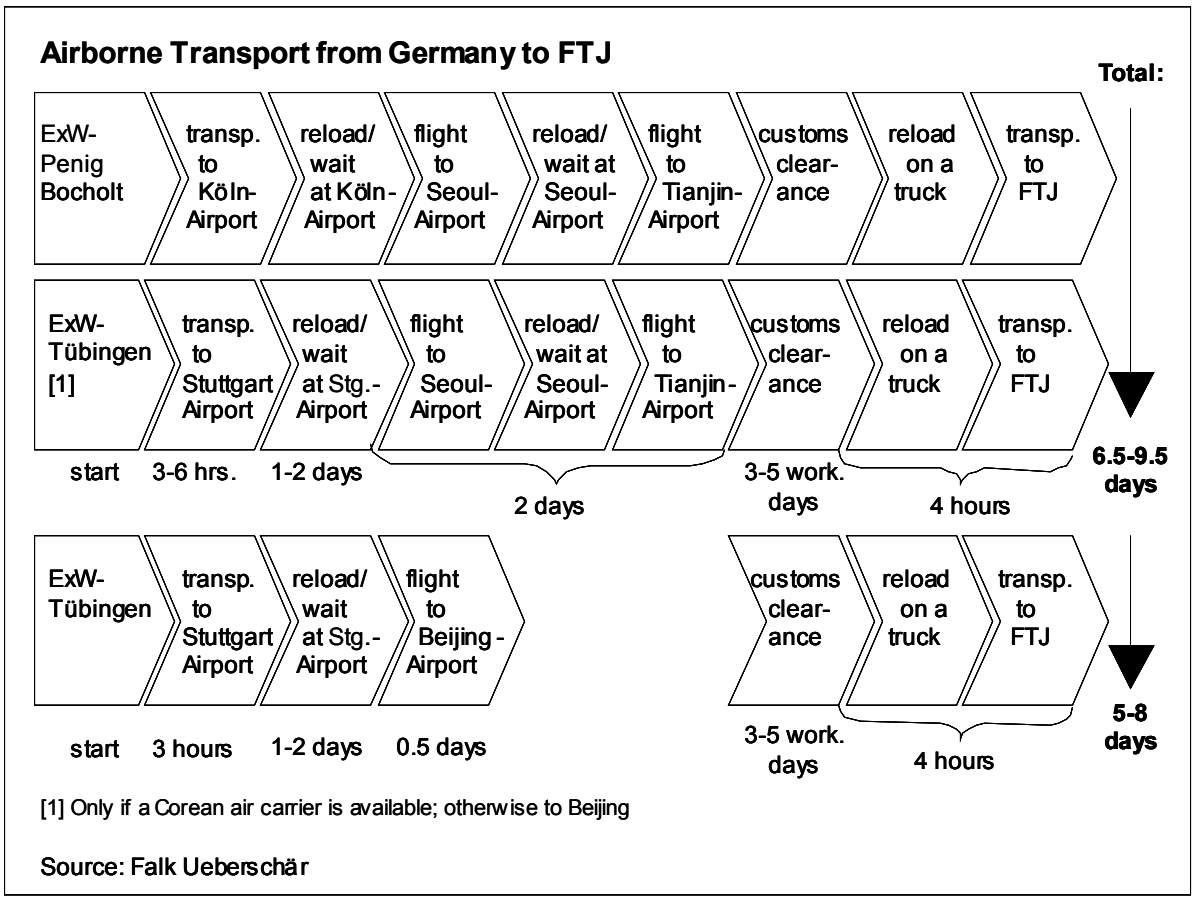

Diagram 2.4.-1: Airborne transport from Germany to FTJ

2.4.2. Material Flow within Flender-Tianjin

The internal flow of supply parts takes place between the assembly and production hall as well as the new warehouse, which is located at the side of both halls. Arriving supply parts are normally handled by a certain scheme: (1) intermediate storage, (2) quality check, (3) transport to the warehouse, (4) taking into stock, (5) commissioning for production and (6) transport to the production place.

As means of transport for the internal material flow are used: different cranes, two fork-lift trucks and a manual fork-lift. Sometimes there is no driver available for the fork-lift truck leading to interruptions for the supply up to the workbench.

35 The suppliers use trucks from 1.5 tons, 5 tons up to 15 tons, which are normally 80% overloaded, i.e. a truck for 5 tons arrives with about 9 tons of supply parts.

2.4.3. Material Flow from Flender-Tianjin back to the Suppliers

Supply parts considered as scrap metal due to poor quality are normally stored in a special area to be handed back to the corresponding Chinese supplier at the end of each month when the supplier arrives the next time.
German supply parts are not shipped back to Germany if quality problems arise or if a surplus of parts appears due to an additional replenishment order as transport costs would be to high in comparison to the value of supply parts. So the former have to be scraped or – in case of surpluses – are often kept in the warehouse in hope for use in the future.

2.5. Cost Structure of the Current Procurement Process [Part B]

2.5.1. Costs of Order Placing and Order Management

At the moment all supply parts for the FZG gear unit are supplied by Flender-Penig[36], except housings, which are already sourced from local Chinese suppliers. The following table 2.5.-1 shows the difference for the order management between both cases.
With 95 up to 125 minutes the time needed to place the order with Flender-Penig and than to check the order status is considerably higher than placing an order with a local Chinese supplier. The first reason is the greater geographical distance to the German supplier leading to a more complex transport chain and a longer transport route, which bears greater risk of interruptions. Secondly the preparation of the export and import documents for supply parts from abroad result in additional time.
With the monthly costs of about 3,000 RMB of an employee in the logistics department, 40 man hours a week, 237 working days per year and additional 9% for overheads[37] the total cost of one man hour is 20.7 RMB[38].

36 Very seldom housings are sourced from Flender-Wittgensdorf. This fact is neglected in this thesis, because of its small sourcing value and quantity.

37 based on information from the logistics department of FTJ

38 cost of one man hour = 1.09 * ((3,000 RMB * 12 months) / (237 days * 8 man hours per day))

Table 2.5.-1: Differences for sourcing from Flender-Penig and Chinese suppliers

	Sourcing from Flender-Penig	**Sourcing from local Chinese suppliers**
Average order placement time[39]	70 min	45 min
Average time for order confirmation	15 min	10 min
How often has the status of the order to be checked?	2 up to 4 times à 5 to 10 min	up to 2 times à 10 min
Means of communication to check the order status	e-mail, phone, (sometimes) fax	Phone, fax, (seldom) e-mail
Total time needed	95 min up to 125 min	75 min
Which information is received throughout the process till arrival of supply parts?	Order confirmation, information about changing delivery time, invoice, bill of lading, packing list	Order confirmation (by fax, very seldom in written form)

According to this cost per man hour table 2.5.-2 shows the resulting average order costs for both order options:

Table 2.5.-2: Average order costs at FTJ

	Sourcing from Flender-Penig			**Sourcing from Local Chinese Suppliers**
	Minimum	Likely	Maximum	
Total costs per order	32.78 RMB	37.95 RMB	43.13 RMB	25.88 RMB
Comparison of costs per order	86%	100%	114%	68%
Number of orders per year[40]	960	960	960	600
Total costs per year	31,469 RMB	36,432 RMB	41,405 RMB	15,528 RMB

If the likely costs, calculated as an average of possible minimum and maximum costs, for order placing and management at Flender-Penig are considered, the same kind of costs for ordering locally with Chinese suppliers equals only 68%. The total yearly order costs correspond to about 52,000 RMB.

2.5.2. Transport Costs

Analyses of transport costs are difficult, because they are normally included in the purchase price of the supply parts. Only in case of transport by air FTJ pays directly for transport costs. The table 2.5.-3 gives an overview:

39 The order placement time includes all preparation, which are checking the stock in FTJ, keying in the order data into the computer, printing the order, checking the order and signing the order.

40 This is a raw estimate: for March and April of 2002 a total number of about 303 orders have been placed with all suppliers, about 80 orders per month at Flender-Penig and 50 orders per month at local Chinese suppliers according to an estimate of the logistics department at FTJ.

Table 2.5.-3: Consignment quantities, cost factors and value of transport

Averages (raw estimates)	**Sourcing from Flender-Penig**		**Sourcing from Local Chinese Suppliers**
	by sea[41]	by air	
Quantity per year	133	57	365
Consignment weight	17,000 kg[42]	200 kg	5,000 kg[43]
Cost factors per kg	1.00	43.57	0.04
Cost factors per cons.	1.00	0.51	0.01
Cost factors per year[44]	1.00	0.22	0.04
Value share	80%	17%	3%

It has to be clearly stated that on average 30% of the total supply part value is currently sourced in the P.R. China, but would only represent 3% of the total transport costs if FTJ would directly have to pay for it. Total yearly transport costs would correspond to about 2.4 million RMB[45] of which 17% are currently directly paid by FTJ and 83% are included in the purchase price.

With a kg-price of an air-consignment about 44 times higher than *by sea* the costs of delayed order placing with German suppliers are far too high. For supply parts, for which a Chinese supplier can be found, a reduction of 94% of transport costs per kg can be achieved in comparison with sea transport from Germany.

Conclusion

The yearly costs of order placing and order management make up only 2% to 3%[46] of the total procurement costs. The high airborne transport costs originate from problems with punctual delivery at Flender-Penig[47] as well as orders, which are often placed too late by FTJ. Comparing only direct purchase prices and quality of Chinese and German products is not enough: at least the procurement price, the degree of quality, the supply time and the flexibility should be taken into consideration in order to decide where to source from.

41 Costs are indicated for a 20'-container from ExW-FTJ via the Port of Hamburg to Flender-Penig.

42 Up to 21,000 kg

43 There is a range from 3,000 up to 7,000 kg per consignment.

44 Costs for duty are included in the procurement costs and represent at least 8% of CIF value of the supply parts at the port or airport of Tianjin.

45 Based on the information of the top management, of the logistics department and of the finance department of FTJ the transport of a 20'-container from ExW-FTJ via the Port of Hamburg to Flender-Penig costs 14,511.94 RMB. With 133 consignments per year this results in yearly transport costs per sea of 1,930,088 RMB. For the estimated 57 airborne transports per year from Germany to FTJ costs of 424,000 RMB have to be paid by FTJ. There is about one delivery from Chinese suppliers per day à 189.20 RMB leading to yearly transport costs of 69,058 RMB.

46 A 3% share is the result of the calculation if the later is only based on costs for air-transport.

47 There seems to be a strong relation between the problems with insufficient production capacity and the delivery date at Flender-Penig.

Even if supply parts are not sourced locally, the (improved) rolling forecast of the sales department should be used to place orders early enough to avoid air transports.

2.6. Information Flow within the Procurement Process [Part B]

New orders are sent to the logistics department by the sales department. For FZG supply parts the logistics department at FTJ has to place its orders with Flender-Penig. Table 2.6.-1 gives a chronological course of the events for the process of order placing, which will be discussed in greater detail in this subchapter.

Table 2.6.-1: Current process times in days for order placing at Flender-Penig[48]

No.	Location	Process	Net Time[49]	Cumulated Time	Time incl. Waiting Period[50]
1	FTJ-logistics	Handle customer contract[51] and submit technical appendix	0.09	0.09	0.15
2	Flender-Penig	Handle technical appendix	0.04	0.13	0.13
3		Work out / submit part list	0.02	0.15	5.54[52]
4	FTJ-logistics	Order preparation (use part list)	0.08	0.23	0.24
5		Place / submit purchase order	0.05	0.28	0.14
6	Flender-Penig	Make out / submit order confirmation	0.05	0.33	0.46
7	FTJ-logistics	Receive order confirmation	0.01	0.34	0.01
	Total		**0.34**	**0.34**	**6.67**

It can clearly be seen that there are currently two main problems:

(1) The information flow is currently running two times from the logistics department to Flender-Penig and back, because Flender-Penig is at the moment responsible for working out the part list needed by FTJ to place the purchase order.

(2) There is an enormous difference factor of 19.6 between the net time and the time including waiting period, mainly because the creation of the part list at Flender-Penig takes 4 up to 7 days.

The means of communication and the assignment of responsibilities add to the above mentioned problems and are partly the reason for problem (1) and (2):

(3) The predominance of paper, as the main means of communication within the logistics department, parallel to the use of internal mail within FTJ, verbal communication within FTJ, fax, e-mail, and partly telephone for communication with the suppliers and the

48 Differences between the sum of the net time per location and the time including the waiting time originate from rounding differences. The calculated time is based on a 40 man-hours per week and employee.

49 The *net time* only includes the actual working hours, but does not the waiting period between the listed processes.

50 The *waiting period* is the time consumed by interruptions of the process.

51 includes the technical appendix

52 To submit the finished part list takes about 4 up to 7 days, i.e. 5.5 days on average.

customer leads to many interruptions and long process times, high error rates, e.g. if remarks are made only on the original, low flexibility in case of information changes, and unclear situations.

(4) The current order process is highly manual and hence includes several redundancies for checking again and again involving at least three employees of the logistics department at FTJ for the same order.

2.6.1. Internal Information Flow and Decision Making

At FTJ there are three persons involved with order placement: the employee who is mainly responsible for the ordered final product and who will order the supply parts, another employee, who prepares the sales order confirmation, and the deputy of the logistics department. For the decision which supply parts have to be ordered the deputy checks the stocks at FTJ, checks and rectifies the purchase order prepared by the mainly responsible employee and submits the purchase order data to the supplier.

To rectify faults in the technical appendix, the mainly responsible employee has to call a sales engineer in the sales department in Beijing. For the management of the basic data of all purchase orders, the CS3 system is used to key in all orders and to automatically transmit the later to the financial department and to the warehouse department. The CS3 system is then used to export the order data into an MS-Excel file which will be used to actually place the order for supply parts with the German supplier.

It can be stated that the internal communication is mainly based on handing over paper documents which are often copied for different purposes causing opportunity costs in regard of an electronic solution for communication.

2.6.2. External Information to Suppliers

Normally consignments of supply parts from Flender-Penig are one to two weeks delayed, but if the sales department informs FTJ about urgent consignments the logistics department is trying to keep the arranged delivery date[53].

As mentioned before, the procurement process is highly manually organized. This fact is reflected by the use of up to four different communication channels if internal[54] and external

53 This is accomplished by additional communication with Flender-Penig, by changing the way of transport from ‘by sea’ to ‘by air’ and by using good relations to the customs department at the Tianjin airport.

54 Internal communication deals with information, which is not leaving the company FTJ.

communication of FTJ is compared[55]. Table 2.6.-2 indicates the communication channels according to the location of the supplier:

Table 2.6.-2: Communication channels for outgoing information/documents

No.	Outgoing Information/Documents	Communication Channel to German Supplier	Communication Channel to Local Chinese Supplier
1	Technical appendix	Fax	Fax
2	Purchase order	e-mail	Fax

FTJ has an interface problem as too many different and low performing communication channels are used. An means of communication like fax is low performing if the information flow is often disrupted and/or in danger of being disturbed and reduced. Adding to this problem is the assignment of different numbers[56] for the supply parts, which belong to the same customer order, and the order itself, by the logistics department at FTJ and by the SAP system of Flender-Penig. These different numbers originate from the transformation of customer orders into production and assembly orders as well as the use of PPC. They are used to uncouple the external control circle, in relation with the customer, from the internal control circle, in relation with assembly[57].

2.6.3. Information Processing with Suppliers

The internal information process with local Chinese suppliers is simple: the supplier checks the demanded delivery date and the received technical requirements and contacts the person in charge at FTJ by telephone if technical points of the order are unclear.

For German suppliers this process is more complex, because FTJ relies on a great part on documents, like rectified technical appendices, part lists and assembly documents, which are provided by the German supplier according to the costumer contract submitted by FTJ.

At the moment the technical department of Flender-Penig receives the technical appendix of FTJ through an employee, who is responsible for communication with FTJ, and set up the part list, which will be sent back to FTJ.

55 see chapter 2.6.4.

56 For one order there exist at least: one number from the sales department, a CS3-number, an FTJ-number and a Flender-Penig order number. All these numbers are incompatible and are partly created outside FTJ.

57 This leads to the need of translation of these numbers at interfaces; see Ehlers, Jörg D.: 'Die dynamische Produktion', p. 10pp.

2.6.4. Incoming Information from Suppliers

The same as for submitting information to the suppliers, incoming information is received by different channels. Table 2.6.-3 gives an overview.

The supplier sends the order confirmation to FTJ, after receiving the order number from FTJ. Information about a change of delivery time and the delivery confirmation arrives before the confirmed delivery date, but in case of Chinese suppliers a change of delivery time is only communicated if FTJ is calling the supplier. This fact indicates a **lack of exact time planning** of the information flow. Invoice, bill of lading and packing list are sent to FTJ after dispatch of the consignment with the German supplier, both by fax for instant information and by express service DHL for the original documents.

Table 2.6.-3: Communication channels for incoming information/documents

No.	Incoming Information/Documents	Communication Channel of German Supplier	Communication Channel of Local Supplier
1	Order confirmation[58]	Fax	Fax
2	Information about change of delivery time[59]	e-mail	Telephone (FTJ is calling each supplier)
3	Delivery confirmation	(Incl. in order confirmation)	Fax
4	Invoice	Fax, express service DHL	No need
5	Bill of lading (B/L)	Fax, express service DHL	No need
6	Packing list	Fax, express service DHL	No need

It has to be stated that FTJ receives **only discontinuous information** about the status of incoming consignments. For German supply parts, because the forwarding agent only informs the German supplier if deviation from the arranged delivery date arises, and for Chinese supply parts, because FTJ has to ring the suppliers to be informed about deviations, which is quite time consuming.

2.7. Analysis of Quality Management [Part A]

Companies, which are sourcing parts in the P.R. China, must be aware of the quality level of goods. As supply parts of a constant quality level are difficult to find[60], the quality control of supply parts as well as the realization of concepts for improvement of quality in order to meet the required standards has to be priority for FTJ and its suppliers.

Flender is known for its high quality products made in Germany. Experiences have shown that Flender products run several years under stable conditions without any complaints from

58 The order confirmation contains: the order number of FTJ and of the German supplier, the identification number, the description of parts, prices and the requested delivery date.

59 Contains: the order numbers, the confirmed delivery date and the changed delivery date.

60 It often appears that poor quality of supply parts results from lack of experiences of the supplier.

customers. To accomplish this quality level the highest quality standard for all supply parts as well as for the final products is required. Flender-Germany uses sophisticated quality methods and tools to achieve their goals.

A central focus of the quality department at FTJ is to assure that only incoming goods from local suppliers which fulfill the defined quality level can pass on. Another aspect is quality control in production and assembly line.

2.7.1. Quality Management of Information and Documents

With the appointment of a quality manager FTJ started to prepare quality documentation after mid 2001. Since than quality target planning of measurements have been recorded for comparison. Despite that, at the moment there is no defined procedure or manual guidance to the handling, storage and numbering neither of quality documents nor of computer files.

All quality measurements are registered in monthly prepared spreadsheets. The quality figures for the previous periods (months) or within the current or precedent fiscal year can be compared to each other. The result of a missing quality process is mostly due to a lack of confidences and limited resources at FTJ and within its quality department.

2.7.2. Quality Management of Supplied Parts

FTJ has done a great effort to reach a high quality level with the suppliers. The already mentioned limited resources of FTJ reduce the possibilities for developing a high quality standard at most of the suppliers in the P.R. China.

During the period January to April 2002, FTJ has purchased housings (FZG, CAVEX, MOTOX) and HF-parts (rings, parts and others). As already mentioned in subchapter 2.3.3, the main local suppliers of FTJ for these supply parts are NWS, WLD, BDF and recently SanDa.

Two ways of quality inspection have been recognized for FTJ:

- Incoming goods inspection and
- Inspection and prevention of quality failure during the production process, e.g. in case material defects become visible during material handling and production like for example. sand or gas holes or shrinkage.

By quality measurements at FTJ an average failure rate of about 6.6% of all supplied casting parts as been detected[61]. An additional 10% of supply parts have been added to every purchased order placed with the suppliers to substitute faulty supply parts and non-conformances at the production process. Based on the total value purchased from local suppliers it can be estimated that non-conforming quality costs for rejection of local sourced

61 In total 39,858 delivered castings have been checked between January and April 2002.

parts counts for up to 388,747 RMB[62]. In case of delivery of insufficient quality suppliers rearrange new delivery or deduct value on the next order from FTJ.

Defective supply parts received from Flender-Germany or from its suppliers are more difficult to handle within FTJ. Due to the high costs for transportation it is not possible to sent faulty German supply parts back to its origin. In most cases the workshop fixes quality problems with supply parts himself. With faulty German supply parts several considerable quality problems have been experienced by FTJ such as:

- Receipt of used supply parts,
- Problems due to material defects and
- Quality problems caused during transportation:
  - Goods bang together due to inappropriate packaging,
  - Packaging does not provide protection against moisture leading to rust problems.

Incoming Goods Inspection Procedure

The respective supplier transports the supply parts by truck up to the entry of the assembly hall. Than he transports the supply parts to an undefined place within the assembly hall. There is no place directly assigned to the receipt of goods so that he has to place the supply parts where space is available.

An employee from the logistics department delivers a memo and a checking list in form of printed paper to the inspector of the shift, who is the responsible quality person (RQP).

The RQP, hence the person who executes testing, receives the memo in the moment the supply parts have already arrived or more seldom during the arrival of the later. The memo contains information about the supply parts and what has to be checked with the supplied parts in regard to quality. The RQP does not take the memo with him.

He also receives a checking list, which he takes with him to the place where testing takes place, normally at the warehouse. The checking list contains information about: quantity of supply parts, drawing number, part number, name of supply parts and name of supplier.

When the RQP arrives at the warehouse, he has to ask the stockkeeper to transport the supplied parts to the exact inspection place, which is located in the assembly hall. The RQP checks the supplied parts and takes notes on a separate sheet. After checking he has to write a

62 This figure is based on the total purchase value for locally sourced parts from January till April 2002. This cost does not include costs for rework of supply parts.

checking report. The original checking report is handed in to the quality department and a copy to the logistics department, which is informed thereby to take the parts into stock.

2.7.3. Quality Management of Stocks

At the moment there is no activity or procedure of the quality department concerning stock management.

As the current CS3 system at FTJ is not consistently used by the logistics department, ad hoc information of the status of material on stock is not available. Due to this very reason the stock can not be properly managed. Currently the storage time of some supply parts is one or several years. This is problematic as during such a long period quality problems can arise, e.g. bearings which dry up.

2.7.4. Quality Management within the Production Process

Within production there apply three general principles:

(1) Everybody who observes a quality problem has to inform the RQP.

(2) As far as possible, each worker should solve occurring quality problems by himself. The respective RQP has to be informed later on.

(3) If a quality problem can not be solves by a worker, the later has immediately to inform the RQP and seek help.

It can be stated, that the RQPs, who represent about 13% of the employees of a shift, also carry out normal tasks. They are the best of all workers within the shift, i.e. they have a wider understanding of production related quality problems. During inspection of supplied parts they are not directly available for questions of the workers.

A standard problem which often occurs is the concealment of quality problems from the RQP, if the quality problem can be solved by the worker himself, because he fears to deteriorate his personal quality record.

There is one monthly and one yearly quality statistics prepared by the boss of the quality department. He uses a data bank, which contains all relevant data of the respective period. The monthly statistics is worked out in the second week of the new month and the yearly statistics in the second week of the new financial year.

Both statistics always focus on three parts:

Table 2.7.-1: Focus of quality statistics

1st Part	2nd Part	3rd Part
Production	Assembly	Incoming supply parts: ➢ Casting (not ready for use by FTJ) ➢ Motor (not ready for use by FTJ) ➢ Finished supply parts (ready for use in assembly)

Monthly statistics like in diagram 2.7.-1 are prepared according to a monthly period and yearly statistics consider the financial year. In general there is a lack of indication of objectives in relation to the statistical material.

The test of final products under the responsibility of the quality department is realized in a testing area in the assembly hall. When the fitter[63] has finished (or almost finished) the final product he informs the inspector. Then the fitter moves the final product to the test area. By the use of special equipment the inspector checks the temperature as well as the noise level of the final product and takes respective notes on paper. As already mentioned the original recordings are handed in to the quality department, where they are kept for about two years. Currently there is no general rule that and the quality department lacks a professional document management.

FZG Housing & PALMOIL		
FY 2001/02		
Month	Work Reject[64]	Mat. Reject[65]
Oct.	1.1%	3.8%
Nov.	0.0%	7.1%
Dec.	0.0%	4.1%
Jan.	0.9%	3.4%
Feb.	0.0%	50.0%
Mar.	2.8%	1.1%
Apr.	0.0%	2.4%
May.	1.3%	2.1%
Jun.	--	--
Jul.	--	--
Aug.	--	--
Sep.	--	--
Average	**1.0%**	**3.3%**

Diagram 2.7.-1: Monthly quality statistic for FZG Housing & PALMOIL

63 *Fitter* is the term used for a worker in the assembly hall.

64 *Work reject* are parts that have been demolished during production and cannot be used in the manufacturing procedure any more.

65 *Material reject* are supply parts that passed the Incoming Goods Inspection, but material defects have been detected during the production process at FTJ.

The fitter only gets a verbal feedback of the test results from the inspector. By that it is difficult for the fitter to see the evolution of his personal quality level.
There is a yearly review of measuring equipment, but the exact review date for the next review is always unclear for a long time, due to a lack of a defined rule. Some of the measuring equipment is sent to the public Weights and Measures Office, while others are calibrated by the quality department itself. For the later a 3D-room with special equipment is available.

3. Analysis of Potential for the Reduction of Delivery Times

This chapter follows the analysis and current situation of the procurement and logistics management at FTJ. The problems of long delivery time of supply parts, defined in chapter 1 and 2, are now taken into consideration. Strategies as well as realization steps for the search of new suppliers are expounded. The following subchapter looks on a method to calculate the potential benefit for FTJ. Since bundling of supply quantities is an important option for the optimization of procurement. Another subchapter discusses supply quantities and questions concerning forecast of the later. Finally a decision criterion for the question of where to source and in which order is developed.

The development of a company like FTJ, with such a great potential and possibility for expansion, depends on the individual contribution every department and employee is able to make. In this situation lies the potential for a modern procurement and logistics management. Through a continuous review of the corporate development and progress that has been made it will become possible to assure a durable success in business for FTJ.

With the current logistical problem at FTJ, which have already been touched on in chapter 1, a dynamic way of organizing processes becomes necessary. Being able to tackle the problem of changing organizational processes is the basic assumption for the survival of any enterprise. FTJ has to accept this challenge on the market of mainland China as it did on other markets.

Basically two kinds of reduction of supply times do exist and are defined as targets within FTJ:

(1) Reorganization of logistical processes for supply parts with long supply times due to Project Oriented Procurement.
(2) Development of local Chinese sourcing starting with DIN/norm parts.

The slow, systematic process of the recognition of market participants, of the own business scope as well as of the general framework of the market is necessary for the identification of business possibilities in the P.R. China[66]. Both, Flender-Germany and FTJ, need to define and identify the scope of local procurement in the P.R.C. The potential for reduction of supply time mainly through local procurement will be discussed in this chapter.

66 German-Chinese BusinessForum, Number 6, December 2000, p. 7

3.1. Strategy for the Search of New Suppliers [Part A]

Long delivery times on the supplier side and as a consequence also on the distribution side, many quality problems, e.g. in the goods receipt, and an ineffective information and material flow within FTJ have already been identified. The development of a new approach for local procurement of DIN/norm parts has been based on a decision of top management at FTJ.

The ABC analysis for all supplied parts as well as for DIN/norm parts in chapter 2.1.7. shows the potential for local procurement of DIN/norm parts as a clear **concentration of value on A-parts** can be found[67]. This fact in combination with the savings potential (chapter 3.1.5.) and the sourcing priority (chapter 3.5.) indicates when and where to change from German to local Chinese suppliers.

Based on this procedure and decisions a procurement management system has to be developed and implemented. The following sections include the necessary systems approach, a supplier evaluation and potential approval of the suppliers.

3.1.1. Procurement Management Process within FTJ

This subchapter discusses a general process model for the procurement process. A structured process model is essential for improvement. Only with clear indicators, objectives and a continual review of the current situation of the company a successful new procurement management is possible.

The diagram 3.1.-1 shows a three-stage **procurement management process** based on (1) analysis, (2) development of strategy and (3) realization. The approach includes all necessary points for a continual procurement strategy with FTJ and its relationship to the suppliers. This process is surrounded by the objective set for procurement at FTJ and the respective review as well as evaluation of the continuous search for new suppliers.

67 The ABC analysis carried out for all FZG supply parts shows that A-parts represent 96.3% of the total value, but only 19.99% of the total quantity. The result for the DIN/norm parts is similar.

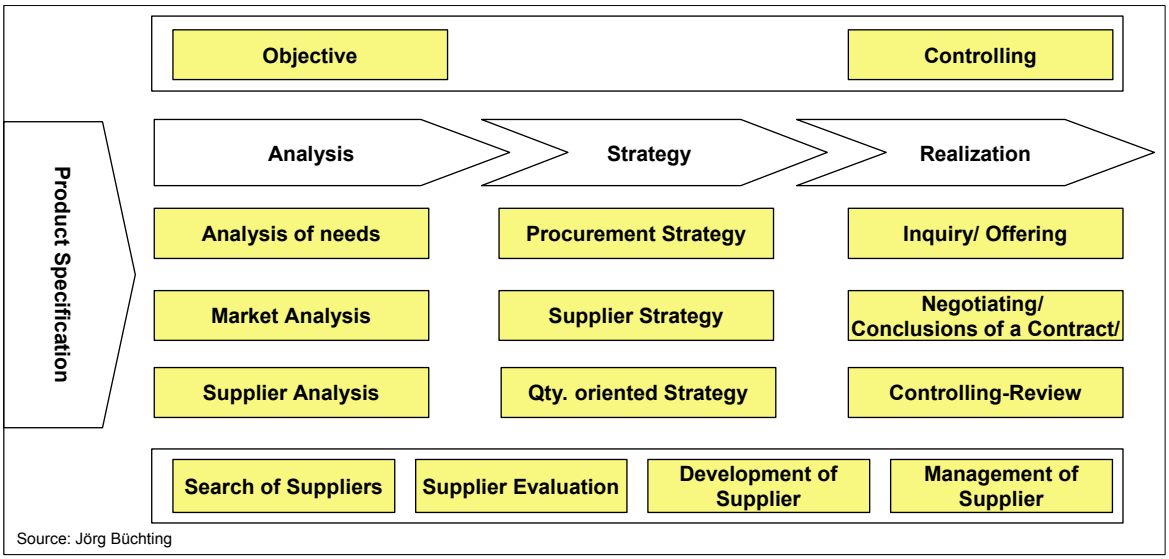

Diagram 3.1.–1: Procurement management

Following [Koppelmann 2000][68] and the diagram 3.1.-1 the following steps are essential for the development of an effective procurement management:

1) Analysis of Situation

The analysis of the current situation includes: analysis of the corporate needs, of potential suppliers and research of the market.

An analysis of the corporate environment within the procurement management process has to be carried out in order to identify the corporate background and to be able to make appropriate decisions. Responsible for the identification and control of the so-called *supply constellation* is the **Buying Team**. The supply constellation includes four aspects expounded in table 3.1.–1.

Following the existing supply constellation FTJ has to establish respective corporate goals and objectives that in a following step have to be reduced to sub goals in regard to the different processes, e.g. the procurement management.

2) Analysis of Needs

Since the responsibility for the design of any gear unit lies with Flender-Germany, FTJ has up to now to accept the required supply parts for the assembly of FZG gear units according to the part list[69]. This constellation does not leave any room for gear units adapted either to the requirements of Chinese customers or to the possibilities on the local Chinese supplier market.

68 Koppelmann, Udo: “Beschaffungsmarketing”, 2000

69 For information on part list procedures see chapter 3.4.1.

Table 3.1.–1: Supply constellation[70]

Supply Constellation		
Defined by the supplier market (six aspects)	Supplier performance (regular review of all aspects of each supplier in the P.R.C. due to changing market conditions)	Monopoly behavior of suppliers (only few foreign companies are able to produce at targeted quality levels)
	Quality problems at suppliers (up to 10% faulty supply parts)	Price level of supply parts (is expected to be lower in the P.R.C.)
	Communication between two parties (a great effort is needed from the Buying Center to the supplier in the P.R.C.)	Delivery quantities (everything is possible - big quantities are most favorable)
Defined by the market for final products (four aspects)	Exactness of forecast (growing market demand in the P.R.C.)	Demanding customer (due to market competition)
	Seasonal demand	Project oriented customer orders (through regular customers)
Within the own company (four aspects)	Production problems (quality rejection, poor stock management)	Development of a new products (long ways of internal communication)
	Wrongly placed purchase order	Reduction of working capital[71]
Defined by the procurement constellation (four aspects)	Legal instability (contradictory law system)	Overall technical development (low performance of most suppliers)
	Transport problems (long and uncoordinated delivery time)	Standardization process (missing of standards in the P.R.C., e.g. DIN standards)

For the financial year 2001/02 the Flender-group assumes c. 40% of order intake from project oriented customer orders from so-called *application sales*[72], i.e. the logistics department is currently putting a great effort into the placement of orders of small quantities[73] due to the separate handling of these kind of customer requirements or orders respectively.

The procurement for locally sourced supply parts is currently difficult to handle and causes several problems for FTJ. This is mainly caused by small order quantities placed with suppliers. So far FTJ has difficulties to provide forecast to the supplier for the establishment of a long-term win-win situation and/or the recognition of the existing savings potential resulting in a change to larger quantities per order. This procurement strategy is called *Quantity Oriented Procurement*. The need for this strategy and the development of the former will be analyzed in chapter 5 of this thesis.

In chapter 2.1.7. the supply parts have been classified according to their value. Later in this paper, in addition to this classification, the savings potential and the sourcing priority of supply parts is calculated. The results of these additional analysis can than be used by the Buying

70 see Koppelmann, Udo: “Beschaffungsmarketing“, p. 88

71 Working capital is calculated in regard to inventory, assets, liabilities and received down payments.

72 source: financial department of FTJ

73 in comparison to bundled quantities

Team for the decision on which supply parts they should focus first to achieve the best possible result for local sourcing. It will than also be easier to receive technical support from the Flender-group in Germany as the later currently does not make any profit with orders from FTJ. In most cases the product requirements are defined and can be found in the 'Organisational Procedure and General Technical Delivery Conditions'[74].

3) Supplier Analysis and Approval

One of the most difficult parts that need great attention at FTJ is the search of new suppliers in the P.R. China. The search is carried out according to the requirements stated above and completed with the final approval of the suppliers[75].

4) Supplier Contracting

So far supplier contracting in the P.R. China has been a more or less difficult process as many problems between buyer and supplier may occur.

The purchase of supply parts without any written contracts with the respective Chinese supplier, which is based on "good cooperation" and informal regulations, are not suitable if conflict arises[76]. Important points that need to be considered are mentioned in chapter 3.2.4.

5) Supply Handling and Supplier Evaluation

The supplier evaluation has to be carried out regularly. This continual review of the relationship with the supplier is one of main presuppositions to accomplish a win-win situation. This procedure is also important for an efficient supplier relation, and by that for the SCM, and it will be easier for FTJ to procure new supply parts from existing suppliers as the later see their advantage which lie in any changes of requirements.

Buying Team[77]

The communication, interaction and influence of a company such as FTJ in respect to its supplier and customer depends on the strength and strategy of its Buying and of its Sales Center. This **Buying Center** is involved in the supply of goods necessary for the production of final products. The Buying Team within the Buying Center is responsible for the search of

74 90% of all created guidance principles count for steel and casting products

75 chapter 3.2. focuses on the whole process of supplier approval

76 see German-Chinese BusinessForum, Number 6, December 2000, p. 34

77 The objective of a Buying Team will be further expounded in regard to the strategy in chapter 5.2.3.1. and in regard to a matrix organization in chapter 5.3.

suppliers, evaluation of existing suppliers and in addition serves as a general communication interface between FTJ and the supplier[78].

Regarding the complexity of the product range, it is absolutely necessary for Flender-Germany to organize the Buying Team in a way that the individual member is assigned to a certain supply part or SPGN respectively. By that the Flender-group can ensure to fulfill its policy of long-term win-win relations between the Flender and its suppliers.

Any change in regard to the work objective and task within the Buying Center, such as the decision for local sourcing of DIN/norm supply parts, need to be planned with the present competences of the involved people.

The members of the Buying Team will only be able to work efficiently if they dispose of the appropriate competences, i.e. the Buying Team has to work in the framework of a matrix organization and should be located on a high position in the company or at least within the department. The question of appropriate competences of the Buying Team, the current targets, the necessary product knowledge as well as knowledge about the supply strategy for newly defined supply parts have to be defined in cooperation by all partners within the Flender-group, like for example FTJ and Flender-Germany. All members of the Buying Team need to be trained and informed regularly especially in regard to changes on the supplier market and in case of changing objectives, for example if FTJ changes its emphasis from price to delivery time for the procurement of supply parts.

The appropriate general organizational conditions for the implementation of systematic activities by the Buying Team within the process of supplier approval and evaluation have to be provided where the Buying Team is situated, e.g. in the logistics department at FTJ. For the organizational conditions the main aspects that need to be determined include the involved people, the period, the respective information sources and the to be defined criteria for the relevant suppliers.

3.1.2. Procurement Strategy

FTJ currently does not dispose of a *business target system*, e.g. for procurement and production. All management decisions are based on experiences and not on the result of defined procedures within the logistics department or other organizational units involved.

The absence of a business target system depicts one of the main weaknesses of FTJ in regard to the missing corporate strategy for general business scopes as well as for special aspects, e.g. logistics. According to the concept of *policy deployment* the strategy of a company is the basis for the definition of goals for each business unit, which are than used to derive objectives

78 see Koppelmann, Udo: “Beschaffungsmarketing“, p. 29

for each department and each member of the company. It is very important that the strategy as well as the goals and objectives are clearly communicated within the whole company and that the later are recognized by each member since the objectives serve as a general orientation for every activity. The involvement of each individual employee and all groups of people[79] within the whole company is necessary for the successful implementation of processes.

The ability of the top management to provide and adapt the corporate strategy is hence the general presumption to provide direction through goals and objectives for FTJ. It is important that both, the hierarchical and the operational organization of FTJ are continuously adapted to the strategy to support each employee in a way that he is able to focus on his objective. The top management has not only to make sure that the overall company goals are broken down to each organizational unit and employee, but that they match and fit to each other within the overall picture.

Since this thesis focuses on the establishment of local Chinese sourcing of DIN/norm supply parts the following chapter provides an overview on a respective strategy and derived goals for FTJ.

Corporate Goals

Corporate goals depend on top management decisions; they include organizational goals and should reflect the overall potential of the company.
The current organizational goals of FTJ focus on production, logistics and procurement:

- Procurement and production of high quality products
- Search and contracting of alternative suppliers[80]
- Reduction of delivery time to a competitive level[81]
- Reduction of the number of employees and/or labor costs
- Reduction of product prices and working capital[82] and
- Restriction of the foreign currency risk[83]

79 A group of people can be a department or a team with members form one or several departments to reach one goal.

80 In this case the general intention is to reduce the dependency on Flender-Germany, as the main supplier of FTJ, and to increase the share of supply parts, which are sourced with local Chinese suppliers. With local sourcing the delivery times can also be reduced.

81 At the moment the competitor SEW sets the standard for the delivery time within the P.R. China.

82 According to the current procurement organization, with the urgent need for a breakthrough, the importance of this goal should step back in regard to the before mentioned ones.

83 One of the objectives of this goal is the procurement of supply parts from Chinese suppliers.

These goals have to be continuously evaluated regarding the market situation in the P.R. China. Local sourcing of supply parts in the P.R. China must be understood as the **major target**[84] within FTJ. First the targets which have been derived from the corporate goals have to be evaluated and than measures, periods and persons have to be assigned to the former to reach them. In case of the target *sourcing of DIN/norm supply parts in the P.R. China* one important measure is to check if the supplier is able to produce the required quality also on long-term and not only for samples of supply parts. As FTJ currently lacks the competence to do so a second target is to *train employees in the area of quality* especially for DIN/norm supply parts. It has to be defined which employees are trained and in which period the training will be finished. A third target could be that the than already trained employees *give advice to the supplier* to enable him to improve its quality.

At the moment another urgent target of FTJ is the direct procurement of all supply parts, which are so far sourced via Flender-Penig, but produced by external[85] German suppliers. Since FTJ is always trying to keep its working capital on a very low level, and by that its inventory of supply parts, the order quantities which are placed with Flender-Penig are normally on a very low, hence expensive, level. Due to that fact Flender-Penig is not willing any more to deliver externally sourced supply parts to FTJ. The related question of how the necessary direct payment of these German suppliers has to be handled is still not answered[86].

The analysis in chapter 2 explains the current situation and potential for improvement at FTJ. Ahead of the **major target** of the search of new suppliers a strategic and global decision of the Flender-group is necessary: regarding the question where to source and up to which level a supplier development should be realized.

Flender-Germany has already attempted to realize the concept of *global procurement management* in Germany some years before, but has not been successful due to the high prices of the foreign supply parts[87]. The general aim of a globally focused procurement is to find suppliers that deliver supply parts at a fraction of the current price with a shorter and more reliable delivery time and even at a higher or at least identical quality standard.

An internal survey carried out at Flender-Germany led to the result that the price level in Germany and also in Europe is considerably lower than expected, especially if compared with the U.S.A., India and even China with its low labor costs[88].

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84 In this thesis the terms *target* and *objective* are used as synonyms.

85 In this context *external* means outside the Flender-group.

86 Up to now Flender-Bocholt serves as invoice recipient for orders of FTJ in Germany.

87 sourced from outside Germany

88 source: Corporate Purchase / Logistics division of Flender-Germany; Mr. Niessing, Jörg

It is true that costs for transportation and customs duty have to be added to the purchase price of imported supply parts with a considerable aspect in International or Global Sourcing[89]. For a balanced judgment of complex decisions FTJ should use the method of **Cost Benefit Analysis[90]**. That means for example that the investment necessary for the establishment of a local procurement management need to be compared with the long-term savings potential of this strategy. By using the results of this analysis and by considering all respective other factors, e.g. currency risk, etc., it will be easier for the management to make a well founded decision.

Strategic Start

As already touched on FTJ currently applies and establishes three types of different supply strategies:

(1) Procurement of supply parts[91] from Flender-Germany
(2) Procurement of castings from local Chinese supplier in the Tianjin/Beijing area or even all over the P.R. China and
(3) Establishment of procurement of supply parts directly from German suppliers, which up to now has been sourced via the Flender-group.

One of the results of the analysis realized in chapter 2 is the fact that the procurement of supply parts from Germany is the decisive weak point in respect to the reduction of the overall lead time of customer orders at FTJ as the average delivery time of 42 days for sea-transport represents about 60% of the former[92]. This problem is the main reason for the already mentioned poor delivery performance of final products to the customers of FTJ. The implementation and optimization of the procurement management process will be discussed in chapter 5.

For the decision in favor of local procurement the top management of FTJ has to analyze first of all the possibilities to do so[93] and in a following step it has to analyze: the potential cost savings,

89 Following [Koppelmann, Udo: "Beschaffungsmarketing", p. 128] the term *International Sourcing* is used for procurement outside the home market when the respective company has only production sides located within its home market.
For the procurement of companies, which in addition dispose of production sites spread around the globe, the term *Global Sourcing* is used. These international companies do not only source outside the home market, but also connect their production facilities through a procurement network. This strategy has a variety of advantage and disadvantages; the main aim is to provide the cheapest supply parts to each production site.

90 The topic of Cost Benefit Analysis is not further discussed in this thesis.

91 comprising DIN/norm, inner geared and other supply parts

92 The average stockkeeping period of supply parts before assembly of gear units is about 21 days.

93 In the current situation FTJ lacks the necessary contact information of the required suppliers like for example their address and telephone number, etc.

the reduction of delivery time, the additional personnel needed to place orders directly with suppliers as well as the gain of flexibility since a direct, personal contact can be established enabling FTJ to more quickly solve arising problems with its suppliers[94]. The following subchapter will provide decision support for an extended local supply.

Spheres of Problem

For the manufacturing process of FZG gear units four main types of supply parts exist: housings, HF-parts, DIN/norm parts and inner geared parts. Housings and HF-parts are less complex parts. DIN/norm parts are either internationally standardized parts (according to a DIN standard) or they are defined by a Flender standard. Inner geared parts are high quality parts and show a special design. So far local procurement decisions have been based on the complexity of a supply part. Therefore up to now only casting supply parts for housing and HF supply parts are sourced locally.

The market for supply parts in the P.R. China is developing. It is well known that the relatively young Chinese market lacks a long experience for the production of industrial products at western standards as well as respective production methods. Based on the well-known market potential it should be quite easy to procure DIN/norm supply parts in the P.R. China[95].

If-Than-Decisions[96]

For decision makers it is clear that a decision often depends on different factors. From that follow several aspects for a beginning of a solution:

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94 Nowadays, following [Koppelmann: "Beschaffungsmarketing", p. 128], limited possibilities of communication are not the decisive factor any more for the question of sourcing locally, i.e. in the direct neighbourhood or on an international level. But nevertheless companies of today attach importance to the possibility of supplier integration when new production sites are chosen (e.g. Ford in Saarlouis, MCC in Hambach). In connection to the Just-In-Time strategy the companies try to avoid any disruption. And it cannot totally be denied that the responsibility as a component of trust becomes weaker with increasing geographical distance, because the social 'pressure' takes off.

95 Following the [German-Chinese BusinessForum, Number 6, December 2000, p. 8] surveys of more than 50 German companies show that the share of local procurement in the P.R.C. is already astonishing high in regard to the total number of suppliers. More than three quarter of the companies have given the information that they already source more than 60% of their supply parts in China. But at 75% of the companies the value of the Local-Content is under 60%. German companies are not able or not willing to localise the procurement of critical supply parts over a longer period in the P.R.C.
But according to personal relations to potential suppliers and own market experience of the author on international trade fairs, e.g. in Guangzhou, Beijing and Shanghai, it can be stated that there are already many foreign and domestic suppliers on the market of the P.R.C.

96 for this part see Koppelmann, Udo: "Beschaffungsmarketing für die Praxis", p. 24pp.

- The defined *procedure* has to be transparent and useful for the procurement manager, who should be enabled to realize results through objective judgments and decisions within a limited period and with scarce means.
- Respective *If-conditions* have to be provided which represent the best approximation of the real procurement situation. By preparing the different 'that-is-what-it-depends-on' the procurement manager will be able to choose the appropriate decision criteria.
- Just as important as if-conditions is the development of *consequences of activities*. Whereas the If-conditions are always valid, i.e. on all stages of the procurement marketing process, the consequences of activities depend on the stage.

It is important that the decision characteristics are not too narrowly related to the market component, but help to influence the overall decision process.

One of the first steps in the right direction has been proposed by Kraljic (1977). Oriented on two characteristics he created four different types of supply parts shown in table 3.1.-2:

Table 3.1.-2: Matrix of profit and risk[97]

Influence on profit **Procurement risk**	**High**	**Low**
High	Strategic supply parts	Bottleneck supply parts
Low	Key supply parts	Standard supply parts

This rough structure is not sufficient for a general decision system. Further analysis is necessary. Additionally the supply parts have to be classified by the following two characteristics:

- constitutive
- accessory

For the classification process the procurement manager has always to start with the assignment of a constitutive characteristic to each product or each supply part respectively[98]. According to the criteria: quantity, degree of innovation and scope of performance the following classification in table 3.1.-3 can be used:

97 see Koppelmann, Udo: "Beschaffungsmarketing für die Praxis", p. 25

98 The expounded classification is in general also useable for other procurement objects, like for example machines, and not only for supply parts. Further on the term *procurement product* is used for the terms *product* or *supply part*.

Table 3.1.-3: Classification of procurement products and respective examples

Constitutive Characteristics	Example for FZG Supply Parts at FTJ
Single procurement product	MOTOX geared box
Standard procurement product	Bearing, shaft seal
Proven procurement product	Pinion shaft
Innovative procurement product	Castings with special design
First-class procurement product	CAVEX worm gearing[99]
Cheap procurement product	Fan, fan cover
Specific procurement product	Special bearings

A *single procurement product* is only procured in small quantities, e.g. process engineering systems. *Standard procurement products* are standardized within the company or between the company and its suppliers, e.g. bearings or DIN/norm supply parts. A *proven procurement product* is already purchased during a long period and is also used for new final products. In contrary to that an *innovative procurement product* represents a new, and by that quite risky procurement product. For high performance procurement products companies procure *first-class procurement products* whereas *cheap procurement products*, with their low performance, make low prices possible. *Specific procurement products* are produced in regard to the special requirement of one company.

After the selection of one of these characteristics additional accessory characteristics can be added. The later complements the current decision environment. The diagram 3.1.-2 gives a selection of possible accessory characteristics[100].

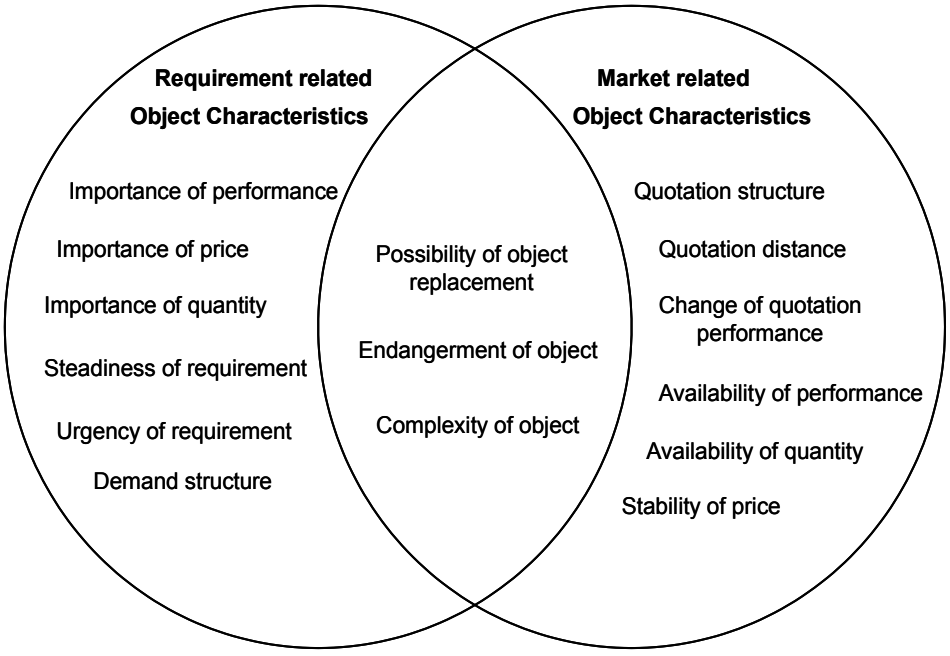

Diagram 3.1.-2: Accessory decision characteristics

99 although it is standardized

100 see Koppelmann, Udo: "Beschaffungsmarketing für die Praxis", p. 26

The *importance of performance* characterizes the strong influence of the procurement product on the performance of the final product of FTJ. A high *importance of price* means that the price of the procurement product has a great influence on the price of the final product due to its own high price level. A high *importance of quantity* catches the high share of quantity of the procurement product per procurement period. The *steadiness of requirement* represents the X-component of the XYZ analysis, hence the continuous constant quantity. A high *urgency of requirement* results from unforeseeable procurement situations and the costs of late delivery. The *demand structure* can be concentrated (high own share of the source of supply) or competing (small own share of the source of supply).

In opposite the competing and concentrated *quotation structure* can be found. The *quotation distance* describes the distance to the supplier. For an international purchase the former would be high. A high *change of quotation performance* means a fast change of the performance of the procurement products. In dependency of the required performance a high *availability of performance* cannot always be expected. Bottlenecks in production and a boom of demand can cause a reduced *availability of quantity*. For the own cost planning a high *stability of price* is necessary; by which the later can be disturbed is well known.

Between these requirement and market related object characteristics lie the following object oriented ones: the *possibility of object replacement* catches the possibility of substitution of one procurement product by another one. A high *endangerment of object* covers on one hand the susceptibility and on the other hand the dangerousness of the procurement product. A product can be classified as *highly complex* in regard to its high sophistication as well as its use in the production process.

From this collection of decision characteristics FTJ has:

- To chose these characteristics, which are situated within the framework of decisions,
- To judge the concrete procurement product according to the former,
- To order the selected decision characteristics within a hierarchy according to their specific importance and then
- To assign the appropriate alternative measures to these decision characteristics.

The following table 3.1.-4 shows the matrix for the relation between conditions (if-component) and respective measures (then-component).

It can be seen that in the example the table contains information for a first-class procurement product where the availability of performance is low (most important accessory characteristic) and the importance of performance is high. It is than necessary to assign respective measures, e.g. supplier evaluations and benchmarks, to each decision characteristic. For each supply part or SPGN respectively such a specific table (decision structure) has to be created.

Conclusion

From those matrixes a respective decision support can be derived during each decision phase. This procedure provides several advantages for FTJ:

1. The supplier is not subject of a general recognized assessment audit, but the assessment is focused on the respective procurement product. That makes the supplier evaluation more realistic and a supplier, which at first glance has been uninteresting, may become interesting again.
2. Once a run from the if-conditions to the then-measures is realized, the result can be saved in a computer application.
3. In case of identical situations this program will quickly provide a systematic printout[101] of recommendations for measures for the new situation.
4. This frame of action makes the quick search of systematic decisions easier.
5. The computer printout or the pdf-file, provided with given reasons for deviation from defined measures, at the same time serves as a lucid protocol. Decisions are moved from the ‘haze of the intuitive-right’ into the ‘light of being-checkable’.
6. The protocols not only serve for justification of the acting person as other employees can easier take over the task.

101 An alternative to a paper printout is the creation of a pdf-file. The later makes document management easier in the future.

Table 3.1.-4: Measures oriented towards specific decision characteristics[102]

Condition (if-component) Measures[103] (then-component)	Single procurement product	Standard procurement product	Proven procurement product	Innovative procurement product	First-class procurement product	Cheap procurement product	Specific procurement product	Importance of quantity (high)	Importance of performance (high)	Importance of price (high)	Availability of performance (low)	Etc.
Hierarchy					1				3		2	
…….. Demand - Requirements …….												

3.1.3. Reasons for the Search of New Suppliers

Changes and adaptations of the supply chain management of FTJ are necessary to sustainable solve the problems expounded in the first two chapters. The author [Koppelmann1997][104] defines five general business problems in regard to the management of supply chains:

- ❑ Problem of costs
- ❑ Problem of profit
- ❑ Problem of time
- ❑ Problem of ideas
- ❑ Problem of acceptance

The **problem of costs** refers to the fact that nowadays cheap competitors force the other companies everywhere in the world to reduce costs leading to the question ‘how’ and ‘where’. Reduction of costs under comparable conditions represents an additional endeavor with buzzwords like ‘lean management’ and ‘business reengineering’. As customers become more and more price sensitive in regard to new products and follow-up models the companies have a **problem of profit**. It is necessary to determine the maximal purchase price of each component proceeding from the competition on the sales market and the targeted customer group to know the achievable product price.

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102 adapted according to Koppelmann, Udo: "Beschaffungsmarketing für die Praxis", p. 28

103 In this context the term *measures* refers to the characteristics of the respective procurement products, which have been assigned to a certain level within the hierarchy (marked with a number). These characteristics have to be further analysed, i.e. respective measures have to be defined.

104 see Koppelmann, Udo: “Beschaffungsmarketing für die Praxis“, p. 1pp.

All activities of a company have to be performed with a competitive speed according to the picture that the fast companies eat up the slower ones. That constitutes the **problem of time**. Every anxious hesitation and inability to deliver is merciless judged by the market. It is eminent that lost market shares are normally permanent. The procurement department has the responsibility to speed up the supply chain in order to enable FTJ to sell more than Me-too-products leading only to Me-too-dividends.

The **problem of ideas**, which is interconnected to the before mentioned problems, represents the hypothesis that there will be a competition for new ideas in the future. This would lead to enormous consequences: flattened hierarchies like in with lean management, obligation for creativeness, etc. Corporate procurement marketing will take the place of an administering material management.

The behavior of yesterday leaves tracks, for example the question how the company behaves in regard to its environment, its employees and suppliers causing so-called image tracks if the involved parties get to know. This **problem of the acceptance** of a company's behavior is independent of the 'correct' interpretation of the tracks left, as can be seen in the case *Shell/Greenpeace* and *Brent Spar*. Misuse of the information and data provided by the supplier prevent both parties from a cooperative development based on mutual trust.

For the search of new suppliers FTJ should pay attention to all of these above mentioned aspects or problems respectively, because **reliable relations** between FTJ and the suppliers are the basis for an efficient supply chain functioning without disturbances. That means these aspects are also vital for the evaluation of suppliers

The following list states reasons for FTJ to search for new suppliers:

- Loss (or imminent loss) of existing suppliers
- Poor performance of the existing supplier (quality, price and delivery time)
- Low flexibility of the supplier in regard to changing order quantities and
- Lack of willingness or ability to deliver new supply parts[105]

It is very difficult for FTJ to find Chinese suppliers, who are willing to adapt their performance to new requirements, especially as FTJ often only orders small quantities.

Competition

With the market entry of the Flender-group in the P.R. China this company has done a mayor step forward and now belongs to the global players. Although the Flender-group already has sales offices and production sites in other countries around the globe, the presence in mainland China is special. On this market Flender-China faces at least three to five major competitors,

105 This means supply parts developed by Flender.

which are all strong positioned on the market, each of them with a special advantage for the customer, and which are all quickly expanding[106]. Local manufactures of gear boxes mainly compete on the market by low prices[107], but fight with a poor reputation due to quality problems.

Foreign competitors (JV, WFOE) of FTJ mainly offer products with the same or even lower price and also with a quite high quality standard and a delivery time of 2 to 8 weeks. In general these foreign companies sell standard products with a standard ratio range in the P.R. China. The biggest competitor of FTJ, a German manufacturer, is also located in Tianjin.

Chapter 1 shows a growing gap between FTJ and its major competitors according to prices and delivery times for FZG gear units. The reduction of procurement costs and delivery time by the already mentioned search of local supplier can help to close this gap. Fast reaction on the **ever changing market** are caused by a growing number of foreign companies entering the Chinese market for the search of market share. A **strategic orientation** is essential for FTJ in order to keep its market share. The related risk and the necessary investment for search, evaluation and development of new suppliers have to represent an appropriate return on investment, either in form of a direct profit or in form of higher flexibility and a greater number of alternative supply sources[108].

Currently it is unclear if it will be possible to procure *inner geared parts*, which represent a high value as well as a complex design[109], on the local Chinese market, i.e. there will be no shift from German to local Chinese suppliers in the near future except for DIN/norm parts.

Since FTJ is so far sourcing most of its supply parts from Germany, the resulting material costs are higher and the delivery times for supply parts are longer than with its competitors in the P.R. China. The current good supplier relations between Flender-Germany and its suppliers in Germany have been building up in the last decades. To establish a respective local procurement network in the P.R.C. by Flender-China or FTJ respectively will also take a certain time, but the existing experience and international relations of the Flender-group made in other countries around the globe can be used to shorten this period and to avoid expensive errors.

3.1.4. Experiences with Current Local Sourcing in the P.R. China

With the entry of the P.R. China into the WTO[110], new opportunities appear for collaboration between foreign and local companies in various fields. More and more foreign companies do not

106 see the analysis in chapter 1

107 Diagram 1.1.-1 shows that local Chinese competitors are up to 30% cheaper compared with FTJ.

108 sehe Koppelmann, Udo: “Beschaffungsmarketing”

109 In most cases inner geared parts are mainly designed and produced by Flender.

110 effective with 1st of January 2002

only produce but do also procure a certain share of their supply parts on the market of the P.R.C. Different requirements and conditions apply for local sourcing.

One aspect for local sourcing of foreign companies is that JV-contracts require a certain share of *local content* of supply parts. Another one is the reduction of procurement costs either in regard to transport or to purchase costs.

An example for a required level of local content is the Joint Venture contract between Shanghai Volkswagen and its local JV-partner. This contract requires a local sourcing content of 85% for the procurement of all parts with the same quality standard as in a German production[111]. At the moment FTJ is not obliged to source a certain share of local content of supply parts for its final products.

Foreign companies, which have set up JVs in the P.R. China, are often more developed in regard of technology and quality level than local state owned production companies. That's why foreign companies often bring in modern technology in the JV and the local partner provides the production site, the work force and local contacts. The first partly foreign owned supplier JV, which in the beginning only supplied inside door handles to Shanghai Volkswagen, is a good example for that. Since this supplier disposes of a better production technology in comparison to the other (100%) Chinese suppliers of Shanghai Volkswagen, he could also win orders for other types of supply parts from Shanghai Volkswagen enabling the later to not contract any more some of its older Chinese suppliers, which have not met the German quality standard required by Shanghai Volkswagen[112].

This example shows that not all companies in the P.R. China have a reputation for bad quality. For FTJ that means to step up its investment into personnel and to provide strategic support to become able to search for the appropriate suppliers.

And what about suppliers, which are not located within the Tianjin/Beijing region? With the search of new suppliers in the entire country FTJ has to consider logistic concerns especially in respect to the different means of transport since the efficiency of logistics as still not reached the western standard[113], even if the current development in the P.R.C. leads to an improved infrastructure making it easier to contact suppliers, which are far away. But certain problems remain as table 3.1.-5 shows for the aspect of transportation.

It can be seen that transport by water is by far most often used, but transport by train is the cheapest and highway as well as air are the fastest ones.

111 Dietz / Harnischfeger-Ksoll: "Erfahrungen im China-Geschäft", p. 64

112 Dietz / Harnischfeger-Ksoll, "Erfahrungen im China-Geschäft", p. 64

113 refers to Wang Xiaoqing: "Neue Marktchancen für deutsche Logistik-Spezialisten"

Table 3.1.-5: Key logistics figures for transport within the P.R.C.[114]

Mode of Cargo Transport	Freight Volume	Avg. Freight Distance	Positive Aspects	Negative Aspects
Rail	32.2%	768 km	Lowest price Fixed schedule High chance of reaching destination	Advanced reservation High degree of product handling Capacity issues
Highway	14.4%	58 km	Flexible schedule No capacity problems Door to door Negotiable Rates Speed	Costs are significantly higher Topping up of loads
Water	53.3%	1,855 km	Decent capacity Reservations available	Limited scheduling Time depends on weather conditions
Air	0.1%	2,482 km	Excellent schedules Speed	High costs

Further aspects of procurement are listed in table 3.1.-6.

Table 3.1.–6: Problem issues in regard to local procurement in the P.R.C.

Problem Issue	Explanation
Delivery time	➢ From stock: ~ 5 days (casting product) ➢ From production: ~ 20 days (casting product)
Order quantity	➢ Small order quantities are difficult to place with big suppliers as they use big machinery for mass production[115].
Price level	➢ Product prices are partly higher than in Germany. ➢ Costs for quality problem, transportation and higher cost for negotiation[116] need to be added to the procurement price.
Quality	➢ Quality level is slowly improving (attention still necessary). ➢ Agreed quality measures and exchange of knowledge can reduce quality problems.

114 Source: “German-Chinese BusinessForum”, Number 6, Dec. 2000 p. 12

115 In the beginning FTJ has contracted one Chinese supplier, which only was a small company. Now this supplier has developed into a big supplier with new customers placing higher order quantities than FTJ. Currently this supplier rejects ‘small’ order quantities from FTJ.

116 The supplier search and approval requires more effort than in Germany due to more visits of the Buying Team with the suppliers in regard to the required quality.

3.1.5. Benefit Analysis of Local Sourcing

The example of Shanghai Volkswagen demonstrates that a successful local procurement in the P.R.C. is also possible for FTJ. With the appropriate investment of time and strategy FTJ will be successful.

In general there are *hard* and *soft factors*, which are used to decide from which suppliers a company procures. *Hard factors* are factors, which can be measured directly, like for example the purchase price of a supply part, and hence can be considered as objective factors.

On the other side *soft factors*, as for example the flexibility of the supplier in regard to the supply of newly designed supply parts, can only indirectly be measured and lead to relatively subjective judgments.

This chapter focuses on the question of how to calculate the **absolute savings potential (ASP)**, which is directly measurable or calculable respectively, and the **relative savings potential (RSP)** for a supply part. The calculation is based on the results of the ABC analysis of DIN/norm parts for FZG supply parts sourced from Flender-Penig[117]. As already mentioned before, the search for new suppliers should start with the supply part group names having an A share of 100% and a high sourcing value and continuing with supply part group names, which have a high A share, but where some supply part models are also defined as B-parts, etc. The absolute savings potential is a helpful decision factor, which indicates the savings potential of a supply part in regard to the current and the new supplier, based on certain standard information, hence if money can be saved by sourcing from the new supplier.

It is calculated for one supply part:

[Absolute Savings Potential] = [real procurement price of current supplier] – [real procurement price of new supplier]

It is very important to understand the difference between the *purchase price*, which is normally used to compare two offers at FTJ, and the *real procurement price*. The purchase price is understood as the price for a supply part offered by the supplier. But with conditions differing per supplier, in regard to the procurement process up to the dispatch of the final product at FTJ, additional costs, like for example stocking costs, have to be covered.

The following formula is used:

[real procurement price] = [purchase price] + [additional costs]

The following table 3.1.-7 shows how to calculate additional costs:

117 see chapter 2.1.7.

Table 3.1.-7: Calculation of additional costs

	Cost Type	Formula
	Transport cost	[weight of supply part in kg] * [transport costs of 1 kg]
+	Order costs	[order costs per order] * ([order frequency] / [total quantity ordered])
+	Late dispatch	(([period 'from ExW supplier up to ExW FTJ'] – [period allowed for payment from ExW supplier]) / [days per year]) * [interest on working capital] * [purchase price])
+	Stocking costs	(([stocking period] / [days per year]) * [total stock holding costs] * [purchase price])
=	**Additional costs**	

For the current situation at FTJ the following general data can be used:

Table 3.1.-8: General data for calculation of savings potential

Interest on Working Capital	Total Stock Holding Costs	Days per year
6% per year	14.5% per year	365

The rest of the needed information depends on the supplier. To get a realistic result for the real procurement price the likely value[118] has been used in table 3.1.-9:

Table 3.1.-9: Specific data according to the supplier

Supplier	Transport Costs per kg (RMB)	Order Costs per Order (RMB)	ExW Supplier till ExW FTJ (days)	Period allowed for Payment from ExW Supplier (days)	Stocking at FTJ (days)
Chinese supplier	0.00[119]	25.88	17.5	44.5	15.0
Flender-Penig	0.85[120]	37.95	72.5	60.0	28.5

According to the above stated formula, it is only possible to calculate the Absolute Savings Potential if the weight and the purchase price of a supply part are known. As up till now no purchase prices for supply parts from local Chinese suppliers have been available, purchase prices have been considered as identical with all suppliers. The benefit analysis has been carried out for a total number of five supply part group names within the DIN/norm supply parts. The following table 3.1.-10 shows example results:

118 calculated by dividing the sum of the minimum and maximum value by two

119 The transport costs for Chinese supply parts are included in the purchase price.

120 These are the costs for the transport ‚by sea'. If transport 'by air' would be considered, the ASP would be far higher.

Table 3.1.-10: Example results for the absolute and relative savings potential

Part Code of Supply Part	Purchase Price (RMB)	Real Procurement Price (RMB)		ASP (RMB)	RSP
		Flender-Penig	Chinese supplier		
01500050015329[121]	1,014.72	1,036.69	1,020.88	15.81	1.6%
01527958823824[122]	249.20	256.99	252.19	4.80	1.9%
01502900068897[123]	29.84	33.68	32.22	1.46	4.9%

The RSP is the percentage value of the ASP in relation to the real procurement price for sourcing from Flender-Penig. It can be seen that the lower the purchase price the higher the probability of a high RSP. The reason lies in the unfavourable distribution of order costs for cheap supply parts as table 3.1.-11 shows:

Table 3.1.-11: Impact of order costs on the increase of procurement prices

Part Code of Supply Part	Purchase Price (RMB)	OF	Total Qty. ordered	Absolute Order Costs per Part (RMB)[124]		Share of Order Costs in regard of Purchase Price	
				Flender-Penig	Chinese Supplier	Flender-Penig	Chinese Supplier
01500050015329	1,014.72	7	17	15.63	10.66	1.5%	1.1%
01527958823824	249.20	3	19	5.99	4.09	2.4%	1.6%
01502900068897	29.84	51	525	3.69	2.51	12.4%	8.4%

The same effect is known for all types of cost, like transportation cost, when the value of the supply part is not taken into consideration for cost calculation hence where fixed costs occur. So the **general rule** reads:

The lower the value (hence the purchase value) of the supply part per order the cheaper it will be for FTJ to stock it for a certain period instead of ordering the supply part according to the incoming customer orders.

To get a general result for a whole *supply part group name* the sum of all ASPs has to be calculated representing the sum of all ASPs per model and considering the quantity ordered per model. This sum is a first hint in regard to the search of new suppliers. The following table 3.1.-12 contains example results:

121 The supply part group name is BACKSTOP.

122 The supply part group name is FAN.

123 The supply part group name is BREATHER.

124 order costs: RMB 37.95 for Flender-Penig and RMB 25.88 for local Chinese supplier

Table 3.1.-12: General results of ASP and RSP

No.[125]	Supply part group name	Sum of ASP[126] for 7 months (RMB)	Estimate of ASP for 12 months (RMB)	Overall RSP
1	BACKSTOP	2,533.52	4,343.18	1.4%
2	FAN COWL	2,300.92	3,944.43	1.4%
3	FAN	1,439.77	2,468.18	2.7%
7	BREATHER	1,196.95	2,051.91	5.8%
33	PARALLEL KEY	5,421.50	9,294.00	12.6%
	Total	**12,892.66**	**22,101.70**	**2.7%**

For a more clear statement an estimate for 12 months should be used instead of the result for seven months, resulting in about 22,000 RMB of absolute savings potential[127] for the total of all supply part group names if the later are currently transported by sea from Flender-Penig to FTJ, if the purchase prices of both suppliers are identical and if all supply part group names would be completely sourced with the new local Chinese supplier in the future.

The five supply part group names represent about 12.6% of the value share of all supplied DIN/norm parts and 3.5% of the value of all supplied parts.

3.2. From Supplier Search to Supplier Contracting [Part A]

For FTJ the supplier relations within the P.R. China are so far not based on a mutual win-win situation for both sides. The top management of FTJ points out that the suppliers should be able and willing to accept almost any order quantity of FTJ. The current procurement problems show that this policy of placing project oriented small order quantities is not appropriate, at least not in relation to the major suppliers.

As already mentioned, some of the (often foreign JV) suppliers already make use of modern, i.e. expensive, production facilities where small quantities are not economical any more. But these companies still accept such orders and forward them to smaller production companies (private or state owned Chinese companies), where the same supply parts are produced at a much lower price and bad quality.

125 Indicates the ranking within the total result of the ABC analysis for DIN/norm parts of 49 group names with no. 1 representing the most important supply part group name if all SPGN are sorted by their A share (descending), B share (descending), C share (descending), value share of DIN/norm parts (descending), quantity share of DIN/norm parts (descending), value share of all parts (descending), quantity share of all parts (descending), A-qty., B-qty., C-qty. and SPGN.

126 For the period 01.07.2001 until including 31.01.2002.

127 The calculated ASP is only valid in case that the transport costs for sea-transports are paid by FTJ, because up till now Flender-Penig pays for sea-transport, but that can change in the future.

3.2.1. Search of New Suppliers

The successful search for new suppliers requires a correct planning oriented on goals and targets as well as based on knowledge about the steps necessary for the search of new suppliers[128]. The search for new suppliers in the P.R. China is realized by the respective Buying Center of FTJ.

An ABC analysis and further calculations have already been carried out, based on the strategic decision to start with DIN/norm supply parts for the search of local Chinese suppliers[129]. By that the **Buying Team** disposes of a respective classification of DIN/norm supply parts according to the ASP, which is necessary in the very beginning.

The Buying Team should use the approach expounded in diagram 3.2.-1[130] to assure a systematic procedure for the search of new suppliers.

The general concept of this funnel procedure is to narrow the number of potential suppliers step by step through the gradual use of selection filters up to the point where FTJ disposes of a small number of suppliers, e.g. three, where the negotiations seem promising. By the use of that procedure the search of new suppliers is economical for FTJ as a specific analysis of a potential supplier is only made for the final suppliers.

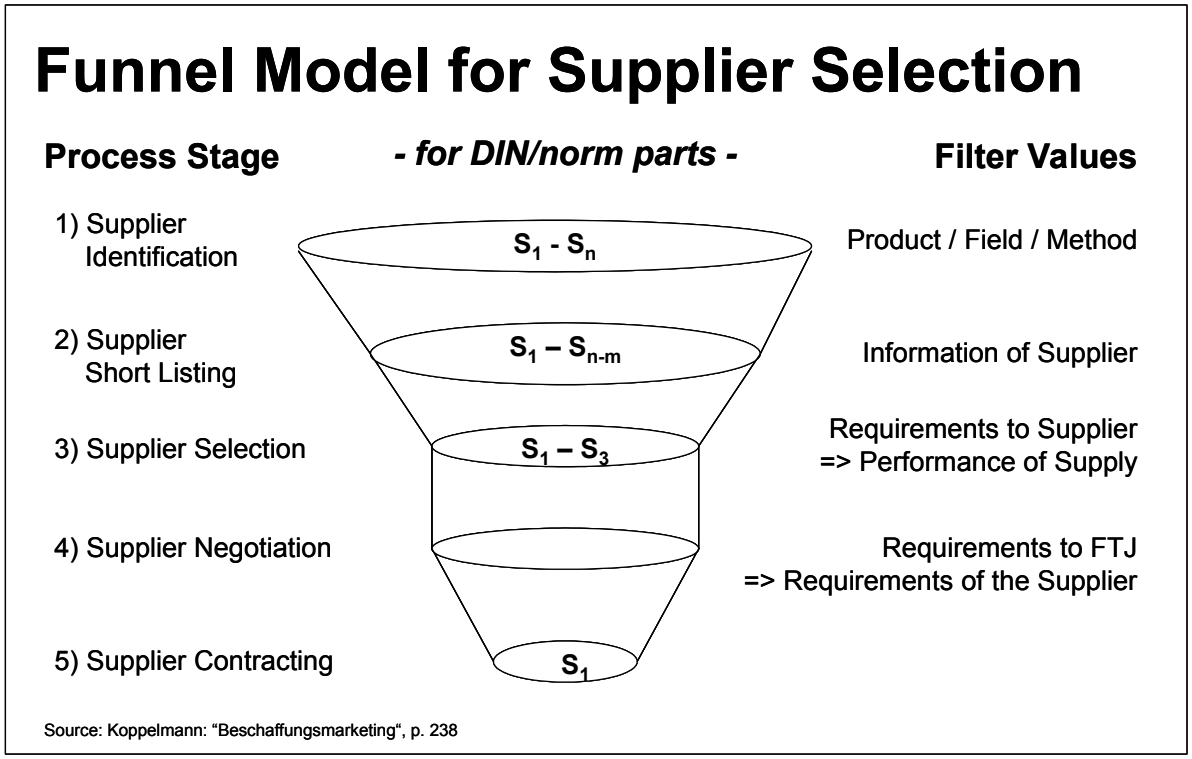

Diagram 3.2.–1: Funnel model for supplier selection

128 see diagram 3.1.-1 Procurement management

129 see chapter 2.1.7. and chapter 3.1.5.

130 for this approach see Koppelmann, Udo: "Beschaffungsmarketing", p. 238pp.

1) Supplier Identification

First of all the Buying Team has to determine the respective market area as suppliers are located on markets.

(1) This market area can for example be based on the material or product range of the supply parts. Since FTJ has defined DIN/norm supply parts for local procurement, suppliers with respective experiences are included in the selection process.

This orientation on the procurement product is simple and understandable, but has the disadvantage to be based on past data. A supplier, which up to now has only produced water pumps of type A, is maybe also able to produce other pumps, but nobody has ever ordered different pumps or the supplier has not actively commercialized his abilities.

(2) That's why it can be ingenious for the supplier identification to look on the broader field. In the before mentioned example all producers of pumps have to be considered. There is certainly one supplier, which likes to expand its product range.

(3) Another possibility, for example in case of a special procurement product, is to look for suppliers which offer similar procurement products or which use similar procedures for production. This can mean that, in case AIR GUIDE COVERS are needed, the Buying Team looks for example for suppliers which produce press parts in small numbers with a high and constant performance.

The vast amount of trading and production companies in the P.R. China makes the search for the suitable supplier a quite complicated task. The 'CHINA BUSINESS GUIDE'[131] includes 500,000 small and medium sized enterprises.[132] This guide and others similar initiatives by the Chinese government shows the contribution of enterprises and suppliers to a comprehensive network of organization engaged in the development for local and international trading.

Within this network of organizations the search of new suppliers includes the identification of the supplier range. The main possibilities for the identification and search of supplier as well as the establishment of commercial relations in the P.R. China are:

- Direct visits and talks to potential suppliers
- Search via Internet[133]
- Search of agents, which sell procurement products of different suppliers

131 China Business Guide – Data bank of China export commodities: http://www.cbg.org.cn

132 The CHINA BUSINESS GUIDE is a project financed by the Chinese government to help Chinese enterprises to expand their overseas market and increase international trade. It contains 500,000 enterprises and 1,200,000 product entries.

133 http://www.cbg.org.cn, http://www.china-supply.com

- ❑ Take part on trade fairs in the P.R. China, e.g. on the *China Export Commodities Fair*[134]
- ❑ Participation on many smaller local expeditions focusing on certain product fields with the possibility to establish relationship to local suppliers

As already mentioned above, foreign companies that have established business relationships in the P.R: China play an interesting part, which should be considered for the search of new local suppliers. Several German suppliers have for example already established business relationships within the Chinese market. They have set up supplier agents, representative offices, WFOEs or JVs. The local procurement of supply parts in the P.R. China, which are produced by WFOEs or JVs, may reduce procurement cost[135], lead to a more reliable delivery time[136] while the product quality of DIN/norm supply parts would be on the level required by FTJ.

2) Supplier Short Listing

After the interesting suppliers have been identified they can be contacted. It can be assumed that in general a supplier has a high interest in a new customer. For the buyer such as FTJ it is helpful to gain information about the supplier via the effective method of a standardized **supplier self-analysis questionnaire**[137]. The later is only appropriate for the first contact between two parties. Additional and continuously reviewed information of potential suppliers need to be established within FTJ. The Buying Team can either send the questionnaire via mail to the supplier or uses a supplier exhibition where it can be directly filled in.

By the feedback of the supplier, FTJ can compare and even benchmark the suppliers according to the before set standards[138] and requirements. A completely filled in questionnaire[139] indicates that the potential supplier has a high interest in being contracted by FTJ[140].

134 Twice a year, in spring and autumn, China's *Export Commodities Fair* takes place in Guangzhou. It is by far the largest and most well known exhibition in the P.R.C. The turnover in regard to signed contracts is estimated to exceed 18 billion US-$; see http://www.chinatradeshows.com

135 For supply parts, which are produced locally in the P.R. China, customs duties are not applied.

136 The transportation time and the risk factor of late delivery are lower due to closer relationship and shorter communication ways; see chapter 2.6.

137 see Koppelmann, Udo: "Beschaffungsmarketing", p. 240

138 includes corporate standards of the Flender-group

139 For an example of a questionnaire appropriate for the requirements at FTJ see Annexes VIII- number 3.

140 see Koppelmann, Udo: "Beschaffungsmarketing", p. 239pp.

3) Supplier Selection

The third step within the funnel model, the supplier selection, is characterized by the possible further reduction of potential suppliers, which remain after assessment of the results of all self analysis questionnaires. This possible reduction of suppliers depends on the question if the potential supplier is able to fulfill the **performance of supply**, required by the Buying Team. The chapter 3.2.2. and 3.2.3. will discuss this topic in further detail.

4) Supplier Negotiation

In the stage of the supplier negotiation[141] the requirements of each supplier, e.g. minimum order quantities or order placement in due time, have to be discussed between both parties. The acceptance of the requirements of each supplier depend on the strength of the supplier or FTJ respectively as well as the sourcing strategy. The latest aspect is discussed in chapter 4.2.

5) Supplier Contracting

The supplier contracting is the final step within the selection process, where the Buying Team focuses on signing supplier contracts with the chosen potential suppliers. These contracts fall apart into general agreements, with definition of technical and logistical conditions, and specific order contracts. The conditions of any contract are based on the newly published legal conditions of the P.R.C.[142]

3.2.2. Supplier Requirements

Current experiences at FTJ show that the disregard of the requirements of local Chinese supplier leads to supply problems. The whole organization FTJ and especially the Buying Team have to be aware of the fact that a supplier is only willing to fulfill a certain demand, hence to deliver supply parts, if respective incentives are provided by FTJ. The demand and the incentives of FTJ have to be balanced.

In the stage of supplier selection additional information about the supplier can help to understand and to approve a supplier more successful. Further information can be collected at various occasions, e.g. supplier exhibitions or more efficient by visits of the supplier factory. The Buying Team or any other involved employee of the purchaser need to create a **'visiting or contacting report'** that may include performance information[143] about a supplier demand such as:

141 see chapter 3.2.4. for additional details

142 see chapter 3.2.4. for additional details

143 sehe Koppelmann, Udo: "Beschaffungsmarketing", p. 163pp.

- Requirements in regard to the delivery quantity
- Required performance (high standard of technology, state of the art)
- Required time (delivery time)
- Required location (interface for the means of transport)
- Required information exchange
- Requirements in regard to delivery (reliability of delivery, packaging, priority of delivery)
- Terms of payment (period allowed for payment, performance oriented discount)
- Service performance (assurance of high quality)

Before the approval process for new suppliers starts, FTJ and the Buying Center have to consider the objective perspective of a potential supplier. On the one hand it is possible that the requirements established by the supplier are not realistic and due to that any further negotiations will fail. On the other hand it is necessary to know the demands of FTJ for the supplier that can be considered in future negations. By this knowledge it is possible to identify and establish a win-win situation between purchaser and supplier. Some of the information that may be required by a supplier are included in table 3.2.-1:

Table 3.2.-1: Example of supplier request list[144]

Supplier Requests		
Field	**Requests**	
Distribution	Grow with purchaser	Explore new market field
	Advanced information flow	Handing over of service to purchaser
Production	Big order quantity	Long-term order quantity
	Constant order quantity	Utilization of underemployed sectors at the supplier
	Production planning support	Production realization support
R&D	Gain of know-how	Use of new technology and equipment
Finance	Advanced payment	Short-term payment terms
	Solvency	Fair price level
Logistics	Delivery to few sites	Early and initial information
etc.	…….……..	……..

Balancing Incentives and Demand

The purchaser FTJ is interested in an acceptance of his requirements by the potential supplier. Adequate instruments are necessary to support the successful implementation of balanced incentives and demand characteristics in regard to the supplier. The purchaser has to make use of strategic incentives that integrate the supplier in a win-win situation.
In respect to the current goal of FTJ, the local sourcing of DIN/ norm supply parts, a possible incentive could be to place the development of DIN/norm supply parts with a supplier. FTJ can make use of the existing design of DIN/ norm supply parts provided by the Flender-group.
Before orders can be placed at the supplier, FTJ has to assure and communicate the demand

144 based on ideas of Jörg Büchting

that all supply parts can be produces according to the set standards. As a respective incentive FTJ can offer help for the installation of respective production processes. By that the supplier can increase its competence in this area, which is also usable for the production of other supply parts of other customers. This constellation mainly applies for suppliers with no or little experiences of these supply parts. The implementation of such an *Incentive-Contribution Theory* at FTJ can have various positive results in the establishment of successful supplier relationships. In short-term FTJ will most likely profit of a reduced purchase price, of a higher quality of the supply parts and of a more reliable delivery performance.

3.2.3. Approval of Supplier

So far FTJ has currently approved[145] around ten suppliers for castings as well as for some other supply parts. The supplier approval at FTJ is only based on a few criteria which are based on subjective perceptions since there is a lack of indicators.
Currently the following aspects are checked with each supplier:

- Product range (scope)
- Supplied products (which have been delivered at least one time)
- Level of the foundry technology
- Level of the company management[146]
- Stability of quality level (at FTJ it is called 'identical quality')
- Service quality
- Casting price (RMB) and
- Comprehensive evaluation.

At the moment these criteria are not weighted to receive a rating of the suppliers.

The casting suppliers are currently approved according to the report of the visit of the production facilities and according to the supplier evaluation of the logistics department. In the logistics department one employee is responsible for contacts to the current suppliers and for the search of new local suppliers. The procurement of castings requires the technical and design review of all supplied parts by one casting engineer. His is regularly visiting each individual supplier to forward current product requirements as well as suggestion for the improvement of quality. At the moment the quality of supplied castings is measured by the quality department of FTJ.

The top management of FTJ is responsible for the final approval of a new supplier.

The supplier selection for DIN/norm supply parts needs a clear structure of requirements within FTJ. Some of the requirements have already been discussed. Each of these requirements are the basis for the measurement of the performance of the suppliers. The evaluation shows if

145 The term *approved* means that the potential supplier has already been evaluated by FTJ and meets the requirements of FTJ, but it does not indicate if he actually delivers supply parts to FTJ.

146 This based on the overall impression FTJ gets of a supplier.

important requirement can or cannot be met by potential suppliers. In case a supplier is unable to fulfill the requirements he is excluded from the pool of suppliers.

The first step and core issue in the supplier selection is the definition of the **supplier position** of the potential suppliers[147]. As already explained in chapter 2.3. the general supplier market in China is currently quite homogeneous[148]. Due to the small variety of different suppliers the range of criteria for a supplier positioning in regard to product cost, performance and risk is limited and still low if compared with Western standards. There is a growing gap between older, state-owned companies and newly founded local or foreign companies such as WFOE or JV with the main differences in the area of product costs, quality, delivery time, management style and innovation rate. FTJ has to consider these points.

As FTJ is mainly focusing on purchase prices, stable quality and delivery time it is necessary to create respective criteria, which are based on internal requirements of FTJ in accordance to the requirements of suppliers and all environmental factors. Some of the criteria for suppliers are expounded in the table 3.2.–2 below.

The established criteria can be further classified leading to adapted requirements that have to be met by new suppliers.

There are criteria for the supplier selection defined by Flender-Germany, like technical requirements and quality standards for a supply product, and others defined by FTJ, such as price range, delivery time and stocking. The Buying Team at FTJ has to control and continually review these criteria in cooperation with their colleagues in the logistics department. Additional criteria for the process of supplier selection are:

- Delivery time
- Distance of FTJ to the supplier company
- Quality of the supply part
- Packaging and
- Maximum production capacity of the potential supplier

One special problem of the Chinese supplier market, experienced by FTJ in the last years, is the fact, that evaluation reports quickly become obsolete as the respective suppliers change according to the rapid market development. That means for example increased minimum order quantities or price leaps making switches to alternative suppliers unavoidable. According to that situation, the supplier development and a regular supplier evaluation are necessary otherwise

147 see Koppelmann, Udo: “Beschaffungsmarketing“, p. 246

148 With the further opening of the P.R.C. the market will become more heterogeneous as more foreign companies will open up production sites in the P.R.C. and compete with local companies.

the customer expectations in regard of high quality gear units at a competitive price delivered in due time will be impossible.

Table 3.2.–2: Priority list for criteria for the supplier selection[149]

Characteristics	Very important	Important	Unimportant
Site/Location			X
Equipment and Size		X	
Image / Rating / Name recognition			X
Stability and Growth			X
Product Quality & Technical Performance	X		
Experience about Product Segment		X	
Delivery Reliability	X		
Punctuality	X		
Quality Certificate		X	
Complaint Handling		X	
Net-Delivery Quantity	X		
Net-Product Price/ Discount	X		
Terms of Payment		X	
Delivery Modality		X	

Supplier Portfolio

The supplier portfolio of diagram 3.2.-2 shows the relative strength of the purchaser FTJ and its suppliers. A **critical supplier** is a leading company on the market, where often no alternative suppliers exists forcing FTJ to look for similar supply parts, which serve as substitution. For **core suppliers** a high supply risk, like for critical suppliers, but in addition also a high impact of the delivery volume on the ability to manufacture at FTJ can be stated. As with **lever suppliers** the technical complexity is lower than with core suppliers, but delivery volume is still important, the focus of FTJ has to be on the potential for the reduction of material costs as well as the sourcing strategy. Low importance of technical complexity combined with low influence of the delivery volume on the ability to produce characterizes the

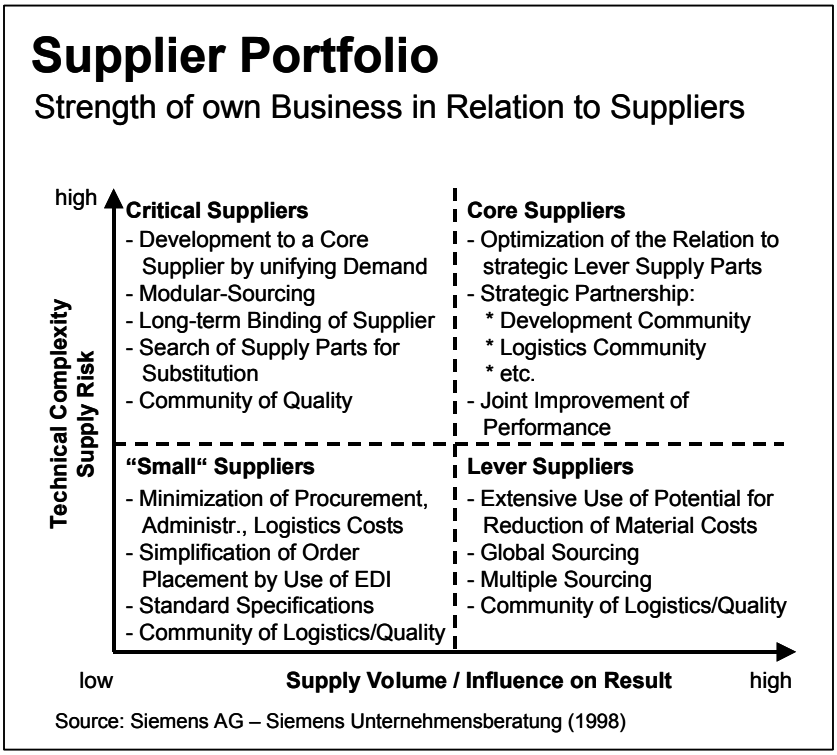

Diagram 3.2.-2: Supplier portfolio

149 following Siemens AG: "Stocking Methods" 2002

“small” supplier. For this case FTJ should try to reduce costs, e.g. by the use of standardized specifications.

The casting suppliers of FTJ can be classified as *“small” suppliers* as castings show a low technical complexity with a small influence on the value of the gear unit. A casting supplier can quite easily be substituted by another one. The same is valid for DIN/norm supply parts. For both groups of supply parts FTJ should focus on standards in regard to the specifications as well as communication, i.e. reduction of procurement, administration and logics costs.

Flender-Penig, as supplier of inner geared supply parts, falls into the category of a core supplier for FTJ, since inner geared supply parts represent a high technical complexity and have great influence on the value of the final product FZG gear unit. Respective measures can be found in the diagram 3.2.-2.

3.2.4. Supplier Contracting

Since the phase of supplier contracting, as final phase of the general procedure for the search of suppliers, is firmly related with the two preceding phases of supplier selection and negotiation, both phases will be once again be discussed in the beginning of this chapter. Since reliability and credibility are very important issues for FTJ it has to be assured that the respective **safety measures** are included within the procedure of supplier selection. Examples for safety measures are: use of standardized key figures in the process stages 1) supplier identification until 3) supplier selection to assure an objective comparison of all potential suppliers. Further on these standardized key figures should be the basis for standardized benchmarks.

During the phase of supplier selection it is especially important to clearly communicate the level of quality, the range of supply quantity, the price level and order frequency required by FTJ to the potential supplier whereas during the phase of supplier negotiation the Buying Team of FTJ has to assure that it has fully understood the requirements of the supplier. It has to check where the requirements of both parties match and where discrepancies appear.

In case of the later it is necessary to re-negotiate with the respective potential suppliers. As a safety measure the Buying Team has to predefine which concessions are acceptable for FTJ. The question of **contract penalty** has to be decided in respect to the type of supply part. In case of DIN/norm supply parts the use of standardized contract penalties makes sense as these supply parts are delivered by “small” suppliers where administration costs should be reduced, but if absolutely necessary the Buying Team should have the competence to adapt these standardized contract penalties.

It should be the aim of FTJ to avoid the actual use of any contract penalty through the consistent use of the before mentioned safety measures.

The internationalization of the P.R. China and the increase of foreign investment, e.g. foreign production sites like FTJ in development zones, make it important for the Chinese government to continually adapt its legal system to international standards.

The Chinese law of 1st of March 1999 contains several new regulations and possibilities in regard to contracts[150]. This law provides the purchaser with the right to define certain quality standards in its contracts and supports him if the supplier does not meet these contractual requirements. In case for example that delivered supply parts do not match the quality level defined in the delivery agreement these supply parts can be rejected. If necessary a signed contract can also be cancelled by one party[151]. Conditions for late delivery are also mentioned within this law, i.e. contracts between buyer and supplier can agree on contract penalties due to late delivery[152].

Currently a contract between FTJ and a local Chinese supplier contains several general agreements established in the 'General Terms and Conditions for Domestic Purchase'. These conditions currently contain information such as:

- Currency for payment (in RMB including VAT)
- Packaging:
  - Suitable packaging for safe delivery and ease of unload
  - Fork lift-able load (less than 3 tons)
- Place of delivery
- Necessary documents
- Additional information (so-called 'special reminder'):
  - Meet technical standard and inspection standard
  - Consequences in case of late delivery

Since so far Flender-Germany has established several additional conditions for contractual agreements with its suppliers FTJ should add at least the following points to its current general agreements:

- Accurate definition of required quality standard
- In case of nonconforming quality or delivery delay:
  - Rejection of supply parts
  - Possibility to cancel the contract

150 see German-Chinese BusinessForum, Number 6, Dec. 2001, p. 7

151 see German-Chinese BusinessForum, Number 6, Dec. 2001: contract law §§ 153, 148

152 see German-Chinese BusinessForum, Number 6, Dec. 2001, p. 34

- Return of advanced payment by the supplier for the order
- Replacement of supply and
- Reimbursement for the rework necessary at FTJ

Conclusion

All the before mentioned points of the general agreement have to be included in the contractual standard conditions used by FTJ in relation to its suppliers. This is especially necessary in the current situation of FTJ where the majority of supplier contracts are more tailored to the requirements of the suppliers than to the requirements of FTJ.
As a foreign company FTJ has the ability to create supplier partnerships where they communicate the advantages of standardization making it easier to convince the local Chinese suppliers to accept the contractual terms as they can see the benefits for themselves.

The use of a standardized procedure for the process of supplier selection through standard key figures and respective benchmarks as well as the use of standardized contractual conditions will be one of the assumptions for FTJ to improve its internal and external processes.

3.3. General Benefits of Local Sourcing [Part A]

Several factors have to be considered for a benefit analysis in regard to the question:
continuous sourcing in Germany or sourcing at the local Chinese market. The table 3.3.-1 gives a rough overview on the pros and cons of an increase of local procurement.

A local procurement has two main advantages for FTJ. Firstly the delivery time of supply parts can be reduced tremendously from an average of 42 days down to 5 days[153], which can also be used to improve the information exchange with supplier in various ways.

153 These figures are based on the experience of FTJ for the average transportation times of supply parts from Germany to the Tianjin (P.R.C.) and for castings within the Tianjin/Beijing region.

Table 3.3.–1: Pros and cons of local sourcing[154]

Contra Local Sourcing	Pro Local Sourcing
FTJ currently lacks the experience and partly the resources (finance, personnel, logistics) for local sourcing.	Local procurement may lead to reduced procurement costs, which can be used to finance the costs for local procurement and to reduce the prices of final products.
Customers do not directly reward locally sourced supply parts as German supply parts have a higher quality.	A reduction of delivery time will be possible. This will increase the attractiveness of the final products of FTJ.
Currently FTJ participates from the procurement volume of Flender-Germany, which assures competitive prices for supply parts.	Creation of direct relations to the local Chinese suppliers due to short distance and identical culture provides new possibilities for the negotiation of acceptable prices and development of supply parts adapted to the requirements of the Chinese market.
FTJ can quickly establish or find alternative suppliers.	Increase of flexibility in regard of delivery times.
FTJ can reduce transportation costs by introduction of Quantity Oriented Procurement.	Lower or no transportation costs as the former are included in the purchase price.

The second main benefit of local procurement is the potential for the reduction of prices for supply parts[155]. These advantages have to be weighted in comparison with the other above mentioned aspects (pros/cons). The transition to local sourcing has to be accompanied by a clear strategy, especially in regard to the schedule, a definition of respective processes and clear indicators, e.g. in the area of quality control, in order to avoid problems along the supply chain.

In regard to the local procurement some additional aspects have to be considered:

- Synchronization of the material and information flows of FTJ and all its suppliers with the goal to reduce warehousing costs and to speed up the supply chain resulting in a reduction of the overall lead time.
- The realization of the pull principle will be the easier to achieve the more efficient the information flows from the (most often Chinese) customer of FTJ to the (most often Chinese) suppliers of FTJ.
- FTJ has to predefine, stipulate, and if necessary to offer the appropriate means of transport according to the required speed, distance and costs for the transport of supply parts within the P.R.C. as the Chinese suppliers often either lack the knowledge or the willingness to pay attention to that aspect.
- FTJ has to lay emphasis on the fact that the suppliers use the appropriate packaging as the later fulfils the main functions for external and internal transport along the supply chain[156]. High costs and a slow material flow will be the result if the packaging has often to be changed at interfaces, e.g. at the receipt of goods of the warehouse.

154 based on conceptual ideas of Jörg Büchting

155 The question of additional costs, such as the cost for the search of new suppliers and evaluation are not considered here. For the calculation of the ASP/RSP of a supply part: see chapter 3.1.5.

Conclusion

The points, which have been touched on, have still to be weighted in regard to the benefits of all involved parties, hence the customers as well as the suppliers of the Flender-group. As the major goal of FTJ is the control of an **optimized supply chain**, which can only be achieved with the respective input of information from suppliers and customers, it very important to inform both parties of any improvements made. These improvements represent the required benefit for these parties and the basis for a joint partnership between them and FTJ.

3.4. Development of Delivery Requirements [Part B]

This chapter will in a first run provide a short-term outlook for the final product output in the financial year 2001/02 together with hints for the forecast of supply part quantities. In a following run it introduces to the topic of prognosis methods to enable FTJ to be proactive according to the evolution of the customer requirements.

"To be able to supply resources, it is necessary to know the requirements of the partner[157]. The better the requirements are foreseeable the better a company can adapt to it. However, if they are unknown, than the requirements will not be matched neither on schedules nor on quantities. That's why the knowledge of the partner requirements has such a great importance.

All activities of a producer have to be focused on the integration of customers. Customer integration is normally founded on trust, being usable for a requirement planning. The knowledge of sales regarding the evolution of customers as well as a coordination with customers according to the certainty of purchases, which can be displayed for example by requirement forecast information from the partners, can be excellently used for a prognosis of the partner's requirements.

On the other side, it will not always be possible to achieve integrated customer relations. So there will be a certain number of regular customers, where there is no special trust between both parties."[158]

At the Flender-group about 40% of the order intake is related to so-called 'application sales', hence orders related to a high customer integration and often joint development partnership, 51% to 'product sales', where Flender products with high standardization are sold and where availability and price of the product are most decisive, and 9% to 'service'.

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156 see Kuhn, Joachim, Harvard Business Manager, 5/2000: "Wenn sich Logistik und Qualitätssicherung ergänzen"

157 The term *partner* means *customer*; see Ehlers, Jörg D.: "Die dynamische Produktion", p. 105

158 see Ehlers, Jörg D.: "Die dynamische Produktion", p. 105, 106

Many of the most important customers of Flender in Germany are also customers of FTJ in the P.R.C., e.g. Suzhou Schindler and the Thyssen-Krupp AG.

FTJ does not make use of the monthly rolling forecast provided by the sales department, which is created once a month, due to the fact that this forecast is unfortunately not edited for the need of FTJ and is only right in about 50% to 60% of all cases[159]. In general forecast made out at FTJ are only rough estimates and are not based on adapted prognosis methods.

3.4.1. Development of Delivery Quantities

This subchapter shows one possibility for monitoring the output of final products and gives advice how to derive the respective supply part quantities in an ingenious fashion.

Monitoring Output Quantities

Diagram 3.4.-1 indicates the output quantity of FZG gear units in the financial years 2000/01 and 2001/02[160] grouped by types[161]. It can be seen that the overall output quantity increases by 47% per year, but the output for the most important type 'B' only increased by 24% and for type

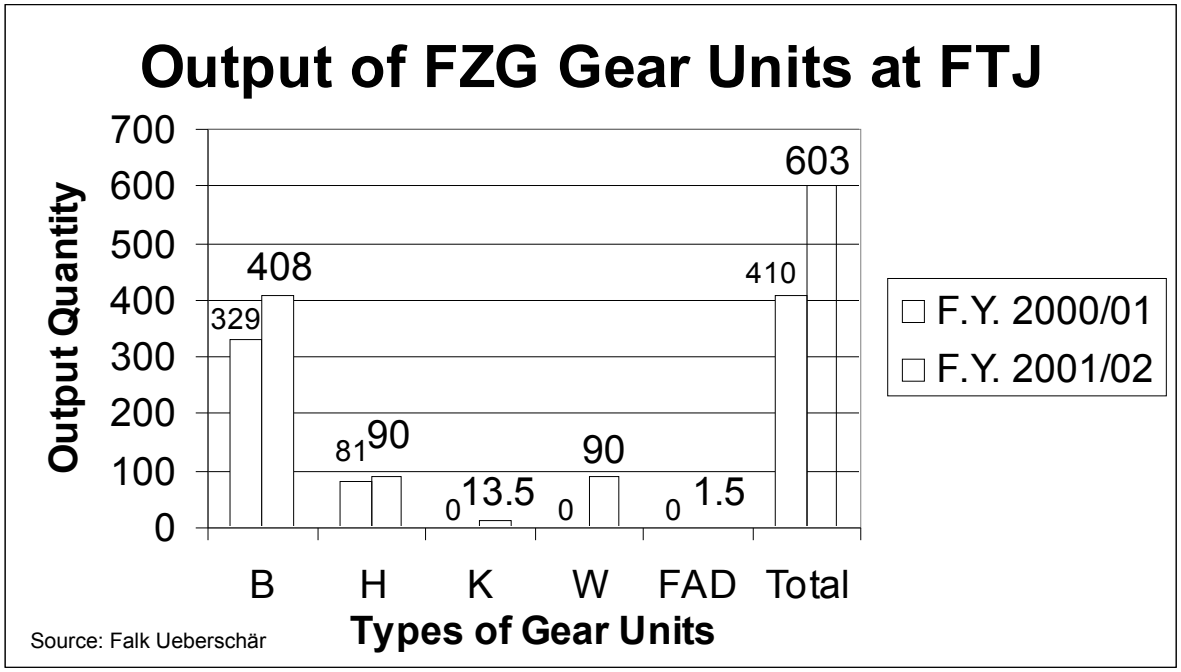

Diagram 3.4.-1: Development of output of FZG gear units at FTJ

159 a statement of the boss of the sales department in Beijing

160 The production output from 1st of June until 30th of September 2002 has been estimated by calculating the simple arithmetic average per month, based on the results of October 2001 until including May 2002, and multiplying this average with 12 months.

161 Type 'B' = 'Bevel-helical gear unit'; 'H' = 'Helical gear unit'; 'K' = 'Helical gear unit with extended total centre distance', hence longer distance between input and output shaft; 'W' is defined as 'traveling gear unit' or 'a type B, where the input shaft is mounted in 90° in relation to the output shaft; 'FAD' = a special gear unit (exact definition unknown)

'H' only by 11%. There seems to be a trend towards the new type 'W', which now accounts for about 15% of total output quantity equal to the output of type 'H'.

According to the currently long supply times of Flender-Penig it is interesting to monitor the change of output within each type group. If the demand for certain models is stable on a high level this model will be under the first 20% of the most important models within a type group every year. The following table 3.4.-1 shows the changes of output for the most important FZG type B.

Less than one fifth of all models represent about half of the customer demand, i.e. output of FZG gear unit type B. But the data also indicates a decrease of output concentration per model with a cumulated output share of 57.1% in 2000/01 dropping to only 48.2% in 2001/02. Additionally there **exist two trends** from models with three stages towards two stage models[162] and from big size gear units to smaller ones[163]. That means that the customer requirements are changing quickly and that hence FTJ has to guarantee that its suppliers are able to supply the increasing numbers of two stage supply parts and the smaller housings. At the moment FTJ has great problems with the search of alternative local Chinese suppliers for certain housing sizes.

Table 3.4.-1: Output changes within the type group B of FZG[164]

No	Model		Output quantity		Cumulated Model Share[165]		Cumulated Output Share	
	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
1	B3SH05	B2SV04	90	46.5	2.7%	2.8%	27.4%	11.4%
2	B3DH06	B3DH06	21	37.5	5.4%	5.6%	33.7%	20.6%
3	B3SH10	B2SV02	21	30	8.1%	8.3%	40.1%	27.9%
4	B3SH07	B3SH05	16	25.5	10.8%	11.1%	45.0%	34.2%
5	B3SH04	B2SV05	14	19.5	13.5%	13.9%	49.2%	39.0%
6	B2SH02	B2SV07	13	19.5	16.2%	16.7%	53.2%	43.8%
7	B3SH11	B2SH05[166]	13	18	18.9%	19.4%	57.1%	48.2%

In a further step in the future the output results for each model have to include the different ratios, which is useful for the ratio related prognosis of supply parts, and have to be recorded per month of the respective financial year. By that it will become possible to see seasonable or regular kinds of demand in case the statistics consists of at least three or four years.

162 The second place of the model code indicates the number of stages.

163 The last two places of the model code indicate the size of the gear unit.

164 Source: Falk Ueberschär

165 with a maximum of up to 20% of cumulated model share

166 The models 'B3SH07', B3SH09', 'B3SH10' and B3SH11' also represent an output of 18.

Deriving Supply Part Quantities

As it takes a lot of time and is very extensive, a result based on real data can not be supplied for this final step, but at least a description of the general procedure, which is useful as orientation.

Each model type of a FZG gear unit consists of different supply parts in different quantities. For deriving the supply part quantities the part list of each different model has to be resolved.

Following [Rainer Weber (1989); p. 26/27] different steps are necessary to resolve the part list. In a first run all in-house manufacturing and all outside manufacturing parts have to be identified. Only module manufacturing parts will remain. The later have to be resolved with the same procedure again and again up to the point where only half finished parts and castings remain. The in-house manufacturing parts have than to be reduced to the respective outside manufacturing parts, half finished parts or castings, which are required to produce the former. By that the total number of outside manufacturing parts, hence supply parts, as well as half finished and casting parts, hence castings, is clearly defined per (B, H, K, W or FAD) model.

By multiplying the results per model with the output quantity per model this process exactly informs about the quantities of supply parts per model, which have to be sourced by FTJ.

3.4.2. Forecast of Delivery Quantities

Currently there is a lack of almost any fundamental data needed for a reliably forecast of delivery quantities at FTJ. As in addition the topic of forecast is quite complex the aim of this subchapter is not to provide a forecast, but to introduce to the topic of forecast methods and to give an indication of the groundwork which has to be done by FTJ before forecasts of supply part requirements are possible[167].

It is well-known that the necessary level of exactness of the determination of requirement depends on the expected cost savings in case of usage of a more exact method in comparison with a less exact method. It is clear, that with a low material value, which only causes a low capital tied-up, a rough estimate of the requirement will be absolutely sufficient. Even if the requirement of such a usage factor[168] is many times over estimated, the resulting increase of warehousing costs often is negligible[169].

This means that the right forecast method depends at least on the type, i.e. the value and ordered quantity, of the supply part.

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167 Here the term *supply part requirement* is used as synonym for the term *delivery quantity*.

168 The term *usage factor* comprises raw material, indirect material as well as merchandise; see Tempelmeier, Horst: “Material-Logistik”, p. 3.

169 see Tempelmeier, Horst: “Material-Logistik”, p. 11

Apart from requirement forecasts of final products prognosis methods are used[170]

- for goods of little value, like for example indirect material and wear-out tools, which in corporate practice are assigned to the group of C-products. In this case program oriented methods would be too costly.
- for ancillary product, which are installed in many different higher modules and final products. In this case the requirement often shows a regular course, which can be forecasted with small effort and in a comparatively exact manner by usage of the appropriate method.
- in cases where program oriented, determined methods are not applicable, because the information needed for applying these methods are not available, e.g. in case of spare part requirements.

Independent of the used forecast method it is important to first discuss the question of how to monitor the prognosis quality.

Judgment of the Quality of a Prognosis Method[171]

There are different reasons for errors in forecasting:

- An unsuitable method is used, which does not match with the actual course of the forecasted time series[172].
- A structural break has occurred within the period. This situation can arise, if due to unforeseeable events the consumption behavior of consumers, e.g. in case of a price increase caused by a tax increase, or the number of consumers has changed. Fundamental changes of that kind within the course of the time series can either make adaptations of the parameters of the used prognosis model[173] or the complete transition to another prognosis model necessary.

For achieving a high forecast quality it is necessary to judge the efficiency of a forecast method before the method is used the first time – during selection as well as during normal use. This can be realized by analyzing the **forecast error e_t**, which is defined as the difference between the **actual observed result y_t** of a time series within a **period t** and the **prognosis result p_t**. The following formula is used: $\mathbf{e_t = y_t - p_t}$

Two characteristics of a forecast error are of special importance for judging the quality of a forecast method:

170 see Tempelmeier, Horst: “Material-Logistik”, p. 37

171 For this part of the chapter see Tempelmeier, Horst: “Material-Logistik”, p. 37-40

172 The *time series* represent the consumption quantities of past periods in a chronologically ordered line.

173 The terms *forecast method* and *prognosis method* is used as synonyms in this thesis.

- the **level** of the forecast error and
- the **mean variation** of the forecast error.

The **level** of the forecast error indicates, if there is a systematic deviation of the prognosis results in regard to the actual observed results of a time series. There will be for example a systematic underestimation of requirement quantities (positive forecast error) if in case of a trend for rising demand a forecast method is applied, which is only suitable for the course of a constant time series. For an efficient forecast method it has to be demanded that the prognosis results on average (considered over a longer period) equal the actual results. From that the condition can be derived that the level of forecast error has to fluctuate about zero.

The **mean variation** of the forecast error represents the degree of safety by which the forecasted requirement quantities will be actually realized in the future. It is often supposed that the forecast error can be described by a normal distribution. From the course of the normal distribution the statement can be derived that c. 95% of all forecast errors lie within a range of two standard deviations (σ_e) about zero.

In general prognosis methods can be told apart into

- prognosis methods for regular requirement courses and
- prognosis methods for irregular (sporadic) requirement courses.

Prognosis Methods for Regular Requirement

If a requirement exists for the majority of periods of a time series the requirement is called a *regular requirement*.
For the selection and the routine use of a quantitative prognosis method the following steps have to be followed by FTJ or the logistics department respectively:

1. Examination of the characteristics of the time series.
2. Development of a formal prognosis model.
3. Estimate of the co-efficients of the prognosis model, which also includes the definition of start values.
4. Calculation of the forecast results for future periods, if need is including qualitative judgments, which are not included within the prognosis model.
5. Observation and analysis of the exactness of the prognosis model over the time; if need is adaptation of the co-efficients of the prognosis model or change of the prognosis model.

Before a suitable prognosis model for the forecast of future requirements of supply parts at FTJ can be used it is necessary to get an overview of the fundamental course of the regarded time series and its requirement quantities. A helpful instrument consists in making a graph out of the time series results, where the **characteristic course pattern** can often be clearly seen.

Time series are usually taken apart into **four components**:

- T – the long-term trend
- C – medium-term cyclical fluctuations (economic cycle)
- S – seasonal fluctuation (within a year)
- I – irregular fluctuations (irregular component)

In general the four components of the time series are either connected by addition or by multiplication to calculate the future requirements Y:

Y = T + C + S + I (with **I** as a component, which can not be forecasted)
or **Y = T * C * S * I**

Most approaches for analysis of time series try to isolate single components of the time series or combinations of components in order to see their pattern. By the classification of the usage factors according to their requirement course typical kinds of time series with regular course have already been distinguished.

Prognosis Methods for Irregular Requirements[174]

A requirement is called an irregular (sporadic) requirement if there is no requirement (zero requirement periods) for a product during many periods. Irregular requirements often arise for subordinated products within a multi-level product structure, because the lotsizing with higher products, i.e. gear units, leads to the accumulation of secondary requirements. It can arise in case of only a small number of potential customers of a product, like in relation to OEM customers of FTJ since these customers place big orders, which have to be processed within a limited period. In addition this requirement course often appears if the used period gradation is too fine, e.g. on a daily basis.
In case of forecasting sporadic requirement courses by application of prognosis methods for regular requirements the resulting forecast errors will be relatively great.

For the prognosis of irregular requirements two groups of procedures can be used, which explicitly consider the reasons of requirement fluctuations. One group of procedures is based on the reduction of the requirement per period to its components, the **number of orders** and the **requirement per order**, where the components are separately forecasted and multiplied with each other for the prognosis of future requirement quantities.

Other procedures consider the requirement per period in the dimensions **time** and **quantity** and forecast each time the period up to the next requirement event (requirement distance) and the respective requirement.

174 For this part of the chapter see Tempelmeier, Horst: “Material-Logistik”, p. 91

Especially for certain ratio related supply parts a prognosis method for an irregular course will be useful for FTJ.

Conclusion

For putting itself in a position to forecast future supply part requirements FTJ should:

1. Standardize the content of the statistics by clearly defining the needed data, for example with data about the production output of gear units per month, per model and with indication of the ratio.
2. Change its management of statistics to make statistics quickly available, for example by creating a collection of all monthly and yearly statistics, which is stored on a data bank and available on an appropriate data carrier like a CD.
3. Train the responsible employees in the logistics department in the area of forecast.
4. Develop a suitable prognosis model for the requirement course of each model of the different gear unit types (considering regular and irregular courses!).
5. Provide and install convenient software to automatically calculate the respective quantity of supply parts according to the forecasted output and the respective part list of each gear unit.

3.5. Development of a Decision Criterion for Local Sourcing [Part B]

Chapter 3.1.5. has made use of the results of the ABC analysis of DIN/norm supply parts in chapter 2.1.7. to expound how to calculate the benefit (ASP and RSP) for FTJ in case of sourcing from a local Chinese supplier instead of sourcing from Flender-Penig.
This chapter shows how to extend the use of the ASP by a new criterion in order to create a ranking of all supply parts. The later can be used to answer the question where to start with the transition from sourcing in Germany to sourcing on the local Chinese market.

This new criterion, called *critical level*, will be used for re-analyzing the five supply part group names surveyed in chapter 3.1.5 and for finally calculating the *sourcing priority*[175].

The **critical level l_c** indicates how severe the consequences of the non-availability of a supply part are according to the number of available suppliers known by FTJ, their delivery time, their quality level and the possibility or impossibility to continue the assembly process without the supply part[176]. The higher the critical level the more problematic is a cut off from the normal supplier. The critical level, which can range from 0.01 up to 1.00, can be defined for each supply part or for a SPGN. The second possibility has been used in this subchapter.

175 based on a concept of Falk Ueberschär

176 There are supply parts where the non-availability at the required moment within the manufacturing process is not very problematic as the manufacturing can be continued without them. This is not possible with all supply parts.

As a final indicator the **sourcing priority sp** indicates in which order the transition from the current (German) supplier to the new (Chinese) suppliers should be realized, according to the critical level and the ASP of a SPGN.

The following formula is used:

$$sp = \frac{ASP}{I_C}$$

It can be derived from the above mentioned formula that, in case of a constant ASP, the sourcing priority will be the smaller the higher the critical level of a SPGN[177].

Using the RSP instead of the ASP is not useful, because it results in high sourcing priorities for group names with a high RSP and a small ASP. But necessary is an indication of the SPGN where the greatest absolute savings can be realized. The analysis in chapter 3.1.5. has shown that a SPGN can represent a high ASP even with a small RSP, like it is the case for BACKSTOP.

Procedure for Calculation

First the critical level has to be assigned to each SPGN. In a following step, the sourcing priority for each supply part has to be calculated, considering also the quantity ordered for each supply part. For transforming the absolute sourcing priority results into relative results (ranging from 0.01 to 1.00), the sourcing priority of each supply part has to be divided by the greatest absolute sourcing priority of all supply parts.

As a final step the minimum, the arithmetical average and the maximum of the different souring priorities have to be calculated per SPGN. The table 3.5.-1 shows the example results, first ordered by the average sourcing priority and secondly by the SPGN.

Now the average sourcing priority clearly indicates, in a descending order, where to start the search for local Chinese suppliers. According to the average sourcing priority, the search for new Chinese suppliers should start first with FAN COWL, followed by BACKSTOP, BREATHER and so on.

177 Critical level can also be assigned to each supply part instead of assigning it to each SPGN. By that the resulting *sourcing priority* will be more realistic, but more time is needed.

Table 3.5.-1: Sourcing priorities of supply part group names[178]

No.[179]	Supply part group name	Critical level[180]	Sourcing priority			
			MIN.	AVG.[181]	MAX.	Width
2	FAN COWL	0.60	0.121	**0.569**	1.000	0.879
1	BACKSTOP	0.70	0.228	**0.537**	0.733	0.505
7	BREATHER	1.00	0.257	**0.355**	0.454	0.197
33	PARALLEL KEY	0.30	0.024	**0.298**	0.985	0.961
3	FAN	0.60	0.026	**0.204**	0.520	0.494

It is important to understand that the lower critical level of the FAN COWL (0.60) in comparison with the critical level of the BACKSTOP (0.70) leads to a higher average sourcing priority, even as the ASP is lower[182]. Both SPGNs represent four different supply parts.

In case of a very great number of supply parts with a small ASP, like for example for the PARALLEL KEY, the effect is a quite small average sourcing priority in combination with a high ASP. The small average sourcing priority of the PARALLEL KEY reflects the difficulty to find a supplier, who is willing and able to deliver the great number of different supply parts of this SPGN.

Conclusion

The *average sourcing priority* is a helpful indicator, because it combines the ASP in regard to the number of different supply parts per SPGN, as a hard decision factor, and the critical level of a supply part, as a soft decision factor.

As the results for the ASP for a great part, beside the purchase price, depend on the assumed transport prices, it is very important that the later are carefully estimated or calculated respectively. The same problem applies for the definition of the critical level as an employee with a great experience according to the manufacturing process is needed.

Both recommendations should be followed; otherwise the resulting sourcing priority will give a false recommendation.

178 source: Falk Ueberschär

179 Indicates the ranking within the total result of the ABC analysis of 49 group names. For example no. 1 represents the most important SPGN.

180 An estimate of the boss of the assembly hall at FTJ.

181 Calculated as the weighted arithmetical mean value of all sourcing priorities per SPGN.

182 the ASP of FAN COWL = 2,300.92 RMB; the ASP of BACKSTOP = 2,533.52 RMB

4. Methodologies for Local Procurement

In general the *Iron Law of Business* applies to every business process: it is the goal conflict of quality, price and speed. This goal conflict often is expounded in a triangle like illustrated in diagram 4.1.-1. This law describes the interdependency of the three aspects: under normal conditions the improvement of one aspect, e.g. quality of the gear unit, leads to a deterioration of the two other aspects, i.e. in this example case the overall lead time and the production costs will increase as higher quality requires more effort.

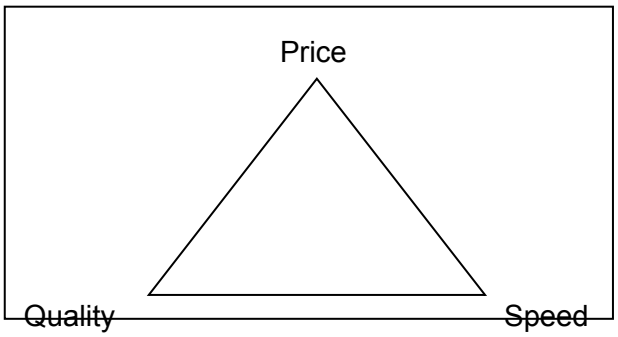

Diagram 4.1.-1: The Iron Law of Business

What distinguishes market leaders from normal companies is the fact that the former have 'cracked' the Iron Law of Business in a way that they are superior in two aspects and at least good at the third aspect. At the moment the biggest competitor SEW is leading in regard to delivery time (speed) and price of gear units in the Chinese market. Its quality level is below that of FTJ, but nevertheless in the upper third of the field of all competitors.

FTJ has realized that it has to improve its overall lead time without deterioration of price and quality. This chapter focuses on respective issues. Chapter 4.1. looks at quality management within the handling process of supply parts and chapter 4.2. focuses on quality and price aspects in regard to the strategic number of suppliers. Finally chapter 4.3. will help to improve the SCM by emphasizing the importance of the information flow and introduces two new concepts for problem management.

4.1. Quality Management [Part A]

The procurement of supply parts and the assembly of final products at a high quality level is the most important goal for FTJ. Flender-China's customers are on one side OEM-companies that use gear units as supply parts for new products such as cranes and on the other side customers that use gear units for their own purpose. FTJ promised both parties to provide high-quality gear units, which is produced at FTJ according to the quality standard of Flender-Germany[183]. The fact that most of the supply parts are sourced from German suppliers is the most important competitive argument of FTJ. Due to this fact any rearrangement of the procurement management and any product change has to be carefully planned and realized at FTJ as well as at Flender-Germany.

183 For the assembly of gear units FTJ is sourcing casting parts, whereas all other supply parts (e.g. inner geared, DIN/ norm parts) from Germany.

Currently the quality management of FTJ deals with two main goals:

- Improvement of the quality of supply parts (supplier performance) and
- Increase of the quality of final products.

In the following subchapter both aspects will be discusses and it is expounded how it is possible to improve the current quality processes of FTJ.

4.1.1. Quality Philosophy

The concept of quality has become an increasingly important means for competition in today's business world. The constant growth of the economy in the P.R. China does not necessarily result in an increase of the quality[184] level for supply parts[185]. Nowadays, many organizations have in some way implemented strategies for quality control based on management commitment often also in regard to the concept of continuously quality improvement.

Out of numerous different **quality definitions**, one that defines products as an article or service is the following:

> The quality of a product (article or service) is its ability to satisfy the needs and expectations of the customer[186].

Beside the quality of a product, the service quality of an organization is another important aspect. The high customers requirements make it necessary for FTJ to provide reliable customer service. The established after service department at FTJ deals with customer complaints in regard to quality problems of delivered gear units.

Product Quality

The defined product quality has many dimensions and effects on the SCM of FTJ. For the delivery of supply parts with focus on local Chinese suppliers some of the following factors in regard to quality have to be considered at FTJ:

- **Performance:** Do the supply parts fulfill the required and provided product definitions or standards of FTJ?
- **Reliability:** How stable is the quality of the supply parts and does the material quality meet the requested standards?

184 The term *high quality* is used in this thesis to describe the quality level which corresponds to the quality standard of Flender-Germany.

185 Delegation of German Industry & Commerce in China: "German-Chinese BusinessForum", Number 6, December 2000, p. 6

186 see Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 16

- **Maintainability:** How easy is it to detect, localize and solve quality problems?
- **Safety:** What is the average defection rate of supply parts in the receipt of goods[187]?

To reach the required performance and reliability of castings from different suppliers in the P.R. China has been a difficult and long process for FTJ. The approval process of new suppliers includes a delivery example from the suppliers in order to early detect quality problems. An example for the weak performance of a potential supplier shows that from two received batches of housing samples a scrap rate of 40% (of 11 castings) and 73% (of 11 castings) has been detected.

In general the concept of quality, which is based on the life cycle of the product, covers four elements:

- The **design quality** indicates that the product has been designed to satisfy the needs of the customer. A good design is one of the assumptions for a satisfying product, but by far not sufficient.
- The **production quality** shows how the product fulfils the specifications of design.
- The **delivery quality** measures how often the product is delivered on time.
- The **relational quality** indicates how efficient FTJ manages its relationship to the customers, i.e. what is for example the benefit of the after sales service etc.[188]

Traditionally companies have mainly focused on production quality and have neglected other important aspects like delivery quality of final products. The poor delivery quality at FTJ[189] is caused by the problems and delays FTJ currently experiences during the order placing process. The main aspects and reasons of poor delivery quality at FTJ are:

- Received consignments of supply parts are incomplete,
- The supply parts do not fulfill the required production quality,
- The placed order has been incorrect and
- The placed order gets lost or is forgotten by the supplier.

All these aspects either lead to an increase of order quantities in advance, like in case of poor production quality, or force FTJ to order again. The later increases the overall lead time of FTJ. By the implementation of key figures, review methods as well as improvement steps the procurement process can be restructured with the aim to reduce the current problems. An introduction to the respective process approach will be given in the succeeding part of this chapter.

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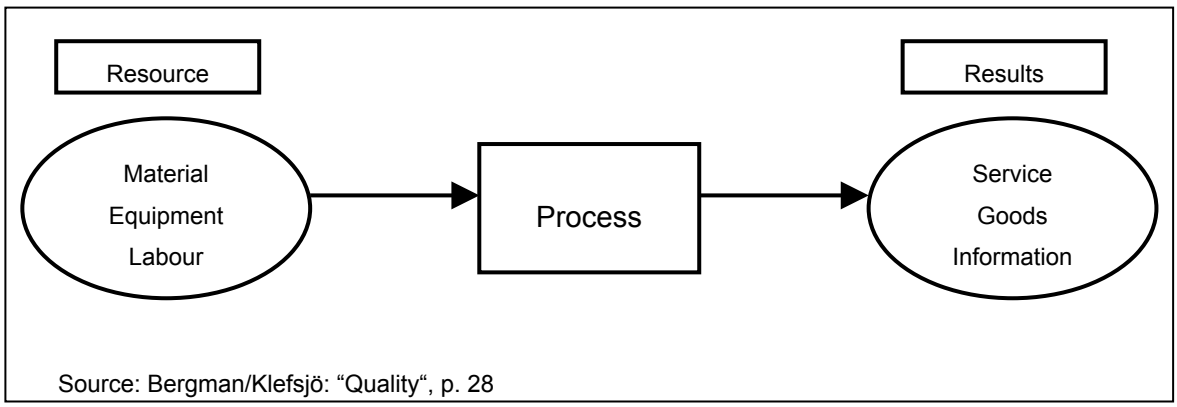
187 see Bergman/Klefsjö: “Quality - from Customer Needs to Customer Satisfaction”, p. 18; Safety concerns are an important fact for the delivery of supply parts in the P.R.C.

188 see Bergman/Klefsjö: “Quality - from Customer Needs to Customer Satisfaction”, p. 20

189 see chapter 2.3., Diagram 2.3.-1 Deviation from delivery date stated in customer contract

Process Quality[190]

Nearly every organization strives to establish processes which provide products and services that satisfy its customers. Diagram 4.1.-2 shows that each process needs input, i.e. resources like material etc., and provides output, i.e. results like service.

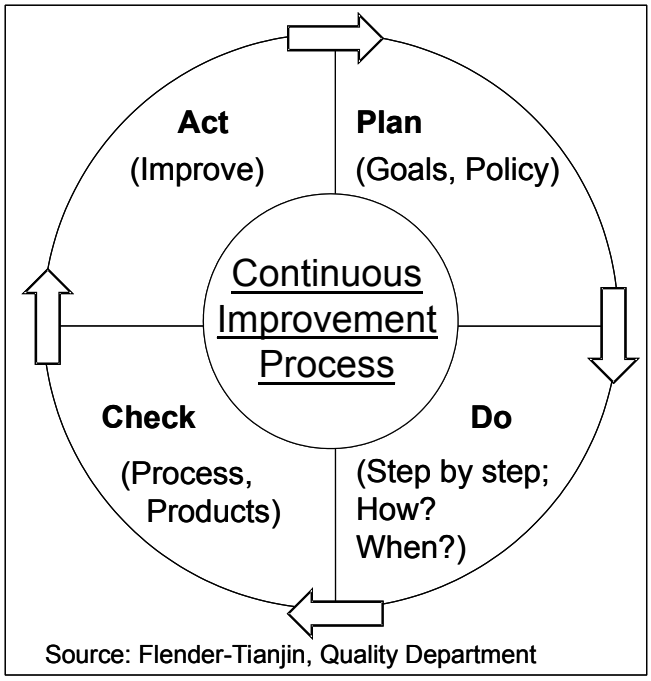


Source: Bergman/Klefsjö: "Quality", p. 28

Diagram 4.1.-2: A process transformation

With the use of statistical data, such as the results of quality inspection, it is possible to obtain the information needed to improve the process. The successful implementation of a quality strategy at FTJ includes a continuous improvement system.

As currently the market of the P.R.C. pays more and more attention to high quality gear units a method for continuous quality improvement can help to achieve reasonable competitive advantages for FTJ on the one hand directly due to the improved quality of gear units and on the other hand indirectly by an improved delivery quality. So far no method for the calculation of costs by poor quality is used at FTJ. The traditional **Deming Cycle** in diagram 4.1.-3 shows how to solve problems by the method of continuous improvement.



Source: Flender-Tianjin, Quality Department

Diagram 4.1-3: The Deming Cycle

The improvement cycle includes four stages: Plan-Do-Check-Act[191]:

Plan: Detected problems must be broken down to the principal causes of the problem that need to be improved,

Do: Carry out the appropriate steps,

190 this subchapter follows Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 28pp.

191 following Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 183pp.

Check: Investigate the results of the steps taken in order to see if the improvement program was successful,

Act: Learn from the experiences and implement necessary further steps.

Borrowing from this PDCA-cycle, FTJ can implement the following improvement steps for the 'Quality inspection process of incoming goods' according table 4.1.-1.

One of the main prerequisite for the successful implementation of this example is the appropriate composition of the improvement team, the integration of each team member and the assignment of respective competencies for the team. The current hierarchical structure at FTJ does not allow process oriented teamwork[192] and has to be adapted.

The following subchapter expounds quality methods that can be used to control the conformance of quality inspection processes at FTJ.

Table 4.1.-1: Example for process improvement

	Process Step	**Activity**
Plan	Goal definition	Define the goal "Optimize incoming goods inspection"
	Appoint improvement team	Integrate delegates from design, procurement, quality and production department into the improvement team
Do	Problem analysis	Analyze principal causes of the problem: insufficient measurement methods, insufficient quality at the supplier, lack of knowledge of inspection methods
	Take steps	Implementation of new procedures and process measurements
Check	Study and investigate	Review of the appropriate steps and investigate on the results of the improvements
Act	Evaluate the result	Increase knowledge about methods
	Improvement	Definition of respective steps and responsibilities
	Assure continuous improvement	Regular review of the changes with all participants and identification of new necessary improvements ➔ Goal definition

4.1.2. Quality Methods Most Useful for the Current Situation of FTJ

The Flender-group has already defined **quality inspection standards** for supply parts as well as final products. The current implementation of these standards has still not reached the level of the Flender-group. This is especially problematic in regard to the goal of FTJ to establish local sourcing of DIN/norm supply parts.

4.1.2.1. Quality Methods in Relation with the Supplier

In the last five years FTJ has experienced a reasonable improvement of the performance of the suppliers. Nevertheless it is still necessary to clearly communicate the quality requirements of FTJ each supplier as the main problem consists in the different understanding of the term *value*.

192 following chapter 5.

Cultural differences, which are often a reason for misunderstanding, and different levels of applied technologies within the production and inspection process lead to quality problems[193]. The implemented quality level for inspection and control at Flender-Wittgensdorf[194] defines the internal quality standards for the procurement of castings in the P.R. China. The facilities and the equipment for quality control of FZG castings at Flender-Wittgensdorf include:

- Chemical laboratory
- Metallurgic laboratory
- Mechanical laboratory
- Radiographic test, ultrasonic test, magnetic test, crack test and
- 3-D coordinate measuring machine[195]

For the procurement castings FTJ can use the experiences of Flender-Wittgensdorf for implementation. This can be done at FTJ or at the required inspection processes of the suppliers. The implementation of the control steps is essential for FTJ to provide the same product quality as Flender-Germany. In order to reduce the high costs due to quality problems and great inspection efforts in the future clear rules between the suppliers and FTJ have to be implemented by the quality department. The Flender-group already has established '**Technical Delivery Conditions'** for most casting products. Their applicability need to be extended to all supply parts sourced with local Chinese suppliers such as DIN/norm supply parts. The respective conditions for inspection consist of own requirements (company standard) or follow general standardized procedures. For the delivery of certain iron casting supply parts it is required by FTJ, that crack and ultrasonic testing is done[196] according to:

- Priming according to Flender standard W 2900
- Testing has to be realized by qualified testers according to defined standards
- Magnetic particle testing according to DIN 54135
- Penetration method according to EN 571 and
- Ultrasonic testing according to Steel-Iron Test Sheets (SEP) 1922, 1924 as well as DIN 1690

The verbal communication with the suppliers without any or only obsolete drawings and sketches is inefficient. It has been experienced in the P.R. China that for new supply parts the exchange of **good-bad examples** with the supplier is an excellent way to clearly communicate the quality requested by the purchaser[197].

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193 see Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 250

194 Flender-Wittgensdorf is the production plant for castings of FZG housings and other parts within the Flender-group. Quality inspection and control for all casting products play an important part in the strive to assure highest product quality.

195 following to www.flender.com

196 Other delivery and inspection conditions are established for mechanical parameters, surface hardness, cooling of procedure and heat treatment.

FTJ has seen that a considerable discrepancy between sample products and serial products can appear. On long-term the quality of supply parts decreases if no appropriate measures are taken. Therefore a quality inspection on a regular basis and the implementation of quality measurements are necessary steps to forward higher product quality for all supply parts. This will also leads to processes that enable FTJ to manufacture gear units within certain tolerance limits[198].

4.1.2.2. Quality Inspection of Incoming Goods

Currently all delivered supply parts are checked at FTJ, but this high inspection level makes it impossible to check all required criteria. With clear process knowledge it is possible to reduce the inspection effort and improve the quality of inspection.
The diagram 4.1.-4 shows the result of all inspections of incoming goods at FTJ for one supplier[199]. A total of 98 lots have been received between January and March 2002 with an average quantity per lot of 194 supply parts.

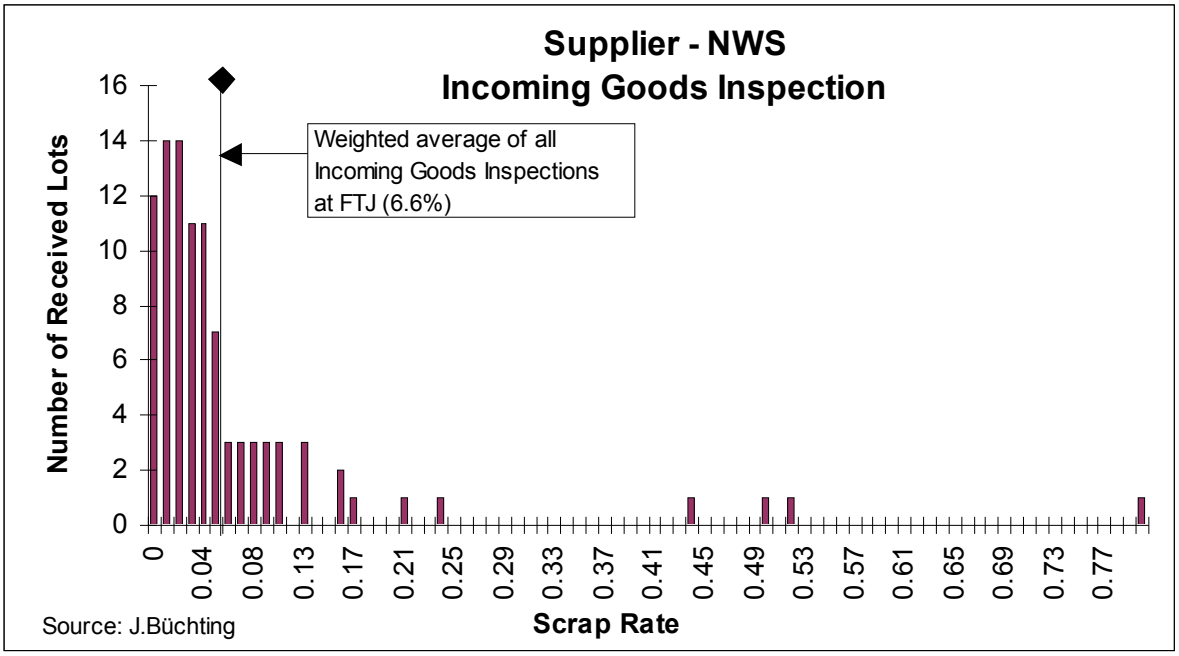


Diagram: 4.1.-4: Incoming goods quality inspection for supplier NWS

Modern quality philosophy aims at the improvement of processes up to a point where actually[200] no defective units are neither be produced nor delivered by the suppliers. activities are guided

197 Delegations of German Industry & Commerce in China, German-Chinese BusinessForum, Number 6, December 2000, p. 8

198 see Bergman/Klefsjö: “Quality - from Customer Needs to Customer Satisfaction”, p. 229

199 The diagram is based on data collected by the quality department at FTJ and includes all incoming lots from one supplier, which mainly supplies HF supply parts.

200 The word actually is used to describe the fact that every process shows a certain error rate. That’s why zero default procedures are not realistic. The method of six-sigma does for example define an acceptable quality (or error) level.

towards a process improvement so that defective units will neither be produced nor delivered by the suppliers.

FTJ uses inefficient measurement methods and tools for the inspection of received supply parts. The quality management has only the possibility to carry out a visual inspection, which is limited to measurements of the diameters as well as the detection of sand or gas holes. This kind of incoming goods inspection does no longer meet the requirements and should be abolished[201]. With the realization of local sourcing appropriate information about the delivered lot has to be available at FTJ, because this is the assumption for the decision whether or not to inspect a lot. A quality checklist can include the following aspects shown in table 4.1.-2:

Table 4.1.–2: Quality checklist[202]

	Aspect	**Check**
1.	Previous deliveries from the same supplier	Do the received goods meet the requirements?
2.	Supplier quality control system	Implementation according to Flender conditions?
3.	Knowledge in regard of the manufacturing process	Evaluation of the production process at the supplier
4.	Variation of characteristics among units	Quality statistics of received batch
5.	Random sampling[203]	What is the quality of the sample?
6.	Quality measurement of the supplier's manufacturing process	Quality measurements done according to the 'Technical delivery conditions' of FTJ[204]
7.	Consequence of quality failure[205]	Determine sampling plan and cost analysis of inspection

The logistics as well as the quality department at FTJ lack established quality inspection methods for incoming supply parts. The table 4.1.-3 gives an overview on different inspections methods in the procurement management process for supply parts.

201 see Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 250

202 following Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 251

203 depends on the cost for inspection and is mainly for: large quantity, low value, standard parts

204 The supplier delivers a certificate according to the 'Technical delivery conditions'.

205 A clear indication of product failure is based on experiences and preconditions from Flender-Germany. Quality methods that focus on problem fields can reduce organizational effort and improve the overall quality inspection.

Table 4.1.–3: Possible types of incoming goods inspections

	Type of Incoming Inspection	Procedure	Result/Remarks
1	Complete check of all incoming goods	Check each supply part	Exact determination of batch quality; requires high efforts
2	Random quality check (no sampling plan)	Check randomly to obtain further information about goods quality	Useful for large quantity, standard products and the decision on sampling plan
3	Quality control at supplier	Establishment of quality inspection at the supplier	Supplier is enabled to guarantee a prearranged quality of its products
4	Exact defined production requirements (see below)	FTJ inspects the production process at supplier	FTJ has to have knowledge about the production process and the supply parts
5	Reduced inspection of sample	Only a reduced number of supply parts is checked per sample	Reduction of checking costs; benchmarking between suppliers becomes possible
6	Checking according to consequence costs	FTJ checks the most important reasons for quality problems based on consequence costs[206]	Continual review of the checklist is necessary
7	Quality check by sampling plan	Goods are accepted or rejected depending on the number of defects per lot	Determination of lot quality based on statistics

The decision for a certain quality inspection at FTJ or at the local supplier must be defined in the supplier contract. The current procedure of shipping back all detected[207] non-conforming supply parts is not suitable[208] for the procurement of DIN/norm supply parts. FTJ has to agree with its suppliers on a certain percentage of supplier risk as well as customer risk[209]. The establishment of both rates can reduce the working effort for the re-order of supply parts at the procurement department.

Based on the quality level of supply parts and the availability of resources at FTJ a strategy for incoming goods inspection must be established. The most common incoming goods quality

206 That can mean for example to check the 20% of problem fields, which are responsible for 80% of all quality problems (following the statistical rule of Pareto).

207 Currently FTJ sends all rejected castings back to the supplier.

208 The cost for reorder parts should be calculated against the cost of accepting the lot.

209 Following [Stegemann1999: “Qualitätsmanager-Ausbildung”, p. 81] in general in Germany the customer risk rate (β-error) and the supplier risk rate (α-error) is by tacit understanding considered to be 10% if nothing else is arranged. The supplier risk is the risk that a consignment is rejected by FTJ even as the number of faulty supply parts does not exceed the prearranged share of faulty supply parts per consignment. The customer risk of FTJ represents the risk of accepting a consignment which contains faulty parts.

inspection for large numbers of supply parts is the so-called sampling plan which offers three different possibilities like expounded in table 4.1.-4:

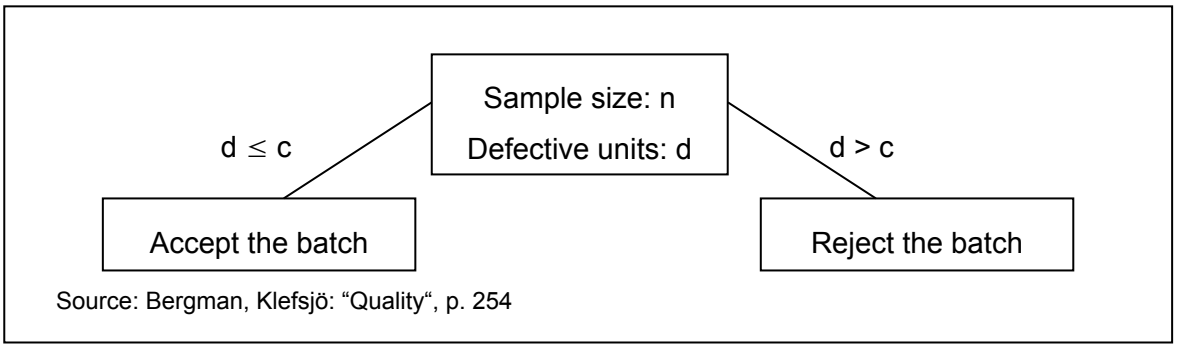
Table 4.1.–4: Accepting sample plan for incoming goods inspection[210]

	Sampling plan	**Explanations**
1	Single sampling plan	A random number n of supply parts of a lot of the quantity N is taken. All supply parts n have to be inspected and the lot is rejected if the number of faulty supply parts d is higher than the defined acceptance number c.
2	Double sampling plan	First a random number of n_1 supply parts is taken and checked. The lot is accepted if the number of faulty supply parts d_1 is smaller or equal to the defined acceptance number c_1. In case d_1 is equal or exceeds the rejection number r_1 the lot is rejected. In all other cases a second sample of the random sample number n_2 has to be taken. The lot can only be accepted if $d_1 + d_2 <= c_{1+2}$.
3	Sequential sampling	After each inspected unit, a decision on “accept the lot”, “reject the lot” or “check another unit” has to be taken.

A **single sampling plan** is usually agreed upon with the supplier or is used within the company for the received supply parts of a certain supplier. The decision for the former is based on long-term experience with the supplier and a respective good quality level of the lots. The overall goal is to reduce the inspection of all incoming goods to an economic level.
As alternative for a single sampling plan, sequential sampling starts with the standard check within the incoming goods inspection process. This standard check serves for find out the quality of a lot in accordance to the defined limits for the number of defined units. In case the *number of quality defects d* within a sample size n of a delivered lot declines then a switch to a reduced inspection of incoming goods should be considered[211]. In case two of five succeeding lots are rejected by the first inspection a switch to an **increased sampling quality check** is necessary. An increase in quality checking will tighten the resources at the quality department of FTJ.

210 see Bergmann, Bo / Klefsjö, Bengt [1] p. 254; Stegemann, G. / Wohlfahrt, I. [48]

211 For the leap from *standard inspection* to *reduced inspection* the following conditions have to fulfilled: reduced inspection is prearranged, ten succeeding lots have been accepted, the respective limit for the total number of faulty has not to be exceeded and has to use continuous production process.



Source: Bergman, Klefsjö: "Quality", p. 254

Diagram 4.1.-5: The principle of a single sampling plan

The decision for a certain quality control method depends on the probability that a manufacturing unit in the supplier's manufacturing process is defective and that this fact is not detected before delivery. The actual resulting number of defective units is due to the random variation in the production process of the supplier. The probability that a defective unit is found a consignment of supply parts is called **process average p**. The later is unknown for FTJ as it is not possible to determine the exact number Np of defective units p (as an process average) within a received lot[212].

The expected number can be based on experience with the supplier or can be calculated out of the inspections of all received lots. The average number of defected units for FZG parts of all incoming goods from one supplier has an weighted average of 6.6%[213].

Therefore the probability that a unit, which is assumed as defective, is used within the manufacturing process at FTJ is known, at least as an average value. Consequently the *average consequence cost K* for production of parts must be calculated. These costs have to be compared with the risk of not detecting a defective unit.

A supply part which is defect but not detected causes about ten fold increased costs at each succeeding process stage till the error is found and rectified. The average inspection costs C have also to be considered in the context as these cost represent the needed time to visually check the supplied parts as well as time needed to carry out the randomly done 3- dimension measurements inspection at FTJ[214].

To further deepen the understanding of the relation between the process average p, the average consequence cost K and the average inspection cost C an example is given. With the process average p representing the probability that a defective supply part is used in the production or manufacturing process of FTJ, in case of no quality inspection, an average consequence cost pK is generated. An average of 6.6% of all supply parts are rejected. The non-conforming costs for material rejection in the production process can be calculated

212 where N is the size of the lot and Np the product of N and p

213 following diagram 4.1.-3

214 Due to missing data the costs of inspection and quality checking at the quality department could not exactly be determined. The cost for one employee per hour can be estimated with RMB 20.- based on a salary of RMB 3,000 per month. The cost of inspection of a supply part is estimated with RMB 10.-.

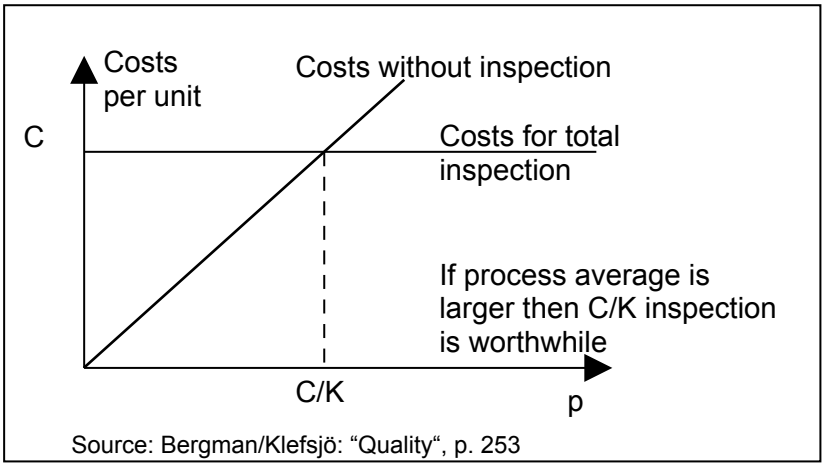
according to a batch size of 20 parts and a total output of 100 parts per month. The production cost for one produced part is defined as RMB 153.78[215].

The decision of quality checking is basically based on a rule:

- A total inspection of the lot has to be carried out if $p \geq \frac{C}{K}$
- Let the lot pass without any inspection if $p < \frac{C}{K}$

The use of the above indicated figures leads to the following results:

$$p = 6.6\% > \frac{\text{RMB 10.00 (C)}}{\text{RMB 153.78 (K)}} = 0.065 = 6.5\%$$

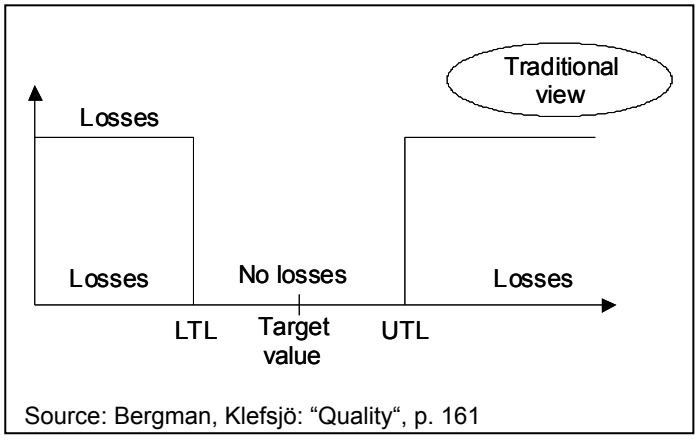


Source: Bergman/Klefsjö: "Quality", p. 253

Diagram 4.1.-6: Inspection cost per unit as a function of the process average p

As the process average p is superior to C/K the total inspection of the lot is appropriate.

This rule is sometimes called '**Deming's All-or-Nothing Rule**'. With the knowledge of the process average p, it is possible to decide whether the lot should be accepted like delivered or if the other units in the lot should also be inspected[216]. This procedure can also be called **statistical acceptance sampling**[217].



Source: Bergman, Klefsjö: "Quality", p. 161

Diagram 4.1.-7: Traditional quality control

4.1.2.3. Final Product Quality Inspection

One of the most known developer for the modern quality system is the Japanese engineer Genichi Taguchi. He defines non-quality as "the losses of a society caused by the product after its delivery"[218].

His opinion in regard to the traditional view of quality control, as shown in

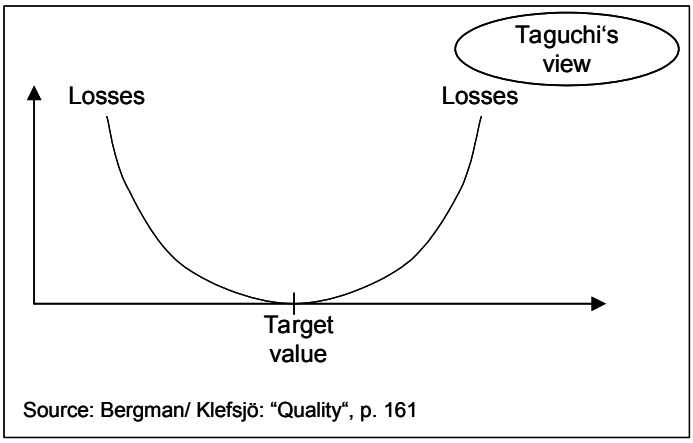
215 This value is valid for a FZG housing that represents a value of RMB 754.92 (before production) and of RMB 1,365.15 (after production). The former includes stockholding costs, actual production costs, human resource costs, ordering costs and overhead costs.

216 see diagram 4.1.-6

217 see Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 251pp.

$$L(Y) = \frac{A * (Y-\tau)^2}{\Delta^2}$$

diagram 4.1.-7, is that this concept only acknowledges losses due to quality problems if deviation from the target value either exceeds the lower or the upper tolerance limit. The result is that any loss to the society is zero as long the parameter value is within limits and the financial loss is large if the parameter exceeds one of the tolerance limits.

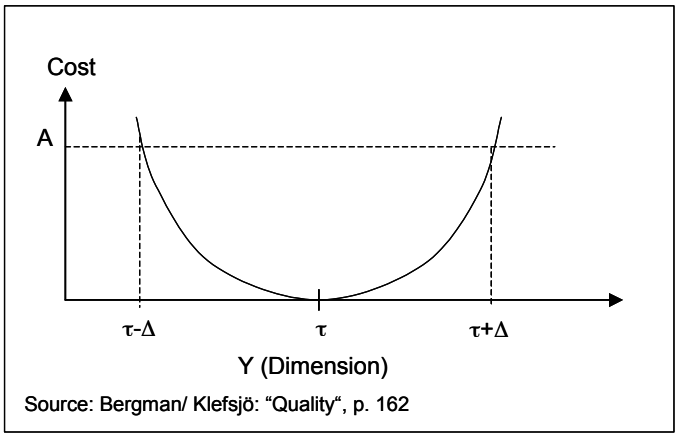


Source: Bergman/ Klefsjö: "Quality", p. 161

Diagram 4.1.–8: Taguchi's view of quality control

Taguchi considers the cost of the customer as well as of the manufacturer. This means that every deviation from a parameter target value causes a customer loss, as can be seen in diagram 4.1.-8, whereas there may be costs for the manufacturer for reducing the variation of the manufacturing process[219]. The diagram 4.1.-9 shows the Taguchi's loss function. He uses a squared loss function

where A equals to the expected costs if the deviation from the target value τ equals δ. According to Taguchi every deviation from the target value represents non-quality cost. The larger this deviation is, the larger the average costs. Taguchi's idea of a good product quality is related to the cost of achieving this quality. He finally emphasizes that for both the costs have to be minimized: that of the customer and that of the manufacturer. In the following diagram 4.1.-10 Taguchi suggests how to chose the tolerance limits. By the loss function of the previous diagram, the tolerance limits are defined in such a way that the scrap cost B is balanced against the customer loss. If the scrap cost is less then the loss of the customer, the company FTJ should scrap the unit. The formula for calculation of the scrap costs B[220] is



Source: Bergman/ Klefsjö: "Quality", p. 162

Diagram 4.1.–9: Taguchi's loss function

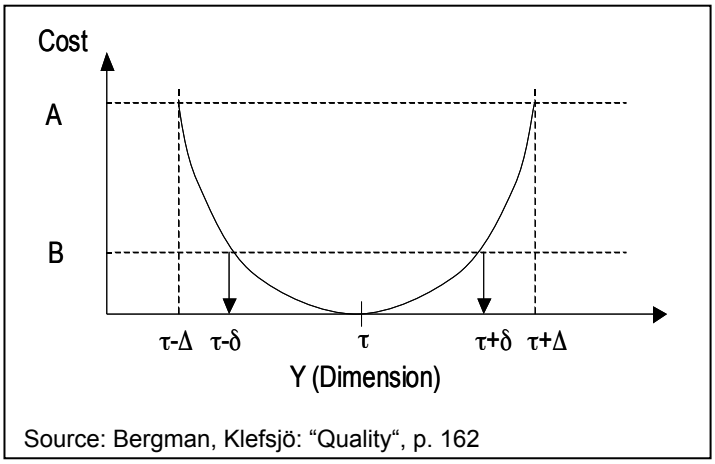
$$B = \frac{A * \delta^2}{\Delta^2}$$

where the tolerance limits are $\tau \pm \delta$.

218 see Bergman/Klefsjö: "Quality - from Customer Needs to Customer Satisfaction", p. 17

219 see Bergman/Klefsjö; "Quality - from Customer Needs to Customer Satisfaction", p. 161

220 see Bergman/Klefsjö: Quality - from Customer Needs to Customer Satisfaction, p. 162



Source: Bergman, Klefsjö: "Quality", p. 162

Diagram 4.1.–10: Suggestions for tolerance limit of Taguchi's function

The quality department realizes a final test of all gear units. Each unit is inspected and a respective 'Inspection record' is written. The main focus of the final test is the noise level (L_{PA} in dB) of the gear unit. This includes: sound pressure level, surface sound pressure and sound power level. The maximum noise level depends on specifications given in table 4.1.-5:

Table 4.1.-5: Example for one final noise test

Specification	**Example**
Gear unit type	B2
Ratio of a gear unit	8
Technical specification (size of the gear unit)	12
Revolutions per minute	750
Maximum noise level L_{PA}	75 dB (A)

The quality department at FTJ has still not defined a 'Target value' for the noise level inspection. There are also no statistical records of the average noise level. For that reason FTJ is not able to determine the additional effort of production as well as the additional customer value. The maximum noise level is at the same time the 'Upper Target Limit' of the final inspection. Any final product that crosses this limit will first be reworked and may later even be scraped[221] if the noise level is still exceeded. The loss to the customer is considerable when FTJ cannot deliver the final product on the requested delivery date or if the customer receives the final product which does not meet his expectations, e.g. in case the gear unit exceeds the requested noise level.

For the aim of quality optimization this above mentioned approach of quality measurement for final products within the quality inspection at FTJ can be used to exactly define the product quality for the customer and at the same time to increase the value added to the product.

The Taguchi's quality philosophy indicates that lack of quality is closely connected to the variation of the product characteristics. Any reasons for variations of the quality level have to be identified. Then improvement steps have to be implemented such as the adaptation of the product design or adaptations within the manufacturing process.

221 The cost of one final FZG gear unit depends on the specification. It usually cost several thousand Euros.

Conclusion

The given approaches of quality management and quality enable FTJ to deliver a high quality product according to customer requirements. In case these concepts are realized at FTJ the costs for quality assurance can be reduced. The focus of the quality strategy of FTJ should switch from the present handling of quality issues within the own organization towards prevention of non-conforming quality at the suppliers. The use of modern methods for quality control will prove especially useful in regard to an increased share of local sourcing[222].

4.2. Importance of Single, Double and Multiple Sourcing [Part A]

For the efficiency of the quality methods expounded in the preceding part of this chapter it will be important that the Buying Center consistently supports the management of these suppliers. The reduction of the delivery time and the respective distribution of its mean variation, the increase of the stake of local sourcing and the development of a win-win sourcing strategy with local suppliers are competitive factors for FTJ and Flender-China. The share of local-content for supply parts of foreign companies[223] is an interesting indicator and benchmark of other companies operating in the P.R. China. The diagram 4.2.-1 shows the average level of the Local-Content sourced by German companies operating in the P.R. China[224].

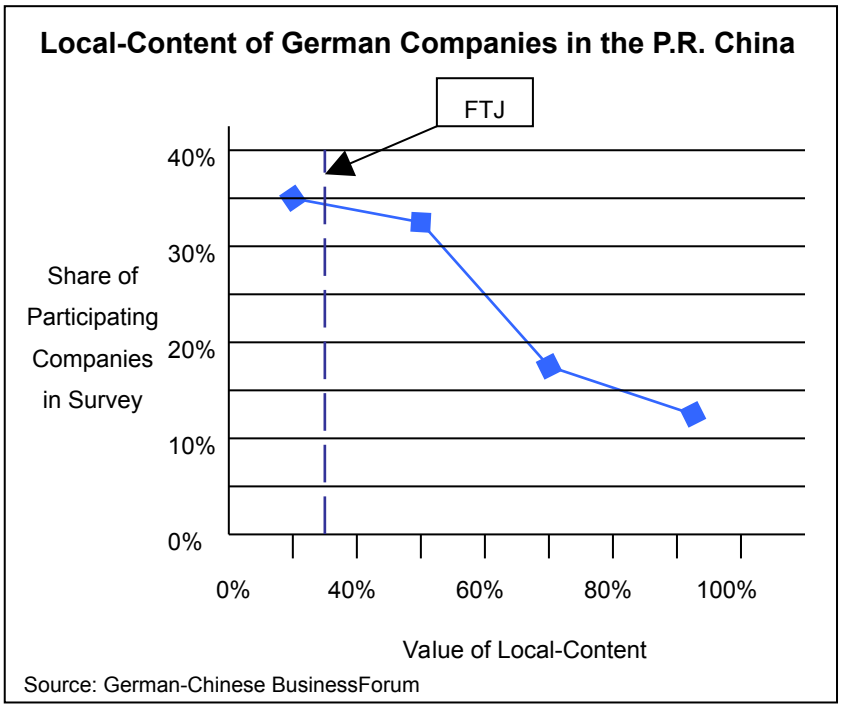


Diagram 4.2.-1: Local-Content of German companies in the P.R.C. (incl. FTJ)

Another survey among German companies shows that the successful companies are raising their level of local-content distinctively slower than the less successful companies. Successful companies want to avoid quality problems of supply parts. In most cases, German companies adapt their products to the needs of local Chinese customers[225]. For FTJ it is important to develop a holistic procurement strategy in regard to the requirements of

222 Current experiences show that an increase of local sourcing would result in a high effort of the quality inspection for incoming goods.

223 This example uses German companies as an indicator.

224 This diagram follows the BusinessForum of the German Chamber of Commerce (AHK), Volume VI, Number 6, December 2000

customers and of suppliers. The four following **procurement objectives** have to be considered for this procurement strategy[226]:

- One that already has been defined is the decision for **domestic or global sourcing**. FTJ sources in Germany and in the P.R. China. The current focus is on the increase of domestic procurement for DIN/norm supply parts.
- Another strategy for a company is the **market mix and market concentration**. For FTJ this means that the supply parts are sourced at the market with the most favorable conditions in regard to delivery time and terms, procurement price and quality. Currently FTJ is sources the cheaper[227] castings in the P.R. China.
- The **supply chain strategy** is of considerable importance for the procurement process at FTJ as it comprises for example the decision where to realize the concept of JIT and where to stock supply parts and final products.
- The **number of supplier** is important for the decision of Single, Double or Multiple Sourcing. Double Sourcing, where only two suppliers exist, is a special case of Multiple Sourcing.

In the following the aspect of Single, Double and Multiple Sourcing is further expounded in table 4.2.-1, especially in respect of procurement of DIN/norm supply parts.

The decision of the number of suppliers can be made according to:

- Procurement costs
- Performance of the suppliers and
- Procurement risk[228]

The procurement costs and the performance of suppliers mainly depend on the available order quantity as well as the specification and complexity of the supply part. The higher the standardization of supply parts the easier it will be to realize multiple sourcing and by that to reduce the supply risk through ‘order splitting’. In general the later is valid for DIN/norm supply parts, but currently FTJ does not reach the necessary order quantities to realize ‘order splitting’. The strategies of Single and Double sourcing are especially convenient for specific supply parts, e.g. inner geared supply parts.

225 86.6% of all German companies adapt their products; see Dietz/ Harnischfeger-Ksoll: “Erfahrungen im China-Geschäft“, p. 13pp.

226 see Koppelmann, Udo: „Beschaffungsmarketing“, p. 128pp.

227 In Germany castings are more expensive. Due to a high weight and large sizes of most castings the costs of transportation, and by that also costs of procurement, are much lower in the P.R.C.

228 see Koppelmann, Udo: “Beschaffungsmarketing”, p. 130

Table 4.2.–1: Comparison of sourcing strategies[229]

Characteristics	Single Sourcing	Double Sourcing	Multiple Sourcing
No. of suppliers	1	2	>1
Objectives of customer	Reduction of cost price and high quality of supply parts by active establishment of one efficient and innovative supplier	Low cost price through promotion of competition among two efficient and innovative suppliers	Low cost price through promotion of competition among the suppliers: reduction of supply risk by 'order splitting'
Definition of supply parts which should be ordered by FTJ	Specific supply parts: customer tailored; e.g. inner geared parts	Specific supply parts: customer tailored; in comparison with Single Sourcing more effort required for reaching high quality level	Unspecific goods with low complexity together with sufficient market capacity, e.g. DIN/norm supply parts
Kind of relationship between supplier and FTJ	Based on institutional and personal trust within the relationship: considerable risk of opportunistic behavior (reciprocal asymmetrical distribution of information)	Based on institutional and personal trust within the relationship. FTJ is aware of supplier requirements (partly reciprocal asymmetrical distribution of information)	Focus only on transaction of goods: risk of opportunistic behavior on both sides is low or not existing due to market transparency
Time limit of relationship	Long-term orientation: quite long period of validity of master contract	Medium- till long-term orientation: medium till long period of validity of master contract	Short-term orientation: no master contracts or only short period of validity
Change of suppliers	On short-term supplier is not changeable: threat of production stop through the loss of supplier	Supplier do not change until the new supplier requirements are made by FTJ requirements	Supplier can be changed on short-term as in principle no barriers for the change to other competitors exist
Competition	Encouragement of a bilateral monopoly by specification of supply parts	Competition between suppliers exists, but FTJ should not misuse the competition to assure the realization of a win-win situation	Encouragement of competition between suppliers

Conclusion

At the moment FTJ should focus on Single Sourcing for DIN/norm as well as inner geared supply parts, as it is partly already the case, due to the lack of necessary order volume, order value and lack of personal at the logistics department. The common arrangement of objectives for product cost and the increasing of performance and quality with each supplier will help to establish a win-win situation between both parties.

4.3. Control of Information and Material Flow [Part B]

For bridging the gap in space, time and quantity between *demand* and *supply* the processes of storing, transporting as well as material handling and packaging have to be performed, controlled and monitored by information processing[230]. In other words: the information flow has

229 following Koppelmann, Udo: "Beschaffungsmarketing", p. 129 (except Double Sourcing)

230 see Tempelmeier, Horst: "Material-Logistik", p. 2

to hurry on ahead the material flow. As this idea is often not easy to realize this subchapter gives an insight into the conditions, which have to be created for optimizing the management of the information process with FTJ in order to improve the performance of the supply chain, hence to reduce the overall delivery time.

In many companies there exist a lot of buzzwords like: total quality management, pull principle, JIT, team work, controlling by key figures, lean management, etc., but seldom are these concepts consistently realized.

According to [Droege & Comp.1998] it will not be sufficient to realize strategic options only with a short-term intention. The following general tendencies for the organizational sphere are seen as most relevant for the future and in that way also important for procurement:

- In future business processes will determine the enterprise organization.
- Flexible, team oriented and increasingly self-responsible organizational units will reshape the traditional forms of organizations.
- Structures will be oriented towards the success of crucial performances.
- Suppliers will be integrated in the corporate processes of their customers as never before.

The authors also indicate the weak points of the current organization of procurement of companies in Europe[231]:

- The too late integration of the purchase department[232] requires a short-term reaction of the later: “high-pressure deadlines beat price”.
- The address of suppliers by the technical departments is realized without coordination with the purchase department, requirements are specified and pre-negotiated.
- The procurement department has only a low know-how-level at his disposal, as the external and also the internal major customers put narrow releases forward. Technical discussions about concepts of a solution hardly take place.
- The procurement process is handled as a pure routine procedure without innovations.
- The procurement process is delayed by change cycles and ‘voting orgies’.

According to these weak point, concepts of a solution have to cover three dimensions to lead to sustainable improvements:

1. The area of responsibility of the procurement department has to be clearly defined, i.e. should the later only do process handling or realize strategic procurement (process dimension of procurement).
2. For the lasting assurance of conceptual procedures the organizational structures have also to be further developed, and by that the question of position/establishment of procurement competence and responsibility within the organization.
3. The use of newly created processes and structures which are adapted to the use of efficient and decision oriented information systems lead to clear efficiency leaps.

231 which is also valid for FTJ

232 into the overall planning process

4.3.1. Information Basis for Communication[233]

One of the current main problems in regard to the communication with suppliers of FTJ consists in the lack of structured information. What is known for German companies[234] is also valid for FTJ: there exist a lot of data saved on huge data carriers, but normally it is scarcely useable for procurement processes. Mostly purchase-relevant data is also stored on different data banks or computers respectively in the book keeping and production department.
The immense quantity of data as well as its lack of structure impede purposeful access. Needed are information structures and instruments which allow an action oriented orientation of the logistics department. Efficient systems represent a real quantitative leap for the procurement efficiency! The main directions for improvement are:

- Establishment of a procurement related materials classification system (**supply part group key**) and
- Establishment and exploitation of computerized systems for data management and distribution.

The **supply part group key** helps to speak a common language, because it is a mnemonic key. One of the basic requirements for such a key is a procurement oriented structure. Keys are often only used for controlling purposes or show a strongly usage oriented structure, like a classification in regard to products, part lists or assembly characteristics. The already mentioned code number problem at FTJ, where at least four different order codes exist for the same customer order, also results in supply part groups which cannot be summarized.
Considering these facts it is clear that FTJ has to **re-define the code and number system** (incl. the materials classification as well as the supplier key[235]) as a first step for achieving a sustainable effectiveness of the procurement process. Necessary is a reduction of the supply parts to the different specification levels. The guideline “as fine as necessary” is valid. A re-definition in a bottom-up way by integration of all experienced employees of the logistics, production, and assembly departments will result in an holistic overview of the total procurement volume per SPGN, per model and per period.

Procurement information systems: decision data by pushing the button

The quality of the procurement information is decisive for the success of the procurement process. At FTJ the procurement process too often sticks to ‘paper and pencil’. Procurement

233 this subchapter follows Droege & Comp.1998: “Gewinne einkaufen”, p. 124pp.

234 see Droege & Comp.1998: “Gewinne einkaufen”, p. 124pp.

235 The existing supplier keys for the suppliers of FTJ are not structured according to the SPGN or models delivered by the supplier. For example ‘NW01-086’ means: the first supplier NW (because the abbreviation of different Chinese supplier names by Latin characters sometimes lead to identical names), with sourcing within the P.R.C. (code 086). Currency abbreviations, like ‘EU’ indicating EURO as currency, can be added. Another code used at FTJ is the warehouse key.

information stored on paper cannot automatically be updated and does only allow an inflexible physical or manual access respectively. Nowadays, with abundance of information everywhere, only with the right instrument the necessary holistic overview can be achieved. This instrument will be a computer based **procurement information system**, which plans and controls the respective processes. Efficient procurement information systems at least inform about supplier turnover for a defined model or SPGN, about prices, alternative suppliers, their offers and about supplier evaluations. The before mentioned information has to be kept current it in regular time intervals.

Supplier evaluations should at least comprise:

- Purchase and procurement price
- Quality
- Conditions
- Delivery reliability and
- Coverage of additional service

Some of the above mentioned information is available at FTJ, but filed in different departments, data banks, applications and is also 'embodied' by the responsible persons. That means in general data or information is not easily and directly accessible, and by that it is difficult to make fact-based decisions. The goal should be to interconnect the data sources of the logistics department with the respective other departments, e.g. the production and book keeping department. The necessary efforts for realizing interconnectiveness often is over estimated by the companies.

In addition to these aspects, FTJ should collect information about competitors, customer expectations and the rating[236] of FTJ by the suppliers and customers to see evolving deviations between the own performance offered and the requirement on the supply market. All the discussed information can and will also be used for the process of supplier evaluation.

4.3.2. Management of the Necessary Information Flow

Parallel to the re-definition of the code and number system and the establishment of an efficient procurement information systems, it has already been pointed out in subchapter 2.6. that FTJ has to **restructure its information flow** in order to improve the control of the material flow and to make its 'reactions' faster and more reliable.

In order to keep its good position on the market for gear units, FTJ should be transformed into a *dynamic company* with a **Dynamic Manufacturing**[237] process. A company which orientates to the model of dynamic manufacturing, follows the goals:

236 The rating of FTJ by the supplier is very important as currently the most important Chinese supplier for housings is not willing anymore to supply all the required housing types. This leads to big trouble for FTJ as no gear unit can be produced without a housing. If the rating had been monitored, FTJ could have taken actions to avoid the current problems.

237 see Ehlers, Jörg D.: "Die dynamische Produktion", p. 51

- Orientate its organization and especially the courses towards the requirements of its customers in order to
- Reliably satisfy their requirements.

Such a company focuses on its target group for which the company generates performances (products or service). Only in that way an own benefit can eventually be realized and the survival is guaranteed. First of all this company pursues the derived goals

- Optimization of the value adding process in order to
- Maximize the customer benefit and
- Bind the customer to the company (regular customers).

A centralized control manufacturing organization is, in case of a high manufacturing depth like with FTJ, normally asked too much to complete all customer orders 'Just-In-Time'[238]. Today it is normal that, in case of differing deliver due dates and customer classifications, the parts, matter and material for manufacturing which are assigned to certain orders, are used for urgent requirements with short-term deliver due dates in order to meet the deadline for the delivery time and the delivery reliability of these urgent customer orders. The other customer orders fall back and are hence not delivered on time. In this way the business objectives of bringing the delivery service level[239] on 98%, cannot be reached.

This is only achievable if all odd manufacturing units, transparent from distribution via manufacturing and goods receipt up to every supplier, are transformed into customer-supplier-relationship. An external customer-supplier-relationship always then generates **customer satisfaction** if the later has his products short-term at his disposal. A satisfying availability is most often assured **by a respective stockkeeping[240]**. By that customers are delivered short-term and the stock is replenished at the next opportunity. In that way the permanent delivery readiness in relation to the external customers is achieved and all conditions of the delivery service can be fulfilled.

So if by stockkeeping of final products at FTJ the customer expectation can be fulfilled than these experiences should be used in a similar manner in the internal relations within FTJ. The general idea is to create adapted buffers (not stock[241]), where it is appropriate, hence at

238 This whole topic is followed Ehlers, Jörg D.: "Die dynamische Produktion", p. 95pp.

239 For key figures like service level please see subchapter 5.1.3.

240 Stockkeeping of final products in combination with a strictly standardized product range and a 24h after sales service is the successful strategy of SEW, the biggest competitor of FTJ in the P.R.C.

241 The term *stock* represents inventory, which is stocked for a longer period, whereas *buffer* represents inventory, which is only stocked up to a maximum of one day between two processes.

interfaces of two processes[242], which are not performed chronological and which therefore have to be decoupled with the aim to improve the material flow.
The ability of a *Dynamic Manufacturing* lies in the ability to maximize the customer value and likewise to optimize the value adding. If the customer value, like demonstrated before, is achieved by creating additional inventory in the warehouse as well as material inventory in production and in supply areas the value-adding process is not optimized! How to solve this contrast? The production has to be segmented according to the core business, the analysis results of the current and the expected customer requirements and the resulting requirement of parts, matter and material[243].
[Droege & Comp.1998] gives an example of a supplier for the car industry, which produces heat exchanger for air-conditioners in mid-level quantity and in high variant variety. As background information it is important to know that European car manufacturers control the calls from a long-term blanket order with rolling medium-term requirements planning. Calls are submitted electronically with a few days preparation time. By that the release quantity apart from the packaging sequence based on the manufacturing sequence and the consignment carrier number is submitted. That means for the supplier that he has to meet the stipulated packaging order and to meet a loading sequence with the truck. The interface between supplier and car manufacturer is by this system and additional penalty sanctions about quality and service level completely defined.
As the topmost **goal** and main problem for the supplier occurred the **reduction of the inventory** in the finished goods warehouse in combination with the service level. The existing conventional organization of the manufacturing process with a batch size oriented manufacturing control is an obstacle to that goal. The big inventory of finished goods not only causes inventory costs and stockkeeping problems (bulky products), but also leads to a high level of depreciation for obsolete heat exchanger due to quick model changes.
In order to solve the goal conflict of service level and inventory costs, the supplier company has chosen an approach, which largely avoids the finished and half finished goods inventory. The implementation of a production control with **minimal batch size** and **demand-driven manufacturing** gets rid of the problem of goal conflicts from its very approach on. Now the supply chain, which exists between the car manufacturer and its supplier, does not end anymore in the finished goods warehouse of the supplier, but reaches trough to the complete manufacturing process of the tier 1 and tier 2 suppliers[244].

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242 The department of quality, technology and management at the University of Linköping, Sweden, defines the term *process* as follows: “A process is an activity or a series of activities which in a repetitive flow refine in data to a result dedicated for a customer.” The definition of a process by DIN ISO 8402: “Satz von in Wechselwirkungen stehenden Mitteln und Tätigkeiten, die Eingaben in Ergebnisse umgestalten.”

243 for deepening this topic see: Ehlers, Jörg D.: “Die dynamische Produktion”, p. 97

By innovations within the manufacturing process the setup-time (of the systems which are most essential for the process) could be reduced to a degree necessary for an economical manufacturing. **Important:** the economy of the chosen batch size has not been calculated on the basis of a single system, but over the whole supply chain.

To achieve the principle of a general supply chain, the car manufacturer concluded cooperation treaties with the main sub-suppliers of the automotive supplier (tier 2). These include procurement prices apart from a remuneration system for the delivery in due time and a penalty sanctions system for late delivery or misdelivery of material. To create transparent processes and clear conditions, a call mechanism for the DP-supported control of the calls have been developed. The cooperation partners deliver the calls resulting from the production planning on time and with the respective quantities. The necessary raw dimension data is transmitted online.

The **benefit** achieved by the general realization of the supply chain principle results from the following categories:

- Reduced inventory
- Defined and bundled quantities per call and per product group

By realization of a manufacturing with an inventory reduced on a minimum degree the inventory costs have fallen by 80%. The average lead time per call has dropped from three months to eight working days. The service level for the whole available product and variant range can be guaranteed, with small limitations, within eight working days. The limitations only result from the availability of raw material. Depreciation of obsolete remaining stock is not necessary any more.

By bundling up the procurement volume per product group on one supplier and by concluding **long-term master contracts** an average savings of the purchase volume over all product groups of 18% as been achieved.

Before the optimization time and again difficulties in regard to the service level appeared, and despite a high inventory of half finished and finished parts a mean delivery error of 2,3% per day arised. That means that the wrong parts have been manufactured or the right parts could not be finished fast enough. By introduction of the supply chain principle the picture has been changed fundamentally: the gross reduced inventory and that on a minimum degree reduced finished goods inventory show that the service level has risen significantly. A remaining missing part share of less than 0.2% per day can be put down to unscheduled special calls listed in the service level statistics.

The presented method of this example case can in principle be applied to all kinds of manufacturing with series character. Limitations do only exist in case the additionally purchased raw material is subject to great price fluctuations (spot markets). Then the purchase of bigger inventory of raw material at low prices can constitute an efficient strategy.

For a Dynamic Manufacturing it is further on necessary to achieve a strategic **transition towards an** electronic **communication**, hence e.g. EDI, e-mail and if need is video

244 Tier 2 suppliers deliver supply parts to the tier 1 supplier and the later delivers supply parts to the customer (manufacturer/producer).

conferencing. As far as possible, all internal and external communication, which is so far based on paper like fax and paper letter, should be realized via EDI or e-mail. This will speed up the information flow and makes it more transparent and flexible. Of course it will be necessary to **create interfaces**, where internal or external information, which is stored on paper, can be transformed into electronic information (computer files). The possibility to vice versa transform electronic information into paper based information by printing has to be limited to processes where this is absolutely necessary. The later can be the case for drawings in great sizes, which can not be presented conveniently on a screen, and for harsh working conditions like in manufacturing with its oily parts. But with an investment in protected screens this problem can also be solved. The goal is to provide consistent up-to-date electronic information at any point within FTJ independent of the department where people work.

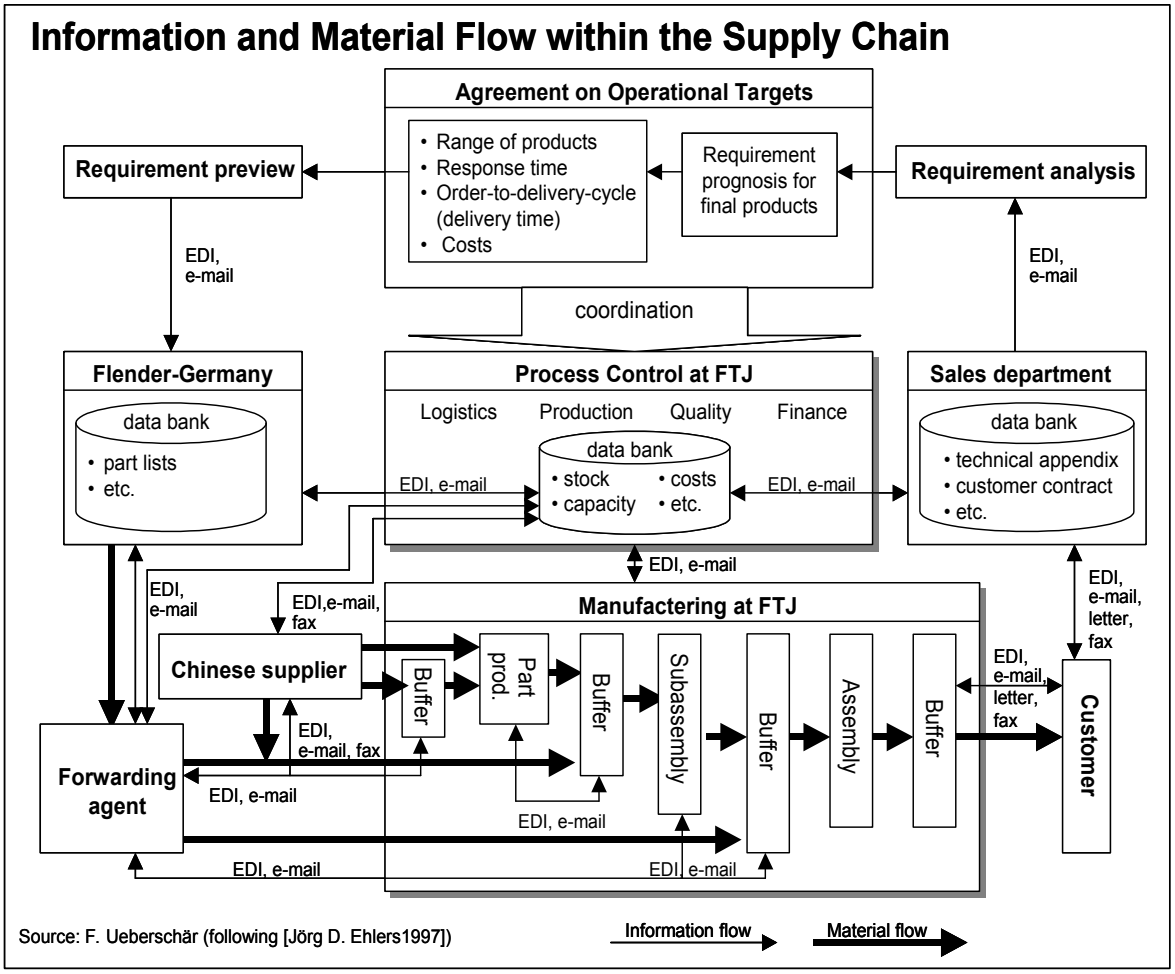

Diagram: 4.3.-1: Information and material flow within the supply chain

Original paper documents can be stored where they are created, like for example the customer contract[245] in the sales department.

245 The identification code of a customer contract (customer order number) is '450.YMM.XXX' and of a quotation '550.YMM.XXX' with 'Y' representing the last place of the year and 'MM' the month, when the contract was signed. With a quotation, in contrary to the customer contract, the customer has still not paid an allowance.

The diagram 4.3.-1 shows the optimized future organization for controlling the information and material flow throughout the supply chain of FTJ. In general the information flow is realized by EDI or e-mail. Only if it is legally necessary as in case of customer contracts on paper or if the communication partner has not the respective equipment or know-how at his disposal or is not willing to use EDI or e-mail, which is the case with some local Chinese suppliers for housings, alternatives like fax, paper letter and telephone should be used. It is important that FTJ does not shy away from investing into man power and equipment, which is needed for an efficient information flow based on electronic data and information.

Why? Because only electronic data and information

- Can be distributed by low costs with light speed throughout the world
- Can be searched for in an efficient manner by employees of other departments
- Can be used to automatically create different reports, fitting the current need
- Can be displayed with a totally different structure and in a new way, e.g. graphically, to gain new insights and knowledge
- Can be accessed at the same time by more than one person
- Allow a cheap information storage, because of its high density of information[246]
- Can be directly safeguarded from access of unauthorized persons, especially in case of sending it to another place, when external access is possible[247]

But there exist also disadvantages of electronic storage as there are:

- Loss of information by computer viruses, power failure, damaged or destroyed data carriers, obsolete data formats or reading devices[248]
- Need of higher investment (high capital tied-up) for equipment and training of staff in the beginning and in regular time intervals

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246 This fact is already recognized by some German hospitals which have decided to convert all paper based patients files into electronic files, because otherwise they have to build a new warehouse only for the patients files, which would be more costly than electronic storage.

247 This refers to the possibility of encrypting files with an asymmetrical encryption procedure like for example PGP. These kinds of encryption procedures use a private and a public key to encrypt files in contrary to conventional symmetrical encryption procedures, where only one key is used for encryption and which are in that way quite easy to decipher, especially if the only key is stolen. PGP (Pretty Good Privacy) was developed by the Massachusetts Institute of Technology in the United States of America. It is strongly recommended to thoroughly inform themselves about PGP before use.

248 Especially the danger of obsolete data formats and reading devices is often underestimated by companies. One example are tape streamers, which are used to store great quantities of information. Many new reading devices have been introduced on the market in the last 20 years, which have quickly replaced older ones. So if a company cannot buy tape streamers on the market, which are able to read its tapes it has used as data carrier 20 years ago, the stored information will become inaccessible in the moment the last tape streamer of the company, which is able to read the tape format, gets broken.

- Possibility of tape-recording of e-mail communication by competitors and governments, which is already practiced at least in some countries.

The above mentioned disadvantages are all well known. Loss of electronic information and deciphering of tape-recorded information can be avoided if a respective data policy is deployed. The necessary higher investment in the beginning and in regular time intervals will quickly be over compensated by the savings in regard to **opportunity costs**[249] for additional office space and lower quality as well as the resulting improvement within the supply chain which leads to a higher customer satisfaction and by that to a higher turnover.

The diagram 4.3.-1 shows that Flender-Germany, FTJ and the sales department in Beijing each will have a centralized data bank accessible by each other company or department within the Flender-group. For example the sales department will store the current information[250] of each technical appendix[251] and customer contract under the respective contract number. By submitting the contract number FTJ can directly access the data of each customer order and store it on its own centralized data bank. In case of changes of any information at the sales department, the data bank automatically transmits an electronic message, containing the customer order number, to all legitimate partners, i.e. at least to FTJ and the companies of the Flender-group in Germany, to update their local data banks. In a following step the respective local data banks update their information by accessing the data bank at the sales department, handing over the received customer order number(s) and download all current information of the customer contract and technical appendix.

That way FTJ and the other partners within the Flender-group have the most current information at their disposal without only relying on the availability of an online connection. In case of a problem with the connection to the sales department, FTJ will be able to operate and only the automatic update is disrupted. By this procedure FTJ is able to swiftly place new orders or change old ones.

According to the new organization of the information flow, and like shown in the example indicated, information now quickly and currently flows into both directions: from the customer via FTJ to the suppliers and from the suppliers via FTJ back to each customer. The **Pull Principle**, where the customer requirements triggers the respective activities within the supply chain of FTJ, is already partly realized as the final products are built according to customer's option[252], but can now be optimized, because any **changes of customer requirements can be better handled**. There are two reasons for this.

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249 The opportunity costs of something is essentially the cost of not putting a resource to its best use (source: http://cooperativegrocer.com/cg1998/economics101.shtml).

250 Very often there occur changes of the content of the technical appendix due to sudden changes within the projects of the customers.

251 The technical appendix has to be signed first, before the customer contract.

252 Contrary to the pull principle is the current stocking of standard supply parts for CAVEX and FZG gear units with the aim of reducing the delivery time of final products.

The **first reason** is that with electronic information an automation of the information flow becomes possible, as explained for the customer data before, and an additional feedback of the successful receipt of information can be used, which is important for a reliable communication and that's why for quality management also. That means: standard information handling and standard problem solving, like for example the re-ordering of supply parts, which arrive damaged at FTJ, is automatically triggered by the procurement system[253]. The employees of the logistics department will now be able to focus on all **non-standard event handling**, hence problematic cases, which can not be solved by the procurement system. In that way any delaying of standard information, like for example a part list, which is forgotten to be sent from Flender-Penig to FTJ[254], can be avoided as long as an online connection between the communication partner is available.

The **second reason** for a better handling of the customer requirements lies in the more efficient[255] way data can be structured and accordingly displayed, what is impossible with information on paper. This new possibility is especially important for the question of supplier development. As the logistics department of FTJ has a lot of different information at his disposal on its local data bank, like the performances of its current suppliers, potential suppliers and the development of the customer requirement, it will be possible to monitor deviations between supplier performance, own performance and customer requirements. By that the respective suppliers, especially local Chinese suppliers, can be developed in due time when trends for new requirements, regarding quality or quantity of supply parts, are seen. One example is the current trend from three stage FZG gear units to two stage ones. An intelligent application would not only display the situation in an appropriate form, but would warn the logistics department about this trend in due time. In that way the later wins time to early communicate with the respective supplier about the new requirement and the supplier has more time to adapt his production processes and communicate likewise with its own suppliers.

In addition FTJ will be able to improve its long-term planning, which is based on the agreement on operational targets within the Flender-group[256]. The requirement analysis, which is the basis for the agreement on operational targets, can be made more reliable if electronic data of at least three financial years is available and respective prognosis procedures[257] are applied.

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253 The procurement system, which normally is part of an ERP application, is a complex set applications including knowledge based applications, also called expert systems, data bank applications, analysis applications, simulation applications and a procurement information system. For information about expert systems and connected simulation systems see [Peter Feil1992].

254 The procurement system will either make out the part list by itself or see when the part list is ready and than send it automatically to FTJ.

255 Many statistics of today are based on data which is delivered by data banks. In regard to the quantity of information a manual data handling does not lead to correct results in due time.

256 see diagram 4.3.-1

257 see chapter 3.4.2.

An important instrument for assuring correspondence of the information flow and the material flow by simultaneously reducing error rates for manually keying in information is the barcode[258]. Palettes sent from Flender-Germany to FTJ can be marked with a barcode containing information about the SPGN of the supply parts, the quantity, the order number(s), the name of the person responsible for packaging at Flender-Germany and other additional information. At FTJ the content of each palettes can then quickly be registered into the data bank at any i-point[259] by reading out the barcode information and automatically making the information of the arrival of the respective supply parts available to each department. In that way the respective storage time can be reduced to a minimum as the supply parts are quicker available for the manufacturing process.
As local Chinese suppliers currently lack experience with the barcode FTJ has to provide support to them if necessary. For internal material flow within FTJ barcodes can also be used to clarify the status of palettes and especially of complete gear units. The production department has to invest in barcode printers[260] which are connected to the local data bank of FTJ. The respective employees can be equipped with portable barcode reading devices. For distribution of final product the use of barcode depends on a certain part on the requirement of the customer. It can often help the customer to improve the control of its own supply chain due to an improved information flow and thus creats an extra value for the customers of FTJ.

4.3.3. Control of the Supply Chain via Reactivity and Pro-activity[261]

At the moment the logistics department at FTJ is not able to foresee arising problems alongside the supply chain due to a lack of information and strategy. That way problems are seen too late for avoiding them in advance, like for example delays according to the sea-transport of supply parts. This leads to high costs[262]. Additionally many current problems are not seen by the management, e.g. the mess and the lack of proper organization within the warehouse management.

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258 In the Internet look for www.casper.de or for http://web.wlwonline.de (the later with the buzzword “barcode”) to find information and addresses around the topic *barcode*. An alternative to the barcode, and an even more efficient means, is the transponder, which is not discussed here.

259 An *i-point* is the abbreviation for *Information Point*. The later has to be available at information interfaces, like for example at the goods receipt. I-points serve for access on the CS3 system for entering or receiving information.

260 The right number of barcode printers and the type of barcode depends on the requirements within the production process and has to be defined in cooperation with the logistics department.

261 In February/March 2002 it was the first time at a lecture given by a lecturer from the company *STEELCASE International Ltd.* in France that the author heard in depth of the idea of *Reactivity* and *Pro-activity*. Some basic ideas of this lecture have been used in this subchapter.

262 If calculated per weight air-transport is c. 44 times as expensive as sea-transport.

This subchapter will introduce to the concepts of *Reactivity* and *Pro-activity* which will enable the logistics department (and FTJ as a whole organization) to flexibly manage and control its processes, especially the SCM, if consistently applied.

First of all the terms **Reactivity** and **Pro-activity** should be clarified. **Reactivity** is the ability of an organization to quickly react to each possible problem in a predefined manner, depending on the current situation by using a register containing the necessary activities and solutions for each problem.

In contrary **Pro-activity** is the ability of an organization to see developments and trends, which could lead to future problems, and to react in such a way to these trends that the problems are avoided. A register contains the respective procedures for each possible trend.

Reactivity is easier to achieve than Pro-activity, because to see a problematic development or a negative trend respectively and to avoid the former is more difficult than realizing a problem which has already been experienced. In order to recognize trends, respective criteria have to be defined based on long-term experience (historical data). But the later is often difficult to achieve in many companies.

Achieving Reactivity

At first a register of all known (experienced) and possible problems alongside the supply chain has to be created. In a following step every problem has to be explained to show its nature and

Reactivity in Case of Late Delivery

Problem Statement

Late delivery of supply parts from Flender-Penig.

Explanation (of the Situation)

The logistics department arranges a delivery date with Flender-Penig according to the requirement within the production process, the planned mode of transport and the respective period needed for sea- or air-transport.

Analysis

1. Reason: Flender-Penig sometimes has, for certain supply parts, not enough production capacity.
2. Reason: Orders of FTJ are treated as less important orders in comparison with orders of other customers, because FTJ is an internal customer.

Short-term Activities

1. Transport the supply parts by train via Moscow (Russia) and Transsib to Tianjin.
   => transport period: ~ 20 calendar days
   => costs: ~ 84% of the costs per kg for sea-transport of a 40‘ DV via the Port of Hamburg (up to 400.- USD cheaper per 40‘); source: “German-Chinese Business Forum“, June 2001
2. Transport the supply parts by air via Köln-airport to Tianjin.
   => transport time: ~ 5 – 9 calendar days
   => costs: ~ 44 times higher per kg than sea-transport via the Port of Hamburg

Long-term Solutions

1. Find alternative suppliers for the procurement of supply parts.
2. Re-negociate the general delivery contract with Flender-Penig and agree on penalty of breach of contract for late delivery to increase the pressure on Flender-Penig to deliver on time.

Source: Falk Ueberschär

Diagram 4.3.-2: Example for the Reactivity concept in case of late delivery

has to be analyzed for identifying reasons which led to the problem.
Then possible activities for handling the short-term situation and possible long-term solutions have to be found. In a final step each activity has to be evaluated by criteria like cost, time necessary for realization, etc., to make it easy to select the most adapted activity according to the situation. The following diagram 4.3.-2 shows an example for the case of late delivery of supply parts.
In the example case the problem of late delivery is already analyzed and short-term activities are quickly available in case the stated problem appears again. The result will be savings of time and the application of an adapted short-term activity in regard to the higher priority: transport time or costs.
Long-term solutions are useful to avoid the problem in the future, but consume more time than short-term activities and are therefore of no use in the moment when the problem appears. To further shorten the reaction time the first solution “find alternative suppliers” can be improved by adding respective contact addresses and other information of respective suppliers. The idea of achieving solutions, in contrast to only using short-term activities, within the concept of Reactivity, will again appear within the concept of Pro-activity

Achieving Pro-activity

By Reactivity FTJ will save time and money, but the respective problem still appears as long as the long-term solutions are not realized. Due to the nature of Pro-activity a division into short-term activities and long-term solutions is not helpful, but a definition of indicators and a register of alternatives.
Indicators are needed to monitor the respective process. In our example of diagram 4.3.-2 it is useful to **monitor** the forecasted results[263] for (1) the **inventory** of the required supply part and (2) the **production capacity** at disposal for this supply part at Flender-Penig in the same period. The sum of (1) and (2) has to be compared with the **forecasted requirement** of the respective supply part[264] and the respective period. As the concept of Pro-activity consists in flexible reactions for avoiding problems, it is necessary to place all orders which - according to the prognosis - cannot be completely served on time by Flender-Penig with alternative suppliers[265]. The register of alternatives would for this problem contain:

- All known suppliers
- Their current production capacities
- Their prices

263 e.g. rolling forecast

264 for questions concerning forecast: see subchapter 3.4.2.

265 It can be considered to place only a certain share of each order with alternative suppliers, but than the risk of late delivery by Flender-Penig will stay quite high and small order quantities will again lead to higher prices and/or longer lead times with all suppliers.

- Their stock of the respective supply part and
- The delivery conditions.

It is clear that Flender-Penig has to be willing to submit regularly the respective data of stock and production capacity. The concept can be further extended by additionally monitoring at least the most important alternative suppliers.

Conclusion

The realization of Reactivity is a preliminary stage before Pro-activity can be achieved. For both concepts a problem statement, an explanation and an analysis is needed, but with Reactivity it is not possible to recognize and judge problematic developments, hence problems are only tackled when a certain damage is already done bearing the inherent risk of repetition.
Pro-activity enables FTJ to solve potential problems even if the kind of problem has never occurred before. By that a shift of faults or problems from one process stage to the following process stages can be avoided. Unfavourable is the increase of necessary effort, because data has to be regularly provided by the supplier which may often not willing to do so and a highly qualified staff is needed.
It is important that the general information for problem handling is regularly revised as otherwise a somehow changed problem cannot be tackled in the right way in the future.

5. Rearrangement of Procurement

This chapter focuses on standard methods and strategies, which are useful for FTJ to rearrange its procurement, e.g. stockkeeping policies, benchmarking and evaluation of the suppliers, Material Group Management, importance of communication networks, etc.
First of all two important procurement strategies will be explained.

For a successful rearrangement of the procurement at FTJ it is necessary to tell apart **operative procurement** and **strategic procurement**.

The **operative procurement**[266] (operative purchasing[267]), which represents the first stage in the development of procurement, is focused on the filling of needs with essentially necessary goods. The main responsibility of such an operative procurement is the punctual supply of required material in the right quality to the plant, which has been pre-defined in quantity as well as in technical specifications by other business units. In general simple calculations models are in use to simplify prognosis efforts and for improving the procurement organization. All these facts are also mainly valid for FTJ.

266 see Droege & Comp., “Gewinne einkaufen”, p. 16pp.

267 The term *procurement* is more general than the term *purchase* as the former includes the later.

In that way the assurance of supply represents the most important guideline for the logistics department of FTJ. The existing potential for the increase of the competitiveness of FTJ through systematic cost reductions is mainly unexploited.

Ordering certainly is important, but it is problematic for FTJ that the logistics department does not realize savings, which according to the experience in Europe can represent more than ten percent of the order value, because it is robbed of the possibility to create competitional pressure in regard to its suppliers either due to deadlines or technical reasons.

Out of the before mentioned problems evolved the **strategic procurement**[268]. By using this concept, the logistics department could achieve a substantial improvement in regard to the supply chain principle. The term *strategic* does not only refer to global sourcing, which is one 'brick in the wall', but represents the long-term and potential oriented character of procurement with changeability of all internal procurement relevant factors within FTJ. In the frame of changing processes it means: all groups which either define supply parts or which transport supply parts from A to B or which consume them have to be reviewed.

Procurement at FTJ only develops from operative to strategic approach if all internal possibilities for costs, logistics and quality optimized procurement are used, as there are

- in regard to the **product** through reduction of complexity, *Value Analysis*[269] and standardization
- in **production** through systematic 'make or buy' and scrap-metal concepts
- for **order processing** through a general logistics and time optimized disposition
- with the **suppliers** through bundling of volume, *Spot-Market-Concepts*[270], *Global Sourcing* as well as *Value-Adding-Partnership*[271]

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268 see Droege & Comp., "Gewinne einkaufen", p. 17pp.

269 The *Value Analysis* is a method for the systematic research into functional structures. The aim is to realize an increase in value of the performance or of the product with a manufacturer, for a user or for the general public; see Ehlers, Jörg D.: "Die dynamische Produktion".

270 The spot-market is an institutionalized short-term market, mostly for deals due on the next day or days. The spot-market most often closes twelve hours before the day when the contract is exercised; source: 'www.pmax.de/glossar%20neu.htm' [15th of June 2002].

271 *Value adding* is the difference between the realized production values (sales revenues) and all performances realized outside the company (input), which are necessary to start production within the company; see Ehlers, Jörg D.: "Die dynamische Produktion".
Value-Adding Partnership (VAP) is a durable kind of hybrid network organization between independent companies with the later positioned alongside the whole value-added chain. 'Hybrid' means the combination of coordinating functions of integrated hierarchies with the decentralized structure of independent companies. The member companies have agreed to relations where mutual benefit is generated and which are typically coordinated by a strategic broker. Each company is responsible for

So in the future the logistics department, which is responsible for procurement at FTJ, will not mainly think about static procurement portfolios but about problems along the supply chain and the realization of Supply Chain Concepts, and instead of prices the focus shifts to value-adding costs. By that the availability of supply parts at the right time and quality as the general assumption for a competitive lead time can consistently be achieved.

As the strategic procurement shows conceptual affinity to approaches like for example *Total Quality Management*, the logistics department will focus on customer value and quality of efficiency. Often the term *Supply Management* is also used to describe this concept in a similar meaning, but with the emphasis on logistical objectives[272].

5.1. Improvement of Project and Quantity Oriented Procurement [Part B]

Project and Quantity Oriented Procurement are both already practiced at FTJ, but the assignment of respective supply parts to one of both classifications is up to now only based on a simple strategy. It will be expounded why a new approach should be considered and in addition the associated question of the appropriate stockkeeping policy for special and common final products is discussed.

5.1.1. Differences of Project and Quantity Oriented Procurement

Currently FTJ applies two different sourcing strategies: on the one hand sourcing of supply parts according to the final product ordered by the customer and on the other hand sourcing of defined quantities of common (often used) supply parts.

Project Oriented Procurement

Every final product represents a certain quantity of supply parts, according to the respective part list. *Project Oriented Procurement* means that all gear units required in an order are taken apart into the respective supply parts and, without unifying the quantities (of supply parts) of this order with the quantities of other orders, the supply parts are ordered with the respective suppliers. Prognosis methods for judging the requirements of supply parts are normally not taken into consideration.

By practicing Project Oriented Procurement the capital tied-up can be kept at a low level as storage time is reduced to a minimum, but it leads to long overall lead times, because for new orders no supply parts are on stock and have to be ordered again leading to high procurement costs for FTJ.

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clearly delimited activities like product design, production, etc., which they contribute to the network (source: 'www.malekigroup.com/newhome/termine/ebtf/deutsch/seiten/congress/ws/ws3_12.html').

272 For further detail to the before mentioned ideas: see Droege & Comp., "Gewinne einkaufen", p. 19pp.

Quantity Oriented Procurement

For achieving Quantity Oriented Procurement either a defined quantity per type of supply part is ordered by using a certain stocking strategy, which is 'independent' of current customer orders and based on requirements of experience for a certain period, or the order quantities of different orders of a certain period are unified per identical type of supply part or per supply part group key[273] to order them together. Often prognosis results are additionally considered to adapt the respective order quantity.

The result for Quantity Oriented Procurement is a reduction of the overall lead time and a considerable reduction of procurement costs[274], especially of transport cost by using only sea-transport instead of air-transport. In comparison with Project Oriented Procurement an increase of capital tied-up has to be put up with.

The concept of Quantity Oriented Procurement is not absolutely new for FTJ since the company currently pursues the strategy of stocking the most common supply parts, like for example 200 complete sets[275] of internal parts[276] for standard types of CAVEX CRW160 and 50 sets of the FZG B-series[277], for shortening the delivery time for these common gear units from about 12 to 14 weeks down to 2 to 4 weeks[278].

Conclusion

As mentioned in the introduction of this chapter the availability of supply parts is vital for the competitiveness of FTJ. The customer seems to be willing to pay at least slightly more if FTJ is able to deliver short-term, hence within 4 to 8 weeks.

In consideration of the goal 'reduction of delivery time' it is recommended to focus on Quantity Oriented Procurement as far as possible. Problems with stocking capacity are not to be feared as currently a new warehouse with big stocking capacity has been taken into service making

273 see subchapter 4.2.1.

274 This reduction of procurement costs is at least achievable for the costs up to the moment the supply parts arrive at FTJ. The longer these parts are stored at FTJ the higher the overall procurement costs will be. At the moment warehousing costs equal only 6% per year of the value of the supply parts. This is cheap in comparison with opportunity costs with Project Oriented Procurement.

275 A *set* comprises all the internal parts necessary to produce one gear unit.

276 All parts of a gear unit are *internal parts*, except housing, cover and ring nut.

277 with a re-order quantity of 60 sets

278 But since the warehouse management is currently not using a data bank and hence the knowledge about the current stock depends on the stockkeeper, it has to be questioned, if the total quantity of common supply parts actually is available.

increased stocking possible. The reduction of transport costs will over compensate the increased costs for capital tied-up[279].

5.1.2. Current Problems with Project Oriented Procurement

Many problems in regard to Project Oriented Procurement have already directly or indirectly been touched on. In general mainly high order frequencies combined with small quantities per order and per supplier lead to the current problems at FTJ, as there are:

- High purchase prices for the supply parts, which is also due to the lack of alternative suppliers[280], hence single sourcing
- High transport costs, since supply parts are not available on the prearranged date and about 30% of all transports from Germany to FTJ have to be changed from sea to air transport
- High management costs as especially in the P.R.C. many suppliers are needed for sourcing of casting parts and also due to double checking and lack of training for the use of software in the logistics department
- Difficulties for FTJ to achieve a strategic supplier development as suppliers are often changing, which is also partly caused by a lacking development strategy
- Long overall lead time, measured from order income up to delivery ExW at FTJ, seeing that in particular at Flender-Germany many employees are involved to manually process the orders of FTJ and as e.g. Flender-Penig has currently problems with its production capacity

Reviewing and adapting the current sourcing strategy can solve all of the above mentioned problems. The use of current key figures like for example 'working capital' should not be the only main decision criteria for FTJ, but have to be combined with a cost-benefit analysis in regard to the overall competitiveness.

5.1.3. Decision Basis for a Consistent Quantity Oriented Procurement

First FTJ has to figure out, which supply parts are **common**, hence are at least needed for half of the total number of all gear units, and which are **special**, i.e. can not be used in more than a few gear units or only one. This classification shows the importance of a supply part within the production process in regard to the number of gear units which can not be manufactured if the supply part is not available.

279 About 6% p.a. is the current cost for capital tied-up at FTJ and costs for air-transport are about 44 times as high per kg as costs for sea-transport.

280 It can be stated that the availability of more than one supplier for the same supply part on the market normally leads to competition and falling prices for the supply parts; see Droege & Comp.1998

In a second step it is necessary to find out the most often sold models of gear units. The later are defined as **common final products**. By using the limit for A-parts of the ABC analysis it can be stated that 19.35% of all models of FZG gear units, i.e. 12 of 62 in the financial year 2001/02[281], are common final products and represent 56.5% of the output quantity[282]. That means that 80.65% of all FZG models are **special final products**.

With both classification results available, it is possible to assign Project Oriented Procurement to every special supply part, which is not used to produce a common final product. Quantity Oriented Procurement method has to be assigned to all other supply parts, i.e. which are common supply parts or are used to produce common final products. In a following step the appropriate stockkeeping policy has to be defined for applying Quantity Oriented Procurement in regard to the ABC type classification of the ABC analysis.

To achieve the later, an introduction into stockkeeping policies has to take place.

5.1.3.1. Warehouse Related Performance Criteria[283]

In general under stochastic conditions it can not be avoided that the available inventory is exhausted in certain periods[284], what is also currently experienced in a great scale with FTJ, and that in that way a customer order can only be served after a waiting period, called **stockkeeping related delivery time**. All required quantities, which can not be delivered immediately due to insufficient delivery capability of the warehouse, are put down and are preferably delivered as soon as possible[285]. There are three similar key figures, which all indicate the ability to deliver: the α-, the β- and the γ-service level.

α-Service level

The α-service level is an **event oriented** key figure. It indicates the probability that an occurring requirement can be completely served from the available inventory. In case one requirement period is chosen as a related period (standardized time definition) the service level[286] α_{Per} describes the probability P, by which an arriving order can be completely served from the inventory at any time. The following formula can be used:

$$\alpha_{Per} = P(\text{quantity of demand per period} \leq \text{physical inventory at the begin of a period})$$

281 The output results for the last four months of the financial year 2001/02 had to be estimated.

282 The most important FZG models are W4DS07 (11.94%), B2SV04 (7.71%) and B3DH06 (6.22%).

283 this subchapter follows Tempelmeier, Horst: „Material-Logistik“, p.367pp.

284 This is due to the fact that certain events or trends can simply not be foreseen.

285 In contrary to that exists the so-called ‘lost sales’ case, which proceeds from the assumption, that the customers are not willing to wait and that therefore a turnover loss appears.

286 of a period

It is clear that the α_{Per} can be used to indicate the service level of any supplier of FTJ and its own delivery performance per final product. The table 5.1.-1 contains an example for a delivery performance, where the supplier, which could be for example Flender-Penig, is able to deliver 12 out of 16 weeks[287] completely from stock. By that the respective service level α_{Per} is 75% as a missing quantity appears in 4 out of 16 periods. For the calculation of the buffer stock, by which an aimed α-service level is achieved, the stationary probability distribution of the inventory at Flender-Penig has to be known.

In case the chosen period refers to a procurement cycle, than the service level α_{Cyc} describes the probability P, that within one procurement cycle no shortfall appears.

α_{Cyc} = P(quantity of demand within the replacement period $\leq$ physical inventory at the begin of the replacement period)

For the example in table 5.1.-1 this version of the α-service level α_{Cyc} is 0.0% as in all (two) cycles the inventory has not been sufficient to completely serve all requirements.

β-Service level

The β-service level as a **quantity oriented** key figure indicates the share of the total quantity of demand which can be delivered without any stockkeeping related delivery time:

$$\beta = 1 - \frac{\text{E (missing quantity per period)}}{\text{E (quantity of demand per period)}}$$

with: E = expected value

287 with one week = one period

Table 5.1.-1:Development of example inventory (each time at the end of the period)[288]

Period	Quantity of Demand	Inventory (Physical)	Order - or Incoming Goods ⊕	Shortage (End of Period)	Missing Quantity (per Cycle)
1	50	350		-	-
2	58	292		-	-
3	44	248		-	-
4	59	189	-	-	-
5	54	135		-	-
6	50	85		-	-
7	83	2		-	-
8	44	-		42	-
9	57	-	⊕	99	99
10	46	255		-	-
11	54	201	-	-	-
12	74	127		-	-
13	64	63		-	-
14	46	17		-	-
15	57	-		40	-
16	38	-	⊕	78	78

That means that β corresponds to the probability that any requirement quantity is delivered without any stockkeeping related delivery time. In the example case the average missing quantity per period is 11.0625 supply parts[289] and the average requirement quantity per period is 54.875 supply parts[290] resulting in a β-service level of 79.84%.

Since the β-service level in contrary to the α-service level does not only include the fact that a missing quantity appears but also the height of the missing quantity, it is preferably used as a performance standard in many companies.

γ-Service level

The γ-service level provides a **time and quantity oriented** key figure. It catches the height of the missing quantity as well as the respective waiting periods of the down noted requirements, which represent outstanding orders. The γ-service level is defined as follows:

$$\gamma = 1 - \frac{E(\text{shortage per period})}{E(\text{quantity of demand per period})}$$

with: E = expectancy variable

Whereas for the β-service level only the shortage in the period directly before the replenishment of the warehouse is relevant, the γ-service level also catches the development of the shortage of the preceding periods[291]. That means the sum of the shortages of any period, where a shortage appeared, has to be calculated and then to be divided in a following step by the total

288 This is a section of the table E.1 given in Tempelmeier, Horst: „Material-Logistik“, p.369

289 (99 + 78 missing supply parts) / 16 periods = 11.0625 missing supply parts per period

290 (878 total quantity of demand) / 16 periods = 54.875 supply parts as demand per period

number of periods to calculate the expectancy E for the shortage per period. In the example the realized γ-service level is 70.50%, as with an average requirement quantity per period of 54.875 supply parts the average shortage per period is 16.1875 supply parts[292].

Conclusion

FTJ should at least use the α- and γ-service level for the control of the efficiency of its SCM. The γ-service level is up to now only rarely used in companies, but does better reflect the reality if compared with the β-service level. The goal is to **improve the supply chain** in a way that both indicators reach a market oriented level, e.g. for the γ-service level 98%.

5.1.3.2. Stockkeeping Policies[293]

In this part stochastic and multi period approaches for a solution for stockkeeping policies will be expounded. Deterministic models, even if they include a dynamic point, will not be considered. The following inventory control strategies are known[294]:

(s,S) model

Following this model supply parts have to be re-ordered if the stock level falls below the buffer stock s (re-order level)[295]. The re-order quantity is sufficient to reach the replenishment stock quantity S, i.e. the later corresponds to the re-order quantity.

(s,q) model

A new order is triggered in the moment, when the stock falls below the buffer stock s (re-order level). In contrary to the before mentioned model a constant re-order quantity q is ordered.

(s,c,S) model

This model represents a special case of the (s,S) model. As described before a re-order is triggered with a replenishment quantity up to the replenishment stock quantity S. In addition there exists a “Can” order point. If the stock falls below this point, an order *can* be triggered.

(t,S) model

A re-order is triggered in regular time intervals of the length t. The re-order quantity results from the difference of the replenishment stock quantity S and the current stock.

(t,s,S) model

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291 To mark the difference the term *missing quantity* is used for indicating the accumulated quantity of demand, which could not be served per cycle, where the term *shortage* indicates the quantity of demand, which could not be served per period.

292 (42 + 99 +40 + 78 shortage) / 16 periods = 16.1875 supply parts as average shortage per period

293 This subchapter follows Feil, Peter: “Schriften zur Produktion”, volume 4, p. 61pp.

294 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 62pp.

295 The *buffer stock* in all these models correspond to the function of the *re-order level* and should not be mixed up with the *reserve inventory*. The later is used for serving unexpected (additional) demand whereas the *buffer stock* covers the consumption until the arrival of ordered goods.

In regular time intervals t it is checked if the stock has fallen below the buffer stock s (re-order level). In this case a re-order quantity is triggered in a way that the replenishment stock quantity S is reached.

(t,q) model

In regular time intervals t a constant re-order quantity q is triggered.

(t,s,S,q) model

This is a special model, which is put together from the (t,S) and the (s,q) model. In regular time intervals of the length t the difference between the replenishment stock quantity S and the inventory is re-ordered. In case the inventory falls below the buffer stock s (re-order level) an additional order with the quantity q is triggered.

(t,s,q) model

This model is put together from the (s,q) and (t,q) model. In regular time intervals of the length t it is checked, if the inventory has fallen below the buffer stock s (re-order level). In this case the firm re-order quantity q is ordered.

For FTJ it is interesting to know if there exist general statements valid for all mentioned stockkeeping policies. The discussed stockkeeping policies proceed from the assumption of a stochastic demand and other stochastic elements, e.g. delivery time.

The use of these policies only makes sense in case of recurring orders. This is the meaning of *multi period*. Single period models proceed from the assumption that merely a one time order is placed.

The expounded eight stockkeeping policies consist of six basic models as well as two derived models. The realization of these stockkeeping policies is limited to the six basic models, which result from the combination of the following five different parameters: firm re-order quantity, the replenishment stock quantity, the re-order level, the firm control time (check the stock in the time interval t) and the firm order time (regular time intervals of the length t). Table 5.1.-2 gives an overview:

Table 5.1.-2: Dependencies between decision variables and stockkeeping policies[296]

Decision Variables	**Stockkeeping Policies**					
	(s,q)	**(s,S)**	**(t,q)**	**(t,S)**	**(t,s,S)**	**(t,s,q)**
Firm control time					X	X
Firm order time			X	X		
Firm re-order quantity	X		X			X
Re-order level	X	X			X	X
Replenishment stock quantity		X		X	X	

296 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 67

The (s,q) and the (s,S) stockkeeping policy is called **order point procedure.** The **order or control rhythm procedures** are represented by the stockkeeping policies with a periodic control like the (t,s,S) and (t,s,q) policies or a periodic ordering respectively, hence (t,q) and (t,S) stockkeeping policies.

Different simulations have been carried out to determine the most efficient of the eight shown models. Of the available simulation studies merely the survey of Eilon, S. and Elmaleh, J.[297] covers five of the above expounded surveys[298]. The different models have been examined with the help of simulation and proceeding from the assumption that there exists a seasonal demand structure, in which also a trend[299] can appear, which is the case with the demand for final products of FTJ. The delivery service level of each model had to range from 90% to 95%. The cost parameters for the valuation of the separate models with its parameters have been predefined.

As result the authors[300] discover that a survey of these models is only possible with the help of simulation. With the chosen parameter situation, especially the cost parameters as well as the parameters of the demand structure, the **(t,s,S) stockkeeping policy** comes off best of all five models. From their view this is surprising as in general the (s,S) stock keeping policy has the reputation to be the most efficient policy.

Lewis[301] surveys in his simulation study the (s,S), (t,S) and (t,s,S) stockkeeping policies by using a real demand structure. The simulation takes into consideration order costs, warehousing costs and missing parts costs. For comparison of the three stockkeeping policies Lewis chooses a firm cost rate. As a result it is emphasized that the (s,S) stockkeeping policy is superior to both other stockkeeping policies. This is also valid for the case, that the parameters s or S respectively varies.

The superior results of the **(s,S)** policy are put down by Lewis[302] to the reaction of the policy. In case of changes of the external situations the (s,S) policy is most easily able to react, because merely the order frequency is changed. Changes of the re-order level s automatically result in a new order frequency. Any changes of the replenishment stock quantity S have an impact on the re-order quantity and in that way likewise on the order frequency.

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297 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 64

298 It is not mentioned in the book which of the eight models have been surveyed.

299 A trend is understood as a long-range influence on the demand structure, which is either monotonous rising or falling; see Peter Feil: “Schriften zur Produktion”, volume 4, p. 64

300 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 64

301 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 64

302 see Feil, Peter: “Schriften zur Produktion”, volume 4, p. 65

Both survey results for the (s,S) and the (t,s,S) stockkeeping policy, which focus on costs, are contradictory to each other, but the (s,S) policy is easier to define as only two parameters are needed and as it is deemed to be more efficient. For FTJ it is important to understand that all six basic models are useful, depending on the classification of the ABC analysis.

Since **A-parts** represent supply parts with high value, a great stock leads to high warehousing costs and high capital tied-up costs. So the strategy should be a small inventory, which in turn demands regular monitoring of the stock.

B-parts likewise represent supply parts with a high value, but in comparison with A-parts the value is lower. That's why monitoring is necessary, but only periodically. According to the consumption quantity it can be assumed that warehousing costs will be lower and that's why it makes sense to reduce the monitoring frequency and with that the monitoring costs.

As C-parts include supply parts with low consumption value, monitoring should be done as simple as possible or not at all.

In general **C-parts** comprise the highest quantity of supply parts combined with very small value[303]. The "TWO-BIN"-system can be used for monitoring causing no monitoring costs. This strategy divides the total warehouse quantity into two quantities in two different 'bins'. First the consumption is served from the first bin. If it is empty an order is released. Until the arrival of the ordered supply parts the demand is served from the second bin[304].

For a consistent Quantity Oriented Procurement the following table 5.1.-3 shows the classification of stockkeeping policies according to part type, kind of control and order type.

Table 5.1.-3: Classification of stockkeeping policies according to part type, kind of control and order type[305]

	Kind of Control		
	Current	**Periodic**	**Without**
Part type	A-part	B-part	C-part
Firm reorder quantity	(s,q) policy	(t,s,q) policy	(t,q) policy
Replenishment stock quantity	(s,S) policy	(t,s,S) policy	(t,S) policy

The shown stockkeeping policies will now be discussed in further detail.

303 For all FZG supply parts the C-parts represent c. 55.21% of the quantity but only 0.56% of the value.

304 see Feil, Peter: "Schriften zur Produktion", volume 4, p. 71/72

305 see Feil, Peter: "Schriften zur Produktion", volume 4, p. 68

Definition of Parameters

In this part of the subchapter the aim is not to show how to define optimal parameter values for the chosen stockkeeping policy, but how to define ingenious starting parameters, which can be adapted with increasing experience.

The definition of the **firm control period t_f** orientate to the existing delivery time for the supply part. The re-order level, which is established at another passage, includes a buffer stock. The appearing requirements between ordering and delivery are covered by this buffer stock. The control period is defined as the half of the delivery time. By that it is assured, that after the stock has fallen below the re-order level and before the delivery arrives a control is exercised.

$$t_f = \frac{t_D}{2} \qquad \text{with } t_D = \text{delivery time}$$

For sea transport from Flender-Penig to FTJ the firm control period t_f is 21 days, as the average delivery time t_D is 42 days. For the same relation and air transport, with an average delivery time t_D of 8 days, the firm control period t_f is 4 days.

The **re-order period**, the **firm re-order quantity** and the **replenishment stock quantity** are parameters which depend on each other. For the definition of the firm re-order quantity the formula of Andler is used. The **optimal re-order quantity q_o** follows from the calculation:

$$q_o = \sqrt{\frac{2 * C_{ord} * x}{C_w}}$$

with: C_{ord} = order costs for one order
C_w = warehousing costs per unit of quantity / of time
x = demand (requirement) per unit of time

The **firm re-order quantity x_F** corresponds to the optimal re-order quantity q_o. In case a constant demand (requirement) does not exist, the average value can be used as an ingenious estimate.

As an example the optimal re-order quantity q_o is calculated for a FZG supply part[306] , which has been ordered from Flender-Penig (C_{ord} = 37.95 RMB), with warehousing costs C_w = 119.02 RMB[307] and a requirement x = 16 supply parts within 215 days. The resulting optimal re-order quantity q_o is 3.2, showing that in reality the re-order quantity has been 2.4 times smaller. In reality a re-order quantity q_o of 3 supply parts is used since 3.2 supply parts cannot be ordered. The rounded result is also used for further calculations.

306 Supply part name: BACKSTOP; supply part code: 01500050015327; period: 1st of July 2001 till 31st of January 2002 (= 7 months or 215 days); total quantity ordered: 16; order frequency: 12; part price: 3,367.57 RMB

307 (6% / 365 days) * 3,367.57 RMB * 215 days = 119.02 RMB with 6% capital tied-up costs per year

The **firm re-order period t_{rp}** follows from the quotient of firm or optimal re-order quantity respectively and the average requirement:

$$t_{rp} = \frac{q_o}{x}$$

q_o = optimal/firm re-order quantity
x = average demand (requirement)

For the example case the firm re-order period t_{rp} is 40 days[308].

For the calculation of the replenishment quantity the firm re-order quantity and the re-order level is needed. The **re-order level x_{RL}** is the point where the order is triggered. The remaining stock, also called buffer stock, has to cover the requirements up to the next delivery. The buffer stock follows from the product of average demand and delivery time. In the most simple cases the re-order level is equated to the buffer stock.

$$x_{RL} = x * t_D$$

x = average demand (requirement)
t_D = delivery time

If proceeding from the assumption, that in the example case the supply part is only transported by sea, hence the delivery time t_D would be 42 days, than the re-order level x_{RL} is 4 supply parts[309]. The reserve inventory is 0 supply parts since the inventory is completely exhausted just in the moment the new consignment arrives.

The **replenishment quantity x_{RPQ}** follows from the addition of the re-order level and the optimal re-order quantity.

$$x_{RPQ} = x_{RL} + q_o$$

x_{RL} = re-order level
q_o = optimal re-order quantity / firm re-order quantity

In the example case the **replenishment quantity x_{RPQ}** is 7 supply parts.

Following [Weber, Rainer 1989, p. 68] the use of a reserve inventory leads to an increase of average stock as well as the respective warehousing costs since the re-order level x_{RL} and the replenishment quantity x_{RPQ} have to be increased by the reserve inventory. But if the reserve inventory is appropriate according to its quantity, it can be seen as a good investment as shortfalls can cause lags in the production or customer orders lost to competitors.

308 The exact result is 40.3125 days = 3 / (16 / 215 days).

309 (16 supply parts / 215 days) * 42 days = 3.13 supply parts (rounded up to avoid shortfall: x_{RL} = 4 supply parts)

In reality the reserve inventory is often estimated and set to the demand for about 15 days. This means a reserve inventory of 2 supply parts[310] in the example case resulting in a re-order level x_{RL} of 6 supply parts and a replenishment quantity x_{RPQ} of 9 supply parts.

Checking the Calculated Parameters

In the following example for the BACKSTOP it will now be shown how to check the before calculated parameters. The table 5.1.-4 indicates the necessary example data:

Table 5.1.-4: Example data for the BACKSTOP supply part[311]

x_i (demand)	1	2	3	Sum
$p(x_i)$	9/12	2/12	1/12	1

In the example the probability p(1) is 75% as the manufacturing department has nine times requested one BACKSTOP from the warehouse and in total 16 BACKSTOPS have been required by a total of 12 inquiries during 215 days. For this kind of processes the model of a normal distribution can be used[312]. In a first step the expectancy value m, the variance v and sigma σ have to be calculated:

$$m = \frac{1}{n} * \sum_{i=1}^{n} x_i \qquad v = \sum_{i=1}^{n} p_i * x_i^2 - m^2 \qquad \sigma = \sqrt{v}$$

The expectancy value m is 1.33333 supply parts, the variance v is 0.388889 and sigma σ is 0.62361. For the period of 17.92 days[313] and an average inventory of 1.33 supply parts that means c. 50% of all inquiries could have been served from the inventory, hence the service level would have been 50%. This correlation can now be used to get an overview over the relation between inventory and the resulting service level as shown in table 5.1.-5.

310 The calculated results for the reserve inventory = (16 supply parts / 215 days) * 15 days = 1.1 supply parts should always be rounded up to the next unit to avoid shortfall. The rule “the smaller the inventory quantity the higher the accurateness of the inventory figures has to be” is valid.

311 Since no real data for the distribution of demand in the production department for the already used example BACKSTOP has been available the author has created the given data.

312 see Weber, Rainer: “Zeitgemäße Materialwirtschaft”, p. 72

313 Since 16 supply parts have been consumed in 215 days the average requirement of 1.33 supply parts is consumed in 17.92 days.

Table 5.1.-5: Correlation of inventory and service level in case of normal distribution[314]

Inventory[315] (for the period of 17.92 days)	Service Level[316]
1	29.65%
1.33333	50%
2	85.75%
2.6145	98.00%
2.66667	98.37%
3	99.62%
4	99.99%

In case of application of a (s,S) stockkeeping policy the service level will fall from 99.99%, in the moment the new order is triggered with x_{RL} = 4 supply parts, after one period of 17.92 days to 98.37% and after two periods (35.84 days) to 50%. Since the new consignment will arrive after 42 days, hence before three periods are complete, the service level will never fall below 50%.

Since the target is a service level of at least 98% the necessary inventory in the beginning of the third period is 2.6145 supply parts. That means a re-order level x_{RL} of 6 supply parts, a reserve inventory of 2 supply parts and a replenishment quantity x_{RPQ} of 9 supply parts.

The already mentioned estimate for the reserve inventory based on 15 days leads to the same result if it is rounded up, with an theoretical reserve inventory of 1.1 supply parts compared to the increase of 1.28 supply parts for the calculation based on the normal distribution and the expected requirement of 1.33333 supply parts per period.

Conclusion

It has been shown which strategy should be used for special and common supply parts. The necessary stockkeeping policies have been explained, based on an example case, in regard to the formula and according to useful starting parameters. It has further been expounded how to check the calculated parameters which is especially important as FTJ will be often forced to use estimated figures for calculating for example the buffer stock or the demand per period. FTJ has to consistently record real and exact statistical data in order to be able to use more appropriate parameters in the future.

5.1.4. Comparison of the Stockkeeping Policies[317]

The discussed stockkeeping policies are related to different stock and order frequencies and by that cause different warehousing and order costs. Since the (s,S) policy as borderline case

314 Source: Falk Ueberschär

315 in the beginning of the period

316 This kind of service level is calculated in regard to the probabilities defined for a normal distribution and should not be mixed up with the α-, β- and γ-service level.

317 this subchapter follows Tempelmeier, Horst: “Material-Logistik”, p. 406

includes the other stockkeeping policies, the minimal stocking and order costs, which can be achieved by this policy, cannot be higher as with the alternative policies. That means that the parameters s and S of the (s,S) policy can always be defined in a way that the later in any case in regard of the two mentioned cost components is at least as good as other policies. Over and above that it can be ascertained, that the (t,S) policy leads to higher costs than the (s,q) policy if both are applied to the same supply part[318]. The procurement costs of both policies are the same in case the optimal control period is defined by means of the classical order quantity formula. But as the replenishment stock quantity S of the (t,S) policy has to cover the uncertainty over a longer period ($t + t_D$) as the re-order level s of the (s,q) policy (t_D), the warehousing costs caused by the (t,S) policy are higher if the same service level is achieved.

Delivery Time

When further comparing the stockkeeping policies it can be stated that with the (t,S) policy the **risk period** can be substantially longer as with the (s,q) policy. This is due to the slower reactions of the (t,S) policy. As the risk period in general can be seen as an upper limit for the stockkeeping related delivery time of a customer order, the distribution of the probability of the delivery time within the (t,S) policy shows a greater mean variation than with the (s,q) policy. This property of the (t,S) policy can prove unfavourable for the integrated optimization of all sub processes of the logistics chain of FTJ.

Further Points of View

In a concrete case FTJ has also to consider other influential factors which will often change the first above mentioned consideration as the later is only based on the sum of order and warehousing costs. If quantities depending on the procurement prices have to be considered, which vary with the respective procurement quantities, than often neither the (t,S) policy nor the (s,S) policy can by applied as with these policies the procurement quantities are aleatory variables, which show a mean variation depending on the variance of the deficit. Additionally in case of defined **firm transport and packaging sizes** the application of these policies is limited, as the replenishment stock quantity S can often not be reached exactly, i.e. the use of the (s,q) policy with its defined procurement quantity q is appropriate.

But in cases where **synergy effects in transport** can be realized like for all the supply parts sourced from Flender-Penig, hence if all supply parts are sourced from one supplier than it can be appropriate to accept the higher costs of the (t,S) policy with the goal to save fixed procurement costs by timewise coordination of the procurement dates of the supply parts.

318 That's why the (s,q) policy, which causes high control costs, should be used for valuable stock, hence A-parts, and the (t,S) policy should be used for supply parts with low value like C-parts.

5.2. Improvement of Quantity Oriented Procurement [Part A]

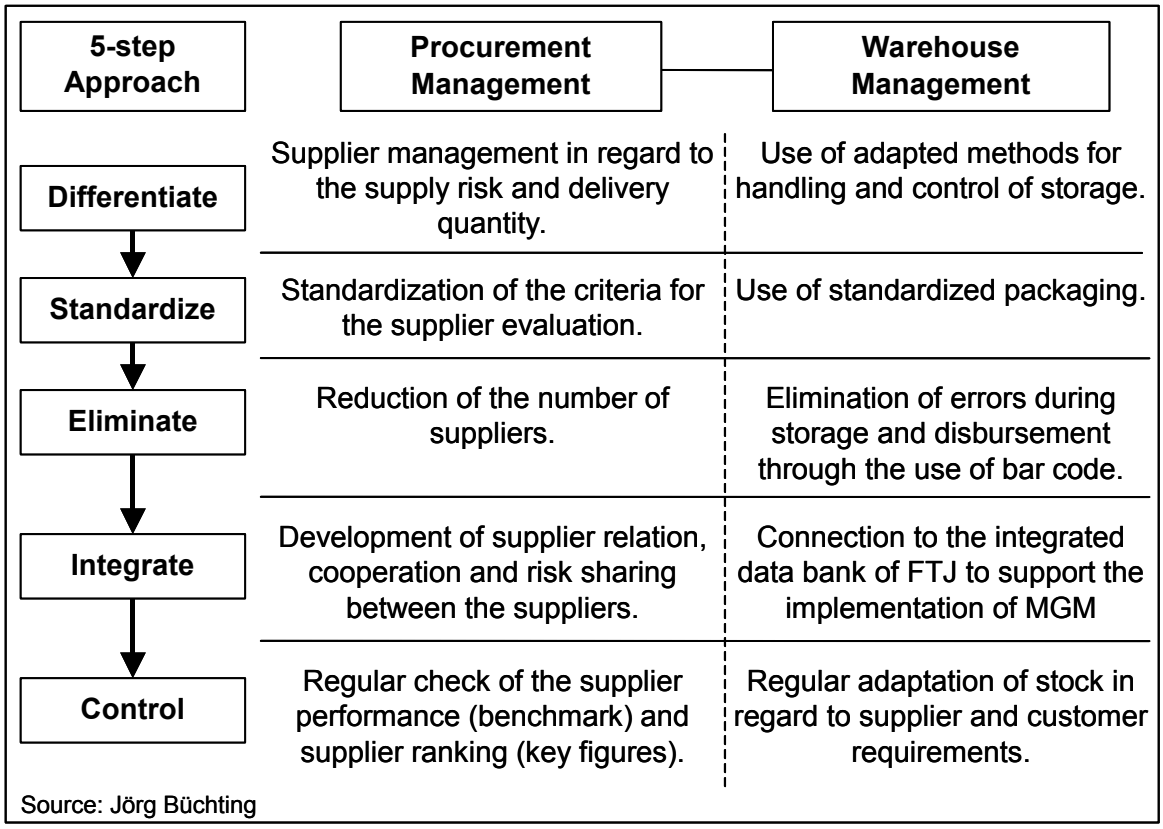

Diagram 5.2.-1: Examples for the 5-step approach in use

The previous subchapter has provided criteria and methods, which are necessary for the implementation of a Quantity Oriented Procurement at FTJ. In respect to that the following subchapter will focus on the improvement for the procurement strategy and give appropriate suggestions to achieve a long-term efficiency at FTJ.

5.2.1. A Reference Model for Implementation

The complexity of the transition from Project Oriented to Quantity Oriented Procurement at FTJ requires a level-by-level procedure with the following five steps: **differentiate, standardize, eliminate, integrate** and **control**[319]. This 5-step approach corresponds to Deming's Plan-Do-Check-Act approach for a continuous improvement process.

The diagram 5.2.-1 focuses on the 5-step approach and examines two example aspects with influence on the implementation of a Quantity Oriented Procurement. Each step within this approach can be further adjusted to the respective requirements of FTJ.

One of the key aspects and success factor within this 5-step approach is the use of appropriate policies and methods, which have already been introduced within this thesis.

319 following Siemens AG: method 'supply management`

The procedure for the delivery of supply parts from local Chinese suppliers or the relationship of FTJ with the suppliers respectively is defined in so-called *roadmaps*, which include the 5-step approach for the realization. These roadmaps identify vital areas for the relationship between the purchaser and its suppliers to achieve an efficient SCM. Roadmaps cover either the topic of supplier evaluation and benchmarking or provide a strategy for the combination of procurement of supply parts from different suppliers as well as additional concepts[320].

5.2.2. Use of Data for Advanced Procurement Management

A well running and efficient supply chain management for Quantity Oriented Procurement is depending on a faultless and reliable data management[321]. The implementation, use and improvement of an efficient data management depends on top management support.

It is a fact that it is more difficult for Flender-China to exactly **forecast** the market demands within the growing and developing Chinese market as it would be in a saturated market. At the moment available forecasts at FTJ are based on customer negotiations of the sales department, which are unfortunately not systematically used to determine the demand of supply parts[322].

The current planning for the manufacturing process is only focused on the short-term capacity of the assembly hall and the availability of supply parts. Future planning should also consider the following aspects:

- Order intake
- Capacity of the warehouse
- Capacity of the production for parts produced at FTJ and
- Value of supply parts in regard of capital tied-up

Each of these aspects comprises more detailed data and is needed for a comprehensive procurement management. The table 5.2.-1 gives an overview.

A comprehensive procurement management, which makes use of the above given data, is able to consider all requirement alongside the supply chain, especially the requirements of suppliers and customers. With the definition of a current re-order level, an optimal re-order quantity, a reserve inventory and trends in regard to the customer demand the following questions can be discussed:

320 following Siemens AG: method ‘supply management`

321 The need of data for stock management and controlling has been explained in the chapter 5.1.

322 This is partly understandable as only 50-60% of all forecasts, which have a horizon of three months, are correct. In addition there are sometimes changes of the technical requirements (recorded in the technical appendix) when orders for supply parts have already placed by the logistics department.

- ❑ Which service level should be realized by the warehouse?
- ❑ How many final products can FTJ sell in the future?

The orientation of FTJ towards a strategic procurement, where the implementation of a Quantity Oriented Procurement is an important milestone, requires a consistent optimization of the SCM.

Table 5.2.-1: Necessary basic data for a comprehensive procurement management[323]

Data for Order Calculation:	Data Used for Purchase:	Data for Storage	Key Figures
❑ Order date	❑ Date of last delivery	❑ Storage quantity	❑ Demand per requirement period
❑ Re-order level	❑ Lot quantity for procurement	❑ ABC classification	❑ Average demand per month
❑ Optimal re-order quantity	❑ Name of core supplier	❑ Latest cost price	❑ Factor for service degree
❑ Reserve inventory	❑ Name of additional suppliers	❑ Date of last order placing	❑ Disbursement in last month
❑ Procurement lead time		❑ Result of inventory	

5.2.3. Feasibility of the Procurement Strategy

FTJ should especially work on the following aspects[324]:

- ➢ Grant each organizational unit, team and employee the necessary flexibility
- ➢ Plan and measure accurately
- ➢ Develop separate logistical operations where appropriate
- ➢ Get lean by emphasizing simplicity and speed
- ➢ Optimize the information flow
- ➢ Operate globally on the procurement and on the sales markets and
- ➢ Practice virtual and collaborative management

By granting more flexibility to teams and employees it will be easier to react on problems. This point is related to the concept of Reactivity and Pro-activity and crucial in regard to an efficient after-sales service. The planning of FTJ has to include an assignment of responsibility and date for completion to a department, a team and an employee in order to assure that objectives are reached on time. Employees should be regularly trained on all aspects of their job, including concepts like job rotation, etc. By that each employee develops a wider understanding of the possibilities and problems at FTJ and is able to assume different degree of responsibility.

323 Weber, Rainer: “Zeitgemäße Materialwirtschaft mit Lagerhaltung”, p. 56pp.

324 see Tyndall, Gene: “Supercharging supply chains. New ways to increase value through global operational excellence”

The aspects mentioned above give an interesting overview on the requirements of today's supply chain. Some of the aspects will be difficult to handle at first, but it is sure that with the fast development of the P.R. China FTJ has to take those aspects into consideration.

5.2.3.1. Importance of Interaction between Departments

The internal organization structures of a company plays a mayor part in today's business world as companies are under pressure to strengthen their business processes in order to reach positive business results. Outdated organizational structures deprive businesses of the opportunity to reach best results. Only those companies realizing optimal internal and external processes will survive. FTJ has recognized its organizational problems and has defined changes as a potential goal[325].

The realization of procurement management depends mainly on professional human interaction and communication. For a *comprehensive procurement management* it is important that everybody in the company understands each other's needs. Therefore process management and teamwork are two main aspects, which have to be considered within FTJ.

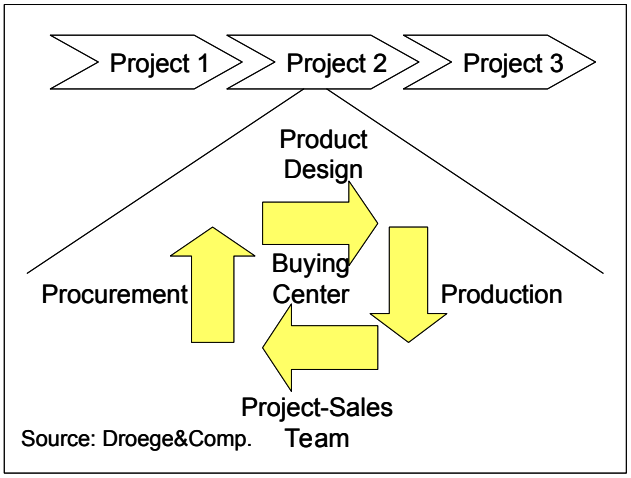

Diagram 5.2.-2: Interface management within the Buying Center

The introduction of teamwork already has a high priority at FTJ. An active involvement of every employee is a visionary step in the P.R. China. It is widely known that even since the re-opening to the West 23 years ago, China has a lack of innovation mostly due to an outdated education system, which does not consider individual creativity[326].

Quantity Oriented Procurement requires a simultaneous information flow through several different departments. For the reduction of delivery times of final products it is important to have in due time access on the information necessary for procurement.

FTJ has no own department for development/design and all changes of the design of final products are provided by the Flender-group in Germany. This situation makes it impossible for FTJ to adapt the final products to the requirements of Chinese customers and to the supply parts available on the Chinese supplier market.

The development/design department of Flender-Germany has to cooperate with the logistics department or the Buying Teams of FTJ respectively namely in the early design phase of a new

325 According to the needs of an ISO 9000 quality management system, FTJ has established company goals for the financial year 2001/02, which for example include the point 'team and group work'.

326 Beijing Review, May 2002, "Economic Competition and Cooperation in Asia"

gear unit in order to jointly optimize the cost structure of the design in respect to the supplier market of the P.R.C. The Buying Team will than also have the opportunity to fall back upon the assessment of the engineers in case of technical questions in the frame of the supplier selection. This procedure is called *simultaneous engineering* as the steps development/design and procurement, which originally are realized in succession, are realized as simultaneous as possible[327].

Coordination of Procurement in Decentralized Structures[328]

One option for a union of procurement volumes through coordination of procurement is the introduction of a *Material Group Management (MGM)*. The aim of MGM is the combination of the advantages of a corporate with the advantages of a decentralized procurement.

The different Buying Teams at FTJ take the responsibility for the MGM, each in regard to a certain number of supply parts. The crucial factor for the success of MGM is the composition of the Buying Team: involvement of each responsible team member, who manages the requirement, as well as the upstream decision maker. The balanced membership of employees from departments like procurement (or logistics respectively), construction, standardization, sales, quality and production has proven its worth. It has already been mentioned before that the Buying Team has to cooperate with the technical department and the respective upstream decision makers at Flender-Germany. The most important assumption is transparency of the data available: a standardized and procurement oriented definition of supply part group keys is the backbone of MGM.

Within the Buying Team all strategic optimization plans for the respective supply part group will be planed and started. This includes for example value analytical approaches as well as company wide standardizations, make-or-buy decisions and change of suppliers.

MGM has a procurement oriented effect and optimizes the internal assumptions for the former. An important and efficient cost lever of MGM is the competence to quickly prepare and also realize **subcontracting of alternative suppliers** in view of the market situation. For the internal perspective of FTJ it means to systematically and consistently question the binding technical and distributional targets: for the procurement department alone these releases often represent absolutely-to-be-obeyed-restrictions of its procurement possibilities.

Project experiences of the interaction of procurement competence and technical competence in the framework of MGM time and again show that the benefit of procurement and production advantages often more than compensate the effort for a redesign and the review of drawings.

327 see Droege & Comp.: “Gewinne einkaufen“, p. 100pp.

328 The term *Buying Team* is explained in chapter 3.1.1.; see also Droege & Comp., “Gewinne einkaufen”, p. 49

“Keep it simple” is the most important requirement of MGM for an efficient Design-to-Cost namely during the specification phase[329]. For FTJ this means on the one hand the general insight to **sell more standard** gear units on the market, a necessity that is currently eagerly discussed, and on the other hand to transmit suggestions and to closely **cooperate with Flender-Germany** for the redesign of gear units with supply parts which are available on the market of the P.R. China.

Design-to-cost means to systematically pursue approaches, which focus on cost reduction through intensive cooperation between distribution, construction, production and procurement department! The procedure is not realized punctual or in regard to one single case, but area-wide for the complete procurement volume and additionally in cooperation with the suppliers[330] like Flender-Germany.

MGM targets on procurement advantages through the creation of optimal supplier portfolios. Experiences show that first of all existing long-term supplier relations prevents market oriented re-orientation. A typical symptom for that fact are market inquiries realized only in case of current procurement cases and merely with active suppliers. Both is true for FTJ.

If the impact of different strategies are compared it can regularly be found that the greatest short-term effective savings potential is achievable through the **development of new procurement sources**. That means for FTJ or the logistics department respectively to consistently invest in employees, who are responsible for the search of suppliers, and to use the strategies laid down in this thesis, e.g. for the search of new suppliers[331] and the development of the later[332].

The Buying Teams within the logistics department, which has the function of a Buying Center at FTJ, have to have the required competence for making decisions within a decentralized communication network within FTJ and the Flender-group. All Buying Centers within the Flender-group should cooperate to use the potential of global sourcing. The effects of *economy of scale*, which become possible through the unification of order quantities, can help to safe

329 The specification phase can be told apart into the planning and the definition phase. During the planning phase the *statement of work* (German: ‘Lastenheft’) is created. It is the first document, which roughly describes the requirements for a new product. The *functional specification* (German: ‘Pflichtenheft’) is the first document created after completion of the planning phase. It contains the complete functional, data, performance and quality scope of the product and embodies the contractual description of the quantity of delivery. It describes the WHAT, not the HOW. According to the functional specification the acceptance through the customer should be possible (source: ‘www.htlwrn.ac.at/hp/PRE5/PRE.html’ [20th of June 2002]).

330 for further detail see: Droege & Comp., “Gewinne einkaufen”, p. 29pp.

331 see chapter 3.2.

332 see chapter 4.

time, money and raise the quality level of supplied products since all Buying Centers together represent high order quantities. With the introduction of a standardized procurement related materials classification system it will not only be possible to easily unify the procurement quantities via identical supply part group keys, but to automatically evaluate their importance. These facts have to be recognized by top-management and throughout the Flender-group.

There are still many problems, which have to be solved before that goal can be achieved. One approach should be the reduction of communication barriers through a global rollout of software or applications respectively[333], which have to be accompanied by an increase of cultural awareness at Flender-Germany. By that communications problems, like for example forms, reports and drawings sent to FTJ in German language even if an English version exists, could be avoided in the future.

Suggestion System

Related to the establishment of corporate goals and quality control teams[334] in a company is the implementation of a **Suggestion System** – a widely accepted method to involve all employees in key problem fields and to make use of their experience. For a manufacturing company such as FTJ management commitment, knowledge and information are 'key figures' for quality issues and have significant influence on the ability to avoid problems or to quickly solve them.

A **Suggestion System,** also known as *Continuous Improvement Program* (*CIP)*, creates an environment where all employees are asked to contribute to the improvement of products and processes. Aim of all CIP-activities is the optimization of **time**, **costs** and **quality** within the company in regard of the customer requirements. CIP helps to simultaneously increase the competitiveness in all three areas and in that way to establish itself as a market leader[335]. The company and its employees as well as the customers will profit from that[336].

Experiences show that under certain conditions a Suggestion System stimulates the employees to make a contribution to the development of the company. At some companies with a suggestion system up to 95% of all employees hand in suggestions.

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333 FTJ and Flender-Germany are using different ERP systems. There are no usable interfaces for the information interchange between these two systems and by that additional effort within the order process is unavoidable.

334 *Quality Control Teams* can be established within the company to focus on a certain problem area. Team members are experienced employees from one or several departments. The overall goal is to prepare and implement solutions for quality problem.

335 The biggest competitor of FTJ became market leader for gear units by mainly focusing on speed. The potential for a company which is superior on all three aspects of the Iron Law of Business (time, speed, price) can clearly be seen.

336 Harvard Business Manager, Dr. Kuhn, Joachim, March 1996

To achieve this level at FTJ the following conditions should be provided:

- ❑ All suggestions have to receive some kind of response.
- ❑ Within 24 hours an answer has be given to the each employee, who handed in a suggestion.
- ❑ The employee should not need to wait and wonder whether anyone cares about his suggestion.
- ❑ A rewarding system for good suggestions should be established with promotion, extra training or money as reward.
- ❑ The management should seriously consider the suggestions and
- ❑ Has to uses the ideas for improvement to create a benefit for company.

Suggestions should not be put down for the reason of budget cuts or forwarded to future budget plans, but the yearly budget has to include a certain amount for the realization of improvements. Management has to provide an environment for the employees in which their suggestions are taken seriously.

To further the competition between different departments, the number of submitted suggestions can be published internally. Examples of successful suggestions and also the respective procedure for realization should be published, for example in trade journals.

Since FTJ currently strives for a continuous material flow without long waiting intervals CIP can be used to collect suggestions in order to reduce the cycle times starting from goods receipt to the completion of gear units[337].

The weak points of a Suggestion System can most easily be seen if compared with the method of *Innovation Management System*, given in table 5.2.-2:

Table 5.2.–2: Comparison of Suggestion System vs. Innovation Management System[338]

Suggestion System	**Innovation Management**
Mistrust: employees hide their creativity	Trust: Employees want to be creative
Suggestions point at other work areas	Suggestions concern the own work area
Few participants	Participants: complete workforce
Focus on certain points	Focus on customer oriented processes
Involvement of leaders is avoided	Leaders are involved
Awards	No awards
Write suggestions instate of activities	Write activities instead of suggestions
Bureaucratic	Unbureaucratic

Every company has to find out which of both philosophies suits them best especially in regard to the organizational structures. For FTJ it is recommended to establish a Suggestion System as

337 Harvard Business Manager, Dr. Kuhn, Joachim, March 1996

338 see Bergmann/Klefsjö: “Quality from Customer Needs to Customer Satisfaction”

the Innovation Management requires the involvement of the top management and the complete workforce, which are currently both difficult to realize.

5.2.3.2. Management of Irregularities

It has been mentioned in preceding subchapters that FTJ produces FZG gear units according to a purchase orders received from the sales department in Beijing. This means that so far gear unit are not assembled on stock. The necessary supply parts are ordered according to the incoming orders. Only supply parts for the most important gear units are on stock.

For the realization of Quantity Oriented Procurement a respective change of stockkeeping policies is necessary in the logistics department. The storage of certain quantities of supply parts for the assembly of gear units has to be introduced. This will enable FTJ to adapt the service level of the warehouse and by that the service level of delivery of final products in regard to the customer requirements. As its own service level on a great part depends on the service level of its suppliers it is important that FTJ is able to compare and evaluate its suppliers.

Benchmarking of Suppliers

The control of the procurement process is always based on the comparison of actual versus estimated figures for a certain period. The purpose is to get a feedback in order to adapt the process which achieve the current target, e.g. a certain service level.

Several different benchmarking methods are suitable for comparison of the suppliers of FTJ or to see if the current performance of a supplier is sufficient. FTJ already faces serious competition. To avoid surprises within the company and on the market benchmarking provides an excellent system to monitor all of its processes and to evaluate the current situation[339].

Benchmarking is a method to see irregularities and opportunities for improvement of processes and products. In the last years many companies in the world have already integrated benchmarking methods within their efforts for quality improvements. Following [Bergmann/Klefsjö 1994] *benchmarking* means “the search for best practices that will lead to superior performance” of a company. The basic idea is to make a careful comparison of a process of the company with the same or a similar process at another company or another division of one’s own company and benefit from the comparison[340].

In regard of procurement benchmarking can be used for following fields:

- Comparison of the efficiency of processes at FTJ, which have an interface function to the processes of suppliers with the aim to find weak points in the supply chain.

339 http://www.fiducia-china.com/Services/China/benchmarking.html

340 see Bergmann/Klefsjö: “Quality from Customer Needs to Customer Satisfaction”, p. 324pp.

- Direct benchmarking of the performance of each supplier of FTJ. The results are especially useful for future supplier negotiation.
- Benchmarking of the different warehouse strategies of the suppliers. This can be helpful in regard to the question which supplier will be able to serve increased demand of FTJ from stock or directly from a flexible production process.

The decision of improving a process through benchmarking starts with the search of a company that is good at that very process. That does not necessarily imply to search for a company in the same business. The well-known process and the outcome at this external company are compared with the own established process. Often immediate suggestions for improvement can be found.

The localization of the respective comparison is decisive for the selection of the appropriate type of benchmarking as can be seen in table 5.2.-3.

It has to be stated that, in general, it is not too difficult for companies to acquire sufficient insight in the processes of other companies for the realization of benchmarking. As long as there is no direct competition no company is interested in hiding anything from another company. Furthermore, insight can be facilitated if FTJ becomes experienced in these matters and is willing to share its experience with other companies.

Table 5.2.–3: Different types of benchmarking depending on where the comparison process is found[341]

Internal Benchmarking	Comparing site to site, department to department, country to country within the organization
Competitor Benchmarking	Comparing our own performance to that of our direct competitors
Functional Benchmarking	Comparing ourselves, not just against our competitors, but against the best organizations operating in similar fields or performing similar activities
Generic Benchmarking	Comparing ourselves against the best from all industry groups

It is important to emphasize that benchmarking is far more than copying. It requires deep self-assessment[342], and the ability to translate practices that work in another context into a process appropriate to the requirements of FTJ. It is the essence of creativity. A basis for successful benchmarking is that FTJ adopts a process view. Benchmarking, in the sense as it is used here, means that FTJ checks the processes of its competitors, not its products[343].

341 see Bergmann/Klefsjö: “Quality from Customer Needs to Customer Satisfaction”, p. 325

342 One method for self-assessment is the EFQM model where the following criteria for the assessment of processes of a company are used: leadership, quality, strategy and improvement of work.

343 see Bergman/Klefsjö: “Quality from Customer Needs to Customer Satisfaction”, p. 326

For a beginning the internal benchmarking should be considered by FTJ as this type of benchmarking, according to the experience of many companies, is quite easy to realize in comparison with other types. A possible area of interest for an internal benchmarking is the comparison of the order placing process at FTJ and at Flender-Penig, especially as both parties are closely related within the Flender-group.

A benchmarking process follows the Deming cycle of Plan-Do-Study-Act[344]. According to that there exists the six-step approach for practical benchmarking[345]. Table 5.2.-4 contains respective questions for each step, which have to be answered if this approach is realized:

Table 5.2.-4: Section of the checklist for benchmarking studies[346]

1 1: Plan	❑ What is our process? ❑ How does our process work? ❑ How do we measure it? ❑ Who are our customers and what do they require of our products and services? ❑ How did we establish the performance goal?
2: Search	❑ Which companies perform this process better? ❑ Which company is the best at performing this process? ❑ What can we learn from that company?
3: Observe	❑ What is their process? ❑ What is their performance goal? ❑ How well does their process perform over time and at multiple locations? ❑ How do they measure process performance? ❑ What enables the performance of their process? ❑ What factors could inhibit the adaptation of their process into our company?
4: Analyze	❑ What is the nature and the magnitude of the performance gap? ❑ What characteristics distinguish their process as superior? ❑ What activities within our process are candidates for change?
5: Adapt	❑ How does the knowledge of their process enable us to improve our process? ❑ Should we redefine our performance (goal) goal based upon this benchmark?
6: Improve	❑ How can we implement these changes into our process?

Plan is the first step: FTJ has to understand and measure critical success factors, e.g. the transport of supply parts by sea from Hamburg to Tianjin. During *Search* FTJ has to research

344 also called Plan-Do-Check-Act

345 see Bergmann/Klefsjö; “Quality from Customer Needs to Customer Satisfaction”, p. 324pp.

346 see Bergmann/Klefsjö; “Quality from Customer Needs to Customer Satisfaction”, p. 327

appropriate companies for process comparison. The process performance of these companies has than to be monitored and the existing performance gaps have to be analyzed (step *Observe*). The *Analyze* step determines the root cause of the performance gap, for example a shorter overall lead time with a competitor of FTJ due to the fact that he receives his supply parts from an agent within the P.R. China. Together the steps Search, Observe and Analyze correspond to the step *Do* of the Deming cycle. In the next step *Adapt*, which corresponds to the step *Study* of the Deming cycle, FTJ has to select best practices for consistently modifying the company environment. Finally FTJ will *improve*, i.e. the business process is enhanced and integrated (*Act*). In the example case it could mean that FTJ adapts its stockkeeping policy, unifies order quantities and orders at least certain supply parts from the agent in the P.R.C. By that the concept of Quantity Oriented Procurement can be used for local sourcing.

For a continuous improvement it is necessary to start the cycle again and again, i.e. to benchmark the new situation where supply parts are sourced from an agent. **Benchmarking** is not a method to reach a stable situation within an organization, but rather helps to find weak points, improve constantly and learn about own processes and from others. By that benchmarking enables FTJ to find out which procurement strategy is feasible under different situations.

The communication difficulties between Flender Representative Offices in the P.R. China with FTJ are mainly the result of the different views on customer satisfaction and quality. In comparison with engineers, sales people have a different idea of the term *quality*. The following diagram 5.2.-3 illustrates the different points of view on *quality*, on the one hand seen by the customer and on the other hand seen in regard to standard from a technical point of view. The quality perceived by the customer contributes to the possibility to sell more at a certain price or to sell the same number of gear units at a higher price. This has an influence on the profit of FTJ. Contrary to that, quality, which is oriented on standards, represents a Zero-Defect-Philosophy in regard to quality costs and productivity aspects.

For FTJ one main interest for benchmarking is the topic of quality either in regard to supply parts or within the production process. In a benchmarking project it is seldom very complex to measure costs, time and quality, but FTJ has to take care that the measurement of quality not only includes the failure rate, but also scrap-metal and work reject in the production and manufacturing process.

Supplier Evaluation[347]

In general there are two different groups of approaches for an assessment of suppliers: quantitative procedures and qualitative procedures. *Quantitative procedures* are strictly based

347 this part of the chapter follows Koppelmann, Udo: “Beschaffungsmarketing”, p. 264pp.

on objective decision factors, like for example liquidity, prices, etc., whereas *qualitative procedures* also cover subjective characteristics, e.g. level of technical advice or performance of the after sales service. Each group contains several analysis methods.

The most well-known qualitative evaluation procedure is the **Scoring-model**. This method uses scores for individual criteria, which further on have to be weighted according to the requirements and expectations of FTJ. The table 5.2.-5 shows a respective example for the three biggest suppliers of castings at FTJ.

Table 5.2.-5: Supplier evaluation by the Scoring-model at FTJ[348]

Criteria	**Relative Weighting (1)**	**Scale (2)**			**Supplier Index (1x2)**		
		NWS	**SanDa**	**WLD**	**NWS**	**SanDa**	**WLD**
Scope	0.15	1	3	2	0.15	0.45	0.30
Supplied Products	0.10	2	2	3	0.20	0.20	0.30
Technology	0.15	1	2	4	0.15	0.30	0.60
Management	0.10	1	3	3	0.10	0.40	0.30
Identical Quality	0.20	1	2	5	0.20	0.40	1.00
Quality of Service	0.05	2	3	3	0.10	0.20	0.10
Casting Price	0.15	3	2	2	0.45	0.30	0.30
Final Evaluation	0.10	2	3	3	0.20	0.30	0.30
Result	**1.00**				**1.55**	**2.55**	**3.20**
Scale:	1 = very good (100% of requirements fulfilled), 5 = unsatisfactory						
Supplier Index:	1.00 to 2.25 = very good; > 2.25 to 3.5 = satisfactory; > 3.5 to 5 = unsatisfactory						

348 adapted for FTJ following Koppelmann, Udo: “Beschaffungsmarketing”, p. 269

The relative weighting assigned to each criterion embodies the importance of the former for FTJ. The importance depends on the subjective assessment of the involved employees. The later should be part of the Buying Center or should be integrated within a Buying Team

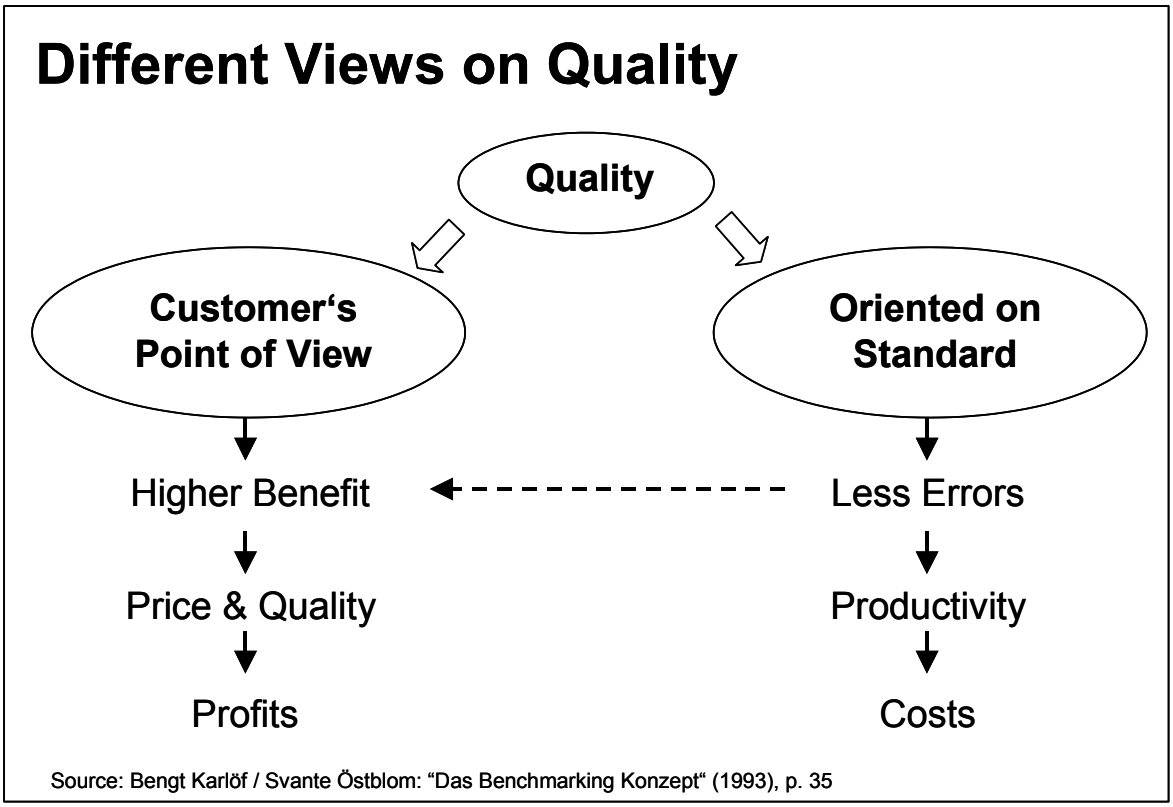

Diagram 5.2.-3: Dependency of the term *Quality* from the point of view

respectively as that can combine the experience of employees of different departments leading to a more realistic weighting of characteristics.

The multiplication of the Relative Weighting (1) with the values of each supplier in the Scale (2) results in the respective Supplier Index (1 * 2). The row 'Result' contains the sum of all criteria for each supplier, which is used to finally evaluate the suppliers.

According to the result of the supplier evaluation the supplier NWS achieves the best result of all suppliers (with 1.55 = very good), i.e. he provides the best performance in regard to the current importance of each criterion.

Conclusion

It has been shown that the Deming Cycle of Plan-Do-Study-Act is essential for the rearrangement of the procurement management, i.e. the realization of Quantity Oriented Procurement. Two respective approaches have been expounded: a 5-step approach, which provides measures for every process of the supply chain, and a practical six-step benchmarking approach. The later contains questions for every element of the Deming Cycle, which does not

only prove useful for benchmarking, but can be used to generate new measures for the before mentioned 5-step approach. By that the later can always be updated.

5.3. Continuing Approaches for Improved Procurement [Part B]

Currently, small order quantities with suppliers, organization of information management and communication between people and departments are the major problems for an efficient procurement at FTJ. This subchapter will show some additional approaches of a solution.

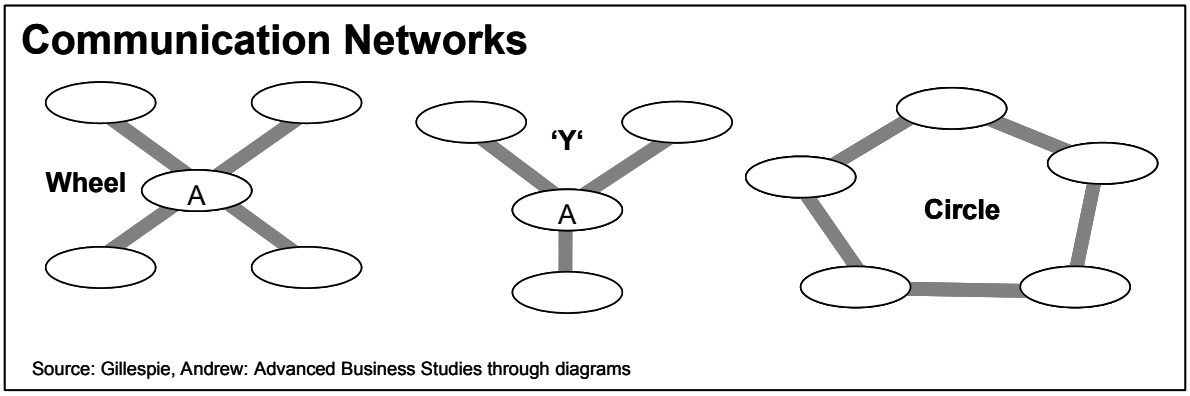

Diagram 5.3.-1: General structures of communication networks

It can be stated that the information flow within FTJ is centralized showing a structure like the wheel or the 'Y' in diagram 5.3.-1. That means the information must pass through a central position (labeled A), embodied by the boss of FTJ. In contrary to wheel and 'Y' the circle is decentralized letting information pass around.

For simpler problems a centralized structure is quicker and makes fewer errors, but for complex problems, and the SCM is a complex one, decentralized networks tend to produce a quicker solution, fewer mistakes, and a more satisfied group. In case centralized networks are assigned to complex problems A becomes overloaded and members do not all have effective input.

The results of poor communication due to the wrong communication structure in the logistics department and also in general at FTJ and within the Flender-group are[349]:

- Low morale, as employees have the strong feeling that they have not the required tools and technology at their disposal[350]
- High level of errors explaining the high effort for multiple checking alongside the whole information flow
- Hostile (or at least unfriendly) relations, especially between the logistics department of FTJ and the respective departments of Flender-Germany

349 see Gillespie, Andrew: "Advanced Business Studies through diagrams", p.83

350 This is especially true for the up to now only limited efficiency of the CS3 system.

- Lack of control, as the logistics department does not receive the current information from its suppliers and from the sales department, which is necessary for a consistent SCM

The use of the right, hence adapted, communication network structure has to be realized in combination with the transition from operative to strategic procurement to achieve satisfying results. With the realization of strategic procurement it will anyway be necessary to decentralize the information flow as teams consisting of employees of different departments and functional profiles have to work together, for example in Buying Teams.

FTJ produces a quite complex product, which consists of many different supply parts, in a great number of variants where the majority of supply parts are sourced over a long distance leading to long supply times and high transport costs. How can an efficient SCM be sustained if a strategic procurement with its decentralized communication structure is realized with FTJ and its logistics department? One solution can be a *Material Group Management*[351].

MGM can be set up as a project organization or as a matrix organization. This corresponds to the targeted time horizon of MGM: in the framework of procurement offensives the **project oriented, temporary MGM** targets on quickly bringing together the decision makers over the whole logistics chain, i.e. for example the bosses of the Buying Teams, for identifying savings potentials for creating a first basis for an integrated supply management.

As a continuation of the temporary approach a **durable MGM in the framework of an informal matrix organization** can be realized. In this case MGM means a stronger durable distinction between strategic decisions, e.g. regrouping within the supplier portfolio, and the operative order processing, which are currently both 'mixed up' at the logistics department. In general with durable MGM each strategic decision lies in the responsibility of the Buying Team. The logistics department, as the responsible department for procurement, will then on the one hand be in charge of the coordination of the different Buying Teams in regard to the current procurement goals and has on the other hand to assure the operative supply with supply part.

It is important to understand that despite the decentralization of procurement, in regard to the organization within the logistics department or worldwide within the Flender-group, the available information has to be centralized and interconnected within the Flender-group[352] and if possible also with the suppliers[353].

351 For detailed explanations to the concept of MGM see also subchapter 5.2.3.1.

352 see subchapter 4.3.2.

353 The U.S.-company *SeeCommerce* provides software for monitoring an existing supply chain and finding weak links. By gleaning data from all parties involved and making them accessible online, the start-up's software lets firms continuously check how well their supply chain is performing – a task that most manufacturing managers still carry out manually, based on printed reports. The program also

The solution of the organisational question has of course to be decided against the background of the current situation of the Flender-group, especially in regard to the worldwide procurement knowledge available, and at FTJ.

In principle it has proven its worth first to start MGM as a project. Indispensable assumption for the success of MGM is the assignment of competence and responsibility through the company management. The start should be made with selected pilot supply part group keys in one Buying Team. In case of success the made experiences can be applied to additional supply part group keys.

Further on it should be made the difference in the Buying Team between **core teams** and **expert teams**. Core teams assume the responsibility for the constant planning and realization of specific work tasks, while expert teams are consulted if necessary. One member of the Buying Team has to be responsible for leading the team.

Conclusion

The approaches and concepts which are expounded in this subchapter show that a general reorganization of the procurement within the logistics department and FTJ is necessary and feasible. In case the concept of MGM is consistently realized the procurement function will almost exceptionally be looked after by Buying Teams integrated in the Buying Center of FTJ.

In the future procurement will hence be realized in the framework of a communication network of Buying Teams at FTJ. The Buying Team of FTJ will on a wider scale be integrated in the communication network of all Buying Centers within the Flender-group. The procurement organization in the sense of a MGM will enable the Buying Center to become a “Service Center for problem solving” for all company departments.

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allows managers to work together to solve, let’s say, a chronic problem of getting replacement parts for cars into the hands of mechanics.

This was exactly DaimlerChrysler’s problem. Its warehouse could not fulfill all of the 220,000 orders that come in every day, which meant that customers had to wait to get their cars repaired – or go elsewhere. To improve the balance of supply and demand, SeeCommerce linked DaimlerChrysler’s Mopar parts division with many of its suppliers and logistics providers, which allowed Mopar’s purchasing and inventory managers **to see what was wrong and speed up the flow of parts**. In the year 2000, the carmaker says, the system saved it $7.2m in reduced stock and $10m through improved order fulfillment; see: The Economist, 2nd February 2002, in “A survey of the real-time economy” p.13/14.

6. General Conclusion

The authors followed the intention to create an awareness model for the company FTJ based on the past and current situation of FTJ and the Flender-group. To develop the shown approaches and beginnings of a solutions, respective modern theories and methods of Chinese, English, German as well as Swedish authors and publishing houses have been used.

One of the biggest constraints for the work out of this thesis has been the often incomplete, incompatible, inaccessible[354] or even simply not existing information in the P.R.C. and at FTJ. The authors have been dependant on information input from individual employees involved in the daily work process. The scarce availability of data has especially impeded the authors from:

- deeper analysis of the part list structure to figure out the SPGN for Quantity Oriented Procurement as part lists have only been accessible on paper
- check of the analysis result of FZG supply parts with results of other final products
- comparison of the sales forecast against the trend of the past production output at FTJ and
- evaluation of the current and potential suppliers based on real data as only subjective personal experience was available

It can be stated that the initial approach, the sourcing from Germany with its long delivery times of supply parts as the main reason for the problems along the supply chain has been proven. This has to be seen in the context of an enormous deviation of the actual delivery performance from customer wished dates.

Nowadays there is a fierce competition on the power transmission market in the P.R.C. By that the success of a company like FTJ, which produces a complex durable good like a gear unit, mainly depends on the consistent control of its supply chain: in regard to prices, quality, delivery time as well as after-sales service. It has been shown in the thesis that FTJ currently has fallen behind its main competitors in regard to at least some of the above mentioned competition criteria, e.g. with a delivery time for final products about three times as long as the best competitor.

The goal of the thesis has not been the implementation of solutions, but the development of approaches for the rearrangement, which can serve as a reference model for all departments involved in the procurement management process, even within the Flender-group.

354 At FTJ the reasons for inaccessibility of information has been: no access on the company server, no access on the CS3-system and huge information quantities on paper making quick access impossible.

The subject of the thesis is quite complex and extensive since FTJ is located within the fast growing market of the P.R. China. This market is characterized by quickly increasing customer requirements, challenging delivery times and an increasing claim for quality, all combined with an increasing competition. The later originates from the fact that the P.R. China represents the last great market of the world[355] attracting more and more foreign companies. For these reasons this subject has been split up into Part A and Part B. The topic of Part A of the thesis has been *the development of the procurement management with focus on quality* and topic of Part B of the thesis has been *the development of the process chain focused on the reduction of delivery times*.

FZG gear units have been the main focus of this thesis as the former have shown the greatest turnover share on the market of the P.R.C. throughout the current financial year.

Currently for Flender-China and FTJ the **main challenge** is the reduction of the delivery time of final products as well as the reduction of the deviation of the delivery time for being able to improve its position in the P.R.C.

It has been shown in the thesis that the main reasons for the problems with delivery times of final products lies in the lack of control of the supply chain at FTJ. The later problem is further worsened through long transport times for supply parts from Germany and the lack of a consistent procurement strategy.

The authors have analyzed the crucial points for the rearrangement and organization of the SCM. The following table 6.-1 (I and II) gives an overview:

Table 6.-1 (I): Important topics of analysis, respective results and recommendations of the thesis

No.	Topic	Results	Importance and recommendations for FTJ
1	ABC analysis of supply parts	➢ Very high value concentration of A-parts (c. 96% for all supply parts; c. 94% for DIN/norm supply parts)	➢ The selection of the appropriate stockkeeping policy, according to the supply part type, and the kind of control period of the former becomes possible - leading to an improved service level.
2	Benefit analysis of local sourcing	➢ five SPGN (12.6% of the total value of all DIN/norm parts) represent an RSP of 2.7%	➢ Indication of the theoretical savings for local sourcing over the whole supply chain. ➢ See the need to adapt the SCM according to the current development of the ASP.

355 see Murray, Geoffrey: “Doing Business In China – The last great market”

3	Decision criterion for local sourcing	➢ Sourcing priority in regard to the ASP, the critical level and price range	➢ Possibility to see factors with impact on the sourcing risk which should be adapted to achieve a high sourcing priority.
4	Sources of supply	➢ Structuring of the suppliers including the location (abroad/local), legal structure and performance	➢ Possibility to structure and evaluate the suppliers in regard to their strength and weaknesses as well as treats and opportunities.
5	Material flow	➢ Precarriage and onward-carriage represents c.75% to 92% (air)[356] or c.33% (ship)[357] of the transport time from Germany ➢ Lack of a packaging standard (no standardized palettes)	➢ FTJ should reduce the total transport time through shortening of the precarriage and customs clearance. ➢ FTJ should define the Euro-palette as its general standard[358] to avoid problems for the internal material flow like for example quickly broken palettes or damaged supply parts.

Table 6.-1 (II): Important topics of analysis, respective results and recommendations of the thesis

No.	Topic	Results	Importance and recommendations for FTJ
6	Transport costs	➢ Sea-transport represents c. 80% of all transport costs, but is currently paid by Flender-Germany ➢ The potential transport costs for local Chinese sourcing[359] would be only c. 4% of the cost for sea-transport from Germany	➢ It is remanded that FTJ further extents regional sourcing in the P.R.C. to make use of the savings potential for transport costs. ➢ For sourcing outside the Tianjin region FTJ should pay attention to the problematic long distance transports due to the lack of the respective transport and communication infrastructure in the P.R. China.
7	Information	➢ The communication	➢ FTJ should invest in respective hard-

356 6 of 6.5 days total transport time = 94 % and 6 of 8 days total transport time = 75%

357 14 of 42 days total transport time = 33 %

358 The Euro-palette is used by Flender-Germany (except Flender-Bocholt) for export to FTJ. Chinese suppliers do not use a standard palette, but DIY-palettes of very poor quality. The Euro-palette has a size of 800x1200mm and a maximum net-weight of 1 to 2 tons.

359 in an average distance of 60km from FTJ

	flow	interchange between FTJ and its suppliers is not oriented to the requirements of a modern SCM	and software and provide standards, e.g. EDI, for the internal communication as well as to realize an information flow which hurries on ahead the material flow.
8	Quality management	➢ The great majority of quality problems are related to locally sourced supply parts ➢ Many of the local Chinese suppliers of FTJ lack a long-term production experience ➢ FTJ's limited ability to evaluate the suppliers leads to a lack of control	➢ FTJ has to use supplier development for the improvement of the quality of the supply parts: directly at the production site of the suppliers, for improving their production process, and accompanied by respective reduction of the quality control at the goods receipt. ➢ FTJ should use supplier development to provided own experiences and to arrange clear quality objectives with the suppliers.

FTJ and its suppliers have already partly realized some of the indicated approaches, like for example the establishment of a functioning CS3-system which will work as a central data bank for FTJ[360]. This is important as FTJ depends on a great part of different external information sources: from its suppliers as well as its customers.

In the future it will not be sufficient anymore only to deliver very good quality and a competitive price. FTJ has to master its supply chain in a way that a competitive delivery time can be assured without deterioration of quality and price. The following table 6.-2 summarizes the current strengths and weaknesses of Flender-China which also apply for FTJ.

Table 6.-2 Summary of strengths and weaknesses of Flender-China and FTJ[361]

Strength	Weaknesses
Complete product range (wide ratio and power range)	Poor delivery performance[362]
Acknowledged market leader	Limited sales flexibility
FTJ is a local independent manufacturer of the Flender-group in the P.R. China	Insufficient after-sales service
Proprietary technology	Short guarantee period

The realization of the betokened recommendations is the responsibility of the top management of FTJ as well as the Flender-group as the later mainly defines the budget for FTJ.

Limits and open Question for Realization

360 diagram 4.3.–1

361 Source: Flender-China Management Meeting, 3rd of July 2002

362 especially for small gear boxes

After comparing the internal and external corporate factors and with the availability of a great variety of market information, on the sourcing as well as on the distribution side, the authors have experienced the fact that there are still a lot of barriers which impede realization of many shown approaches.

The following factors had been faced:

- The claim for product quality of the Flender-group, and thus also of FTJ, is up to now not clearly defined and available in a written form at FTJ and could by that not been used to judge the local supplier market.
- The company FTJ could not provide experience with local Chinese suppliers, except with casting suppliers for raw material.
- The current legal situation in the P.R.C. causes enormous practical problems, as this fact has a direct impact on logistic services available on the market. It means for example that foreign suppliers and logistics companies, which can only settle down in certain development areas independent of the actual logistical requirements, are only able to provide very limited logistic services. By that FTJ does by far not dispose of the same degree of logistic services as available in Europe.

In addition to the just mentioned factors it is also unclear for the authors:

- if FTJ is currently able or willing to invest into the rearrangement of the respective processes, which are necessary to change to local sourcing, especially as
- the required budget is unknown and which support FTJ can expect from its parent company Flender-Germany.

At the moment, especially due to the new WTO membership of the P.R.C. from 1st of January 2002 on, there is a durable process of change that will lead to an improvement of many environmental factors in the next few years. Since the P.R. China is currently unable to develop its own system of innovation, production and services and spreads its systems throughout Asia and the world, it continues to import knowledge, technology, and equipment from the West, and therefore has to accept Western standards of trade and investment as well as Western values in general[363]. According to the need of investment the P.R. China will further open up for foreign companies and Western standards.

Continuous Spheres of Research

The analysis results available in this thesis are based on the most current data available, but will quite quickly become obsolete as the market for gear units in the P.R.C. is rapidly developing and changing. There is no doubt that FTJ has to continuously adapt itself to stay in this market.

To come to grips with this challenge and to fully benefit from the shown approaches FTJ should achieve the following suggestions:

363 source: Beijing Review, Vol. 45, No.22, 30th of May 2002, p. 7

1. The top management of FTJ has to assure:
    - that the necessary communicational infrastructure, e.g. e-mail and telephone for the employees are always available and standardized[364]
    - that every employee is consistently and continuously trained to be able to understand and to use the available communicational means
    - that the organizational changes described in this thesis are realized, e.g. team or group work
    - that the required analysis is continuously updated and available on a central data bank
2. Further research on the overall topic and on necessary areas:
    - Quality Management alongside the procurement process
    - Development of a performance measurement system for local sourcing with the aim to regularly evaluate local suppliers and the sourcing process at FTJ and
    - Analysis of the necessary output level of standard gear units at FTJ to assure the economic efficiency of the concept for a Quantity Oriented Procurement of supply parts

In case the strategic approaches shown in this thesis are realized and further extended on the whole supply chain the result will be a consistent SCM. FTJ should not shy away from investment in its SCM as the expected costs will in mid-term be overcompensated by a more demanding Chinese market, which rewards only companies with short delivery time, high quality and reasonable price level.

The authors are quite confident that FTJ sees the potential which lies within its supply chain management along with the already initiated positive changes in this organization. In that way FTJ will again be back on a competitive market position for all of their final products.

With the support both authors have received during their work for this thesis, they are sure that the developed approaches, which are tailored to the situation of FTJ, are understood and successful integrated in the current processes.

364 In this context the term *standardized* means, which the company FTJ defines the means of communication, which have to use by the employees.

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V) List of Diagrams

365 The remark ‘following data of’ means that the diagram is created by one of the authors of this thesis, but the data needed for its creation is provided by another source.

VI) List of Tables

VII) List of Annexes and Attachments

Annexes

VIII) Annex 1: Result of the ABC Analysis of All FZG Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Qty. per SPGN	Qty. Share of All Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
1	GEAR WHEEL	4.545.733,18	30,711522428	1.368	1,062260254	57	100	0	0	0	0
2	PINION SHAFT	1.482.124,54	10,013412413	1.351	1,049059651	69	100	0	0	0	0
3	SHAFT	909.199,60	6,142662317	561	0,435619885	37	100	0	0	0	0
4	PAIR OF MATING BEVEL WHEELS	564.884,51	3,816427980	208	0,161513255	22	100	0	0	0	0
5	HOUSING	413.018,87	2,790405373	78	0,060567471	12	100	0	0	0	0
6	BEARING COVER	362.261,58	2,447482991	1.504	1,167865074	82	100	0	0	0	0
7	BEVEL GEAR	222.740,50	1,504861722	62	0,048143374	19	100	0	0	0	0
8	BACKSTOP	212.022,66	1,432450700	106	0,082309640	7	100	0	0	0	0
9	FLANGED BUSH	206.743,89	1,396786693	339	0,263235545	11	100	0	0	0	0
10	COVER	203.274,79	1,373349034	936	0,726809647	43	100	0	0	0	0
11	HOLLOW SHAFT	179.059,36	1,209746664	73	0,056684940	14	100	0	0	0	0
12	BEVEL PINION SHAFT	178.138,34	1,203524142	61	0,047366868	18	100	0	0	0	0
13	FAN COWL	171.491,24	1,158615531	200	0,155301207	10	100	0	0	0	0
14	BEARING BUSH	153.222,39	1,035188974	1.018	0,790483142	21	100	0	0	0	0
15	FLANGE COVER	77.735,83	0,525192657	97	0,075321085	10	100	0	0	0	0
16	FAN	71.534,00	0,483292344	238	0,184808436	19	100	0	0	0	0
17	RING CARRIER	67.886,37	0,458648515	156	0,121134941	19	100	0	0	0	0
18	SHRINK DISC	63.730,55	0,430571294	44	0,034166265	7	100	0	0	0	0
19	ADAPTER FLANGE	54.046,55	0,365145020	34	0,026401205	12	100	0	0	0	0
20	AIR GUIDE COVER	46.950,52	0,317203384	32	0,024848193	9	100	0	0	0	0
21	COMPENSATING RESERVOIR	40.572,95	0,274115751	60	0,046590362	3	100	0	0	0	0
22	FISH PLATE	40.141,40	0,271200147	424	0,329238558	12	100	0	0	0	0
23	HELICAL PINION SHAFT COMPL	21.701,88	0,146620523	15	0,011647591	7	100	0	0	0	0
24	ECCENTRIC	18.627,84	0,125851937	224	0,173937351	1	100	0	0	0	0
25	BUSH	17.912,06	0,121016041	70	0,054355422	9	100	0	0	0	0
26	COUPLING WITH ROUGH BORE	13.250,52	0,089522114	38	0,029507229	2	100	0	0	0	0
27	COOLING COIL	12.422,66	0,083928991	6	0,004659036	3	100	0	0	0	0
28	MOTOR LANTERN	11.600,00	0,078371001	8	0,006212048	1	100	0	0	0	0
29	HOUSING COMPL	10.304,49	0,069618379	1	0,000776506	1	100	0	0	0	0
30	PINION	10.293,20	0,069542102	4	0,003106024	1	100	0	0	0	0

based on data of all FZG supply parts procured from 1st of July 2001 until incl. 31st of January 2002

VIII) Annex 1: Result of the ABC Analysis of All FZG Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Qty. per SPGN	Qty. Share of All Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
31	OIL DAM RING	9.945,43	0,067192526	63	0,048919880	16	100	0	0	0	0
32	FITTING WASHER	8.208,64	0,055458563	128	0,099392772	1	100	0	0	0	0
33	WAELAL	8.086,20	0,054631344	4	0,003106024	1	100	0	0	0	0
34	BIPEX-COUPLING	6.826,68	0,046121875	18	0,013977109	1	100	0	0	0	0
35	HELICAL PINION SHAFT	5.897,70	0,039845574	5	0,003882530	1	100	0	0	0	0
36	SHEET METAL HOLDER	3.983,83	0,026915237	66	0,051249398	5	100	0	0	0	0
37	BALL TAP	3.265,00	0,022058734	86	0,066779519	2	100	0	0	0	0
38	PROTECTIVE TUBE	3.222,78	0,021773491	6	0,004659036	1	100	0	0	0	0
39	PROTECTIVE CAP	3.208,97	0,021680189	11	0,008541566	5	100	0	0	0	0
40	THERMOMETER	2.845,50	0,019224542	6	0,004659036	1	100	0	0	0	0
41	BAFFLE PLATE	2.565,60	0,017333503	4	0,003106024	1	100	0	0	0	0
42	CENTRING FLANGE	2.337,23	0,015790608	7	0,005435542	3	100	0	0	0	0
43	LABYRINTH RING	1.667,01	0,011262521	14	0,010871084	6	100	0	0	0	0
44	COMPENSATION TANK	978,30	0,006609513	2	0,001553012	1	100	0	0	0	0
45	RING FASTENER	883,14	0,005966601	12	0,009318072	3	100	0	0	0	0
46	VENTILATION PIPE	865,49	0,005847355	23	0,017859639	1	100	0	0	0	0
47	OIL GUIDE	272,32	0,001839827	2	0,001553012	1	100	0	0	0	0
48	SHR-VSHL	76,38	0,000516033	2	0,001553012	1	100	0	0	0	0
49	SUPPORT	54,69	0,000369492	1	0,000776506	1	100	0	0	0	0
50	ROLLING CONTACT BEARING	2.799.563,71	18,914190575	5.594	4,343774751	84	97,67	1	1,16	1	1,16
51	INSPECTION COVER	353.744,60	2,389941245	2.429	1,886133155	17	94,44	1	5,56	0	0
52	LOCATING BUSH	20.094,08	0,135758032	173	0,134335544	18	90	2	10	0	0
53	FLANGE	17.247,76	0,116527950	90	0,069885543	9	90	1	10	0	0
54	ADAPTER RING	45.151,43	0,305048515	360	0,279542172	9	81,82	2	18,18	0	0
55	CAP	19.824,76	0,133938473	287	0,222857232	11	73,33	2	13,33	2	13,33
56	RING	241.414,22	1,631023630	4.001	3,106800640	140	72,92	49	25,52	3	1,56
57	PE. SHEET	17.069,26	0,115321982	390	0,302837353	7	70	3	30	0	0
58	SHAFT SEAL	111.466,09	0,753078368	1.884	1,462937367	32	68,09	15	31,91	0	0
59	REDUCING SCREW	3.682,74	0,024881036	94	0,072991567	2	66,67	1	33,33	0	0
60	ANGLE	11.960,20	0,080804556	448	0,347874703	6	60	3	30	1	10

VIII) Annex 1: Result of the ABC Analysis of All FZG Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Qty. per SPGN	Qty. Share of All Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
61	END PLATE	12.297,28	0,083081909	871	0,676336755	14	58,33	8	33,33	2	8,33
62	PROTECTIVE COVER	4.540,85	0,030678531	3.897	3,026044012	6	54,55	0	0	5	45,45
63	PIPE	9.713,75	0,065627268	241	0,187137954	8	53,33	5	33,33	2	13,33
64	CYLINDRICAL PIN	22.537,84	0,152268369	1.016	0,788930130	1	50	1	50	0	0
65	PLUG	358,36	0,002421123	10	0,007765060	1	50	0	0	1	50
66	SCREW CONNECTION	23.236,38	0,156987790	567	0,440278921	4	40	6	60	0	0
67	LAMELLAR RING	91.807,83	0,620264789	2.064	1,602708453	10	37,04	16	59,26	1	3,7
68	DIPSTICK	4.546,57	0,030717176	385	0,298954823	1	33,33	2	66,67	0	0
69	REDUCING SOCKET	3.738,18	0,025255596	169	0,131229520	2	33,33	4	66,67	0	0
70	SLOTTED NUT	11.557,98	0,078087109	407	0,316037956	2	28,57	5	71,43	0	0
71	BREATHER	21.097,85	0,142539623	696	0,540448199	1	25	3	75	0	0
72	PARALLEL NIPPLES	1.758,30	0,011879287	209	0,162289761	2	25	4	50	2	25
73	LOCKING CAP	50.097,18	0,338462599	1.149	0,892205432	1	20	4	80	0	0
74	HEXAGON NUT	5.660,75	0,038244711	600	0,465903620	2	20	0	0	8	80
75	SEAL	11.301,32	0,076353083	618	0,479880729	2	16,67	10	83,33	0	0
76	REDUCING NIPPLE	2.313,98	0,015633528	333	0,258576509	1	16,67	2	33,33	3	50
77	CIRCLIP	28.440,72	0,192148940	1.943	1,508751223	3	13,04	12	52,17	8	34,78
78	PARALLEL KEY	44.673,20	0,301817535	4.430	3,439921728	9	10,98	37	45,12	36	43,9
79	PLUG SCREW	50.191,08	0,339096999	6.421	4,985945241	2	10,53	12	63,16	5	26,32
80	STUD BOLT	2.927,26	0,019776922	212	0,164619279	1	7,14	11	78,57	2	14,29
81	HEXAGON SOCKET HEAD CAP SCREW	68.426,53	0,462297902	13.619	10,575235670	2	5	11	27,5	27	67,5
82	DISC	17.676,32	0,119423353	1.686	1,309189172	1	4	10	40	14	56
83	HEXAGON HEAD SCREW	21.696,99	0,146587485	27.335	21,225792424	1	2,38	0	0	41	97,62
84	OIL SIGHT GLASS	5.483,90	0,037049891	290	0,225186750	0	0	1	100	0	0
85	SUPPORTING PLATE	2.137,12	0,014438641	132	0,102498796	0	0	3	100	0	0
86	OIL SIGHT GLAS	1.935,60	0,013077147	60	0,046590362	0	0	1	100	0	0
87	T-PIECE	1.586,38	0,010717775	126	0,097839760	0	0	4	100	0	0
88	HS-SCREW	1.564,56	0,010570356	72	0,055908434	0	0	1	100	0	0
89	EYE NUT	164,84	0,001113679	26	0,020189157	0	0	1	100	0	0
90	NILOSRING	104,37	0,000705136	6	0,004659036	0	0	2	100	0	0

based on data of all FZG supply parts procured from 1st of July 2001 until incl. 31st of January 2002

VIII) Annex 1: Result of the ABC Analysis of All FZG Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Qty. per SPGN	Qty. Share of All Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
91	ROHR-HYDRAU	82,68	0,000558596	6	0,004659036	0	0	1	100	0	0
92	MEASURING FITTING VKA	27,17	0,000183564	1	0,000776506	0	0	1	100	0	0
93	DISTANCE RING	1.788,52	0,012083457	339	0,263235545	0	0	8	88,89	1	11,11
94	RETENTION PIECE	391,20	0,002642994	69	0,053578916	0	0	5	62,5	3	37,5
95	SHIM	98.403,66	0,664827013	11.152	8,659595285	0	0	29	60,42	19	39,58
96	SHIM RING	61.699,00	0,416845896	5.700	4,426084391	0	0	18	52,94	16	47,06
97	O-RING	8.362,34	0,056496979	824	0,639840972	0	0	5	33,33	10	66,67
98	SOCKET	1.084,73	0,007328567	215	0,166948797	0	0	1	33,33	2	66,67
99	NAME PLATE	6.797,50	0,045924731	2.610	2,026680747	0	0	1	25	3	75
100	HEXAGON SOCKET SCREW	8.755,54	0,059153486	11.638	9,036977217	0	0	0	0	4	100
101	GREASE NIPPLE	497,60	0,003361846	160	0,124240965	0	0	0	0	1	100
102	SET SCREW	480,39	0,003245573	521	0,404559643	0	0	0	0	16	100
103	SEALING RING	299,71	0,002024877	375	0,291189763	0	0	0	0	3	100
104	SPRING TYPE STRAIGHT PIN	98,24	0,000663721	32	0,024848193	0	0	0	0	1	100
105	HEXAGON SCREW	15,60	0,000105395	8	0,006212048	0	0	0	0	1	100
106	PLATE	0,00	0,000000000	16	0,012424097	0	0	0	0	2	100

VIII) Annex 2: Result of the ABC Analysis of All FZG DIN/norm Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Value Share of DIN/norm Parts	Qty. per SPGN	Qty. Share of All Parts	Qty. Share of DIN/norm Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
1	BACKSTOP	212.022,66	1,43245070	5,14666485	106	0,08230964	0,100279079	7	100	0	0	0	0
2	FAN COWL	171.491,24	1,15861553	4,16280004	200	0,15530121	0,189205809	10	100	0	0	0	0
3	FAN	71.534,00	0,48329234	1,73642536	238	0,18480844	0,225154912	19	100	0	0	0	0
4	SHRINK DISC	63.730,55	0,43057129	1,54700343	44	0,03416627	0,041625278	7	100	0	0	0	0
5	AIR GUIDE COVER	46.950,52	0,31720338	1,13968286	32	0,02484819	0,030272929	9	100	0	0	0	0
6	CYLINDRICAL PIN	22.537,84	0,15226837	0,54708638	1.016	0,78893013	0,961165508	2	100	0	0	0	0
7	BREATHER	21.097,85	0,14253962	0,51213188	696	0,54044820	0,658436214	4	100	0	0	0	0
8	COOLING COIL	12.422,66	0,08392899	0,30154922	6	0,00465904	0,005676174	3	100	0	0	0	0
9	OIL SIGHT GLASS	5.483,90	0,03704989	0,13311688	290	0,22518675	0,274348422	1	100	0	0	0	0
10	SHEET METAL HOLDER	3.983,83	0,02691524	0,09670399	66	0,05124940	0,062437917	5	100	0	0	0	0
11	BALL TAP	3.265,00	0,02205873	0,07925502	86	0,06677952	0,081358498	2	100	0	0	0	0
12	PROTECTIVE TUBE	3.222,78	0,02177349	0,07823017	6	0,00465904	0,005676174	1	100	0	0	0	0
13	PROTECTIVE CAP	3.208,97	0,02168019	0,07789494	11	0,00854157	0,010406319	5	100	0	0	0	0
14	THERMOMETER	2.845,50	0,01922454	0,06907203	6	0,00465904	0,005676174	1	100	0	0	0	0
15	OIL GUIDE	272,32	0,00183983	0,00661033	2	0,00155301	0,001892058	1	100	0	0	0	0
16	MEASURING FITTING VKA	27,17	0,00018356	0,00065953	1	0,00077651	0,000946029	1	100	0	0	0	0
17	ROLLING CONTACT BEARING	2.799.563,71	18,91419057	67,95696344	5.594	4,34377475	5,292086467	85	98,84	1	1,16	0	0
18	SHAFT SEAL	111.466,09	0,75307837	2,70574196	1.884	1,46293737	1,782318717	44	93,62	3	6,38	0	0
19	FLANGE	17.247,76	0,11652795	0,41867431	90	0,06988554	0,085142614	9	90	1	10	0	0
20	REDUCING SOCKET	3.738,18	0,02525560	0,09074105	169	0,13122952	0,159878908	5	83,33	1	16,67	0	0
21	SEAL	11.301,32	0,07635308	0,27432967	618	0,47988073	0,584645949	9	75	3	25	0	0
22	SLOTTED NUT	11.557,98	0,07808711	0,28055987	407	0,31603796	0,385033821	5	71,43	2	28,57	0	0
23	SCREW CONNECTION	23.236,38	0,15698779	0,56404283	567	0,44027892	0,536398467	7	70	3	30	0	0
24	LOCKING CAP	50.097,18	0,33846260	1,21606528	1.149	0,89220543	1,086987371	3	60	2	40	0	0
25	ANGLE	11.960,20	0,08080456	0,29032341	448	0,34787470	0,423821011	6	60	4	40	0	0
26	STUD BOLT	2.927,26	0,01977692	0,07105668	212	0,16461928	0,200558157	8	57,14	6	42,86	0	0
27	PROTECTIVE COVER	4.540,85	0,03067853	0,11022517	3.897	3,02604401	3,686675181	6	54,55	0	0	5	45,45
28	PLUG	358,36	0,00242112	0,00869888	10	0,00776506	0,009460290	1	50	1	50	0	0
29	PARALLEL NIPPLES	1.758,30	0,01187929	0,04268120	209	0,16228976	0,197720070	3	37,5	5	62,5	0	0

based on data of all FZG supply parts procured from 1st of July 2001 until incl. 31st of January 2002

VIII) Annex 2: Result of the ABC Analysis of All FZG DIN/norm Supply Parts

No.	SPGN	Value per SPGN (RMB)	Value Share of All Parts	Value Share of DIN/norm Parts	Qty. per SPGN	Qty. Share of All Parts	Qty. Share of DIN/norm Parts	A-Qty.	A-Sh.	B-Qty.	B-Sh.	C-Qty.	C-Sh.
30	PLUG SCREW	50.191,08	0,33909700	1,21834462	6.421	4,98594524	6,074452486	7	36,84	8	42,11	4	21,05
31	DIPSTICK	4.546,57	0,03071718	0,11036401	385	0,29895482	0,364221182	1	33,33	2	66,67	0	0
32	SHIM RING	61.699,00	0,41684590	1,49768933	5.700	4,42608439	5,392365546	11	32,35	13	38,24	10	29,41
33	PARALLEL KEY	44.673,20	0,30181754	1,08440290	4.430	3,43992173	4,190908661	22	26,83	34	41,46	26	31,71
34	T-PIECE	1.586,38	0,01071777	0,03850799	126	0,09783976	0,119199659	1	25	3	75	0	0
35	SHIM	98.403,66	0,66482701	2,38866288	11.152	8,65959529	10,550115889	12	25	28	58,33	8	16,67
36	O-RING	8.362,34	0,05649698	0,20298850	824	0,63984097	0,779527932	3	20	5	33,33	7	46,67
37	HEXAGON NUT	5.660,75	0,03824471	0,13740976	600	0,46590362	0,567617426	2	20	0	0	8	80
38	CIRCLIP	28.440,72	0,19214894	0,69037363	1.943	1,50875122	1,838134431	4	17,39	13	56,52	6	26,09
39	REDUCING NIPPLE	2.313,98	0,01563353	0,05616984	333	0,25857651	0,315027671	1	16,67	5	83,33	0	0
40	HEXAGON SOCKET HEAD CAP SCREW	68.426,53	0,46229790	1,66099424	13.619	10,57523567	12,883969538	5	12,5	10	25	25	62,5
41	DISTANCE RING	1.788,52	0,01208346	0,04341476	339	0,26323555	0,320703846	1	11,11	7	77,78	1	11,11
42	DISC	17.676,32	0,11942335	0,42907723	1.686	1,30918917	1,595004967	2	8	11	44	12	48
43	HEXAGON HEAD SCREW	21.696,99	0,14658749	0,52667548	27.335	21,22579242	25,859703893	1	2,38	0	0	41	97,62
44	GREASE NIPPLE	497,60	0,00336185	0,01207881	160	0,12424097	0,151364647	0	0	1	100	0	0
45	EYE NUT	164,84	0,00111368	0,00400135	26	0,02018916	0,024596755	0	0	1	100	0	0
46	SPRING TYPE STRAIGHT PIN	98,24	0,00066372	0,00238469	32	0,02484819	0,030272929	0	0	1	100	0	0
47	HEXAGON SOCKET SCREW	8.755,54	0,05915349	0,21253308	11.638	9,03697722	11,009886004	0	0	1	25	3	75
48	SET SCREW	480,39	0,00324557	0,01166105	521	0,40455964	0,492881131	0	0	1	6,25	15	93,75
49	SEALING RING	299,71	0,00202488	0,00727520	375	0,29118976	0,354760891	0	0	0	0	3	100

based on data of all FZG supply parts procured from 1st of July 2001 until incl. 31st of January 2002

VIII) Annex 3: Example Questionnaire for the Supplier Self Analysis of the Suppliers of FTJ[366]

General Information: 大致信息	Address: 地址	
	Contact person: 联系人	
	Communication techniques: 联系方式	Mail: 邮寄地址 Fax: 传真 E-Mail: 电子邮件 Other: 其他
Sales: 经营项目	Products produced: 产品	
	Customers: 顾客类型	
	Restriction on product sale/ exclusive sales: 产品销售控制	
	Customer service of goods in case of quality problems: 质量问题的处理	
	Service level for supply of parts: 交货时间，周期	
	Export of products: 产品的出口 To where?: 出口地	
Products: 产品	Knowledge of material: 材料	
	Use of DIN: 标准件的生产 Knowledge of DIN-parts: 标准件的知识	
	Cooperation for new product development: 新产品开发的合作意向	
	Change to new product requirements possible: 生产我们需求的新产品的可能	
Production: 产品	Production capacity: 生产能力	
	Required order quantity: 订单数量的要求	
	Production to stock: 产品的库存 Delivery out of own stock: 库存品的货时间	
	Delivery time: 发货时间 Delivery from where?	
	Quality Management: 质量管理	
	Quality control: 质量控制	
	Use of equipment: 生产设备	Origin: 原产地 Age: 年龄

366 developed by Jörg Büchting in cooperation with the logistics department and according to Koppelmann, Udo: “Beschaffungsmarketing“, p. 241