Benchmarking for spare parts logistics

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Abstract This article shows the use of benchmarking for the spare parts logistics in the German mechanical industry (investment goods or capital goods). After pointing out the areas of benchmarking application, the use of total function deployment (TFD) for the evaluation of benchmarking metrics is explained. With TFD customer requirements on spare parts supply and the process structure of spare parts logistics are brought together in quality matrices, which are the bases for the metrics derivation. The last paragraph contains the results of a survey in the German mechanical industry. Concrete values of benchmarking metrics from the questioned companies, belonging to metrics on delivery service, costs of logistics and on materials management, are given. All theoretical and empirical results are drawn from a research project conducted in the Institute of Business Administration/Department of Business Management at Darmstadt University of Technology.

Introduction
The spare parts supply as a part of the after-sales-service for capital goods has an increasing importance as a competition tool in this industry. Its effect for winning new customers and binding existing ones depends on the recognition and the fulfilment of customer requirements. Benchmarking can be used as an instrument to measure the fulfilment of the customer requirements and to compare cost structures with the benchmarking partner. Moreover, benchmarking studies help to indicate additional potential of market position or (higher) productivity by defining and comparing certain metrics to assess the fulfilment of customer and process requirements.

The following article presents the main results of a benchmarking project in the German mechanical industry. An introduction into the German handling of benchmarking will be given by describing the development of benchmarking metrics and investigating the theoretical and practical outcomes of benchmarking studies within the selected industry. Some of the results might even be transferable to other branches of industry. The presented results are drawn from a research project conducted in the Institute of Business Administration/Department of Business Management at Darmstadt University of Technology between 1995 and 1997.

Benchmarking: the basics
Benchmarking as a part of TQM (Total Quality Management) is a continuous process of comparison of products, services, processes and methods with the best in class companies (Camp, 1989, p. 1). The best in class companies are
defined as the best companies with regard to the investigated performance processes. Traditional German metrics comparison projects only refer to businesses within the same industry, whereas benchmarking projects can cover different branches of industry. The selection of those businesses depends on their performance of specific processes. Companies with the most efficient fulfilment of similar performance requests to the processes in question should be included in a benchmarking project, as illustrated in the benchmarking project conducted by Rank Xerox (Photocopying Machines) and L.L. Bean (mail order company for sports equipment) (Camp, 1989, p. 289). Even if products may vary in form, size and weight, the requests on the logistical handling during warehousing and transportation are very similar.

Performance gaps of benchmarking partners are identified through the comparison of selected metrics. In order to analyse the underlying processes and subprocesses, those metrics should measure the performance of the business process regarding the fulfilment of customer requirements and the induced cost.

Benchmarking is a structured proceeding which can be divided into four phases including the ten steps as shown in the list below[1]:

**Planning**

1. Selection of investigated process.
2. Selection of benchmarking partner.
3. Information collection.

**Analysis**

5. Evaluating causes for the gaps.

**Introduction**

6. Persuading the employees.
7. Fixing goals.

**Implementation**

8. Developing action plans.
9. Implementing actions.
10. Controlling.

**Planning**

The relevant processes need to be determined for investigation and separated from one another in detail. This is an indispensable requirement for effective working in the following steps.

The selection of the benchmarking partner is a very important decision for the success of the project. In the case of external benchmarking the decision for the best suitable partner has to be made among different companies or groups
of companies, whereas the selection of a partner for an internal benchmarking process is limited to departments within the company or holding structures. In both cases it is of utter importance to identify companies (or departments), which have a better performance considering the selected business processes.

**Analysis**

During the phase of analysis performance gaps have to be detected. Then, possible reasons for those performance differences have to be investigated. Performance gaps refer to the difference in those metrics which were before defined as benchmark variables compared to the metrics of the best performing company. If this comparison leads to a negative performance gap, further investigation of the underlying processes is necessary. This means that business processes have to be re-analysed carefully in order to initiate adequate steps for improvement. However, performance differences between benchmark partners should be made explicitly transparent and should be interpreted very carefully, since the results of a benchmarking study can lead to important organisational, technological, and people-oriented changes.

**Introduction**

In this phase, the results of a benchmarking survey have to be transferred into objectives such as annual budget figures and strategic planning measurement units or performance metrics for the different business departments. Goals have to be discussed with employees regarding the acceptance of the goals. If benchmark findings suggest the existence of performance gaps, a company is forced to monitor continuously the process developments in comparison with those of the best-practice-companies.

**Implementation**

In this phase it is essential to determine all corresponding responsibilities in detail, which include also the acknowledgement of technical and psychological aspects. The acceptance of affected employees, for example, is an indispensable prerequisite for the successful implementation of process improvement.

When an activity-plan has been accepted, it is important to implement the means of measurement decided on before and to control all advances permanently. Obviously, the implementation requires the understanding of new procedures, process sequences, methods and, furthermore, as already mentioned, the clear assignment of responsibilities. By comparing the achieved objectives with the defined milestones, process advances can be controlled.

**Starting anew**

After finishing a benchmarking project, the comparison with better companies has to be continued. There must be a constant search for improvement and the performance on the selected business processes has to be permanently compared with the performance of other companies. Therefore, benchmarking can be
defined as a continuous process. In fact benchmarking is a way for companies to become a learning organisation (Leibfried and McNair, 1993, p. 368).

As shown in the previous paragraph, the orientation towards customer requests is an essential component of benchmarking projects. Every process within the company has to be checked in view of possible metrics (benchmarks) which contribute to the fulfilment of the defined customer requests within the framework of the entire performance of the company.

Therefore, the customer requests concerning the supply with spares will be presented in the first step to show afterwards the definition of metrics by comparing these results with the process structure.

**Benchmarking in the German mechanical industry: results of theoretical and empirical research**

*Use of benchmarking in German mechanical industry*

A survey in the German mechanical industry (investment goods or capital goods) – conducted in 1995 – showed the degree of awareness and the use of benchmarking in the companies, included in the survey. The 1,252 biggest companies of the mechanical industry have been asked in this questionnaire-survey about their benchmarking knowledge. A total of 68 questionnaires were sent back and analysed. In the following paragraphs the results of this data analysis are described.

*Use of benchmarking*

Of the responding companies, 58 never used benchmarking (85 per cent). Only ten of them have performed benchmarking projects (15 per cent). Figure 1 shows their fields of use.

The main application field is the production management, followed by sales and procurement.

The application rate of benchmarking of only 15 per cent is founded on the reasons presented in Figure 2.

Interviews within the management staff of those companies revealed their interest in benchmarking to improve their position in competition. The influence for benchmarking projects came from literature, conferences and consulting companies.

**Evaluation of benchmarking metrics**

*Quality function deployment for the evaluation of benchmarking metrics*

As mentioned before, benchmarking is an instrument to measure the fulfilment of customer requirements in every part of the performance process. Therefore, the defined metrics for benchmarking investigations have to indicate this fulfilment. An instrument of TQM, quality function deployment (QFD), can be applied for the evaluation of benchmarking metrics.

Initially, QFD serves as an instrument for simultaneous engineering, to consider customer requirements within the technical development of products and processes[2]. Relevant current and (expected) future customer
requirements are translated into product/process characteristics in a comprehensible transformation process. This transformation process is divided into three steps (see Appendix 1)[3].

Step 1: Customer surveys reveal concrete customer requirements concerning the product (tertiary requirements). They are summarised to secondary and primary requirements groups.

Step 2: The tertiary quality features of the product are derived from the tertiary customer requirements. Both are compared in a matrix (see 2a in Appendix 1). For every customer requirement a quality feature is developed. The tertiary quality features are summarised step by step to secondary and primary quality features (see 2b in Appendix 1) (Akao, 1992, p. 31; Shindo et al., 1992).

Step 3: The correlation between customer requirement and quality feature is presented in a constructed matrix. In this connection it is important to emphasise the interdependence between both sides of the matrix. Appendix 1 shows the development of a quality matrix in general; Appendix 2 shows a quality matrix for the developing of a radio telephone.

The idea of QFD is also applied to other areas. It is used as software quality deployment (SQD, for example in software engineering, where customer requirements are related to software features (Zultner, 1989)). Furthermore, it is an instrument for the modulation of logistic processes, called logistic function.

![Use of benchmarking](chart.png)

**Figure 1.** Areas of application for benchmarking in the German mechanical industry. Result of a survey of 68 companies.

**Source:** Ester and Pfohl, 1996

*Production management, Sales, Procurement, EDP, Staff management, Management, Logistics, R & D, Finance*
deployment (LFD) in the process chain management (Pielok, 1995, p. 123). Whereas QFD converts customer requirements into quality features of the product, LFD correlates customer requirements to the affected logistical processes. With this instrument, the contribution of process structures to the fulfilment of customer requirements can be measured.

The structure of a quality matrix for LFD is presented in Appendix 3.

The use of the QFD approach for benchmarking leads to a matrix that relates customer requirements to process structures for the development of measurement points, in which metrics can be put in. Appendix 4 presents the quality matrix for the development of benchmark metrics.

If a correlation between the customer requirement and the tertiary process activity does exist, a benchmarking metric can be installed. The metric then measures the contribution of the process activity to the fulfilment of the customer requirement. Detailed examples for the building of the metrics are shown in paragraph “The matrix”.

As shown before, the main components of developing benchmarking metrics is the knowledge of customer requirements and detailed process structures. These components are described for the spare parts logistics and combined in a quality matrix in the subsequent paragraphs.
Customer requirements as an evaluation basis

Customer requirements can be distinguished into requirements on delivery service, on spare parts quality, on customer communication and on spare parts supply costs[4]. The detailed requirements are explained in the following paragraphs.

Customer requirements on delivery service

Delivery time has an effect on the customer’s inventory level and a longer delivery time normally causes more supply uncertainty and a higher inventory level. Delivery time itself depends on the stock availability of the supplier and on the implemented distribution system. The reliability of delivery has an additional influence on the customer’s inventory level. A high reliability means meeting the promised delivery date. Possible changes in the delivery date and a timely confirmation of order must be communicated to the customer.

High quality delivery, means also a delivery:

- without any damaged goods;
- of the right kind and amount of products according to the customer’s order.

The avoidance of wrong deliveries demands high reliability within the entire order cycle process, especially order taking and order picking. Moreover, packaging has to provide a reliable protection against possible damages during transport.

Expectations from the customer concerning the supply flexibility should be met by a corresponding capability of the supplier to adapt to different customer requests. The adaptation could take place during the processes of order processing, delivery procedure, and customer information processing. The flexibility of order procedure can be accomplished by not using:

- minimum order quantity;
- fixed order quantities; and
- fixed dates of order placing (free rhythm of order placement for the customer).

Moreover, a free choice of the way the order is transmitted should be realised.

A flexible procedure of delivery includes the consideration of the customer’s requests on packaging, shipment choice and the offer for a delivery “on call”.

Customer information must refer to delivery alternatives, state-of-the-order process and possible delays in delivery.

Although measurement of flexibility is limited to only qualitative criteria, an evaluation is still necessary and useful. Since every kind of flexibility in the order management process has an influence on the customer’s value chain, flexibility is an important tool to fulfil customer requirements.
Delivery service also includes dealing with customer queries. Dealing with customer queries should be done quickly and must be very reliable because of possible failing costs for machine breakdowns on the customer’s side.

**Customer requirements on communications**

Concerning the technical side of communication, the EDP systems of customers and suppliers have to be directly connected to one another to reduce transmission time and to avoid errors in data input and data transmission.

Customers need consulting for placing their orders (e.g. article number of the requested spare part, technical advice for the installation). Therefore telephone consulting should be offered to the customer and be on duty as long as possible (e.g. a 24-hour hotline).

Customer information requests are also connected with the forecasting of spare part demands and recommendations for the maintenance of machines and spare parts.

In this context, the appearance and personality of the salesforce and the consulting staff are quite important. That means they have to meet high standards regarding their technical qualification, which comprises the understanding of the customer’s technical and organisational problems. Furthermore, they are expected to show politeness and understanding towards the customer.

An important prerequisite for a reliable order consulting and a correct order management is a clear and correct numbering and labelling of spare parts. This allows a quick identification, a clear order placement and an easy storage at the customer’s facility. A careful documentation of all offered spare parts is also an important condition for customer consulting, in particular if the period of storage is very long (in Germany the guaranteed period of spare parts supply for some capital goods is about 20 years and longer).

**Customer requirements on quality of spare parts**

The quality of spare parts, the possibility of their repair and an easy assembling and reassembling have a high effect on the customer’s value chain. Particularly, the quality of spare parts is an argument of prime importance for the customer’s choice of the supplier for capital goods.

**Customer requirements on the costs of spare parts supply**

The two components of supply costs are the prices of spare parts and the supply costs (delivery or procurement cost). Both components are affected by the spare parts logistics. Prices of spare parts depend on the costs of production and storage, whereas the costs for supplying depend on the structure of the distribution system.

Table I presents the customer’s requirements in summary.

A survey among spare parts customers in Germany – conducted in 1995 – showed the importance of the single customer requirements. The results are shown in Figure 3.
The main process of spare parts logistics can be divided into two components: customer-driven processes and support processes. Customer-driven processes cover all activities in direct connection with the customer’s order fulfilment: order processing, distribution and query management. Support processes have no direct connection to the customer’s order, but they support the customer-

Table I. Customer requirements to spare parts supply

<table>
<thead>
<tr>
<th>Summarized requirements</th>
<th>Detailed requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery service</td>
<td>Short delivery time</td>
</tr>
<tr>
<td></td>
<td>Delivery reliability</td>
</tr>
<tr>
<td></td>
<td>Good condition of delivered goods (no transport damages)</td>
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<tr>
<td></td>
<td>High correspondence between order and delivery in kind and amount of products</td>
</tr>
<tr>
<td></td>
<td>Flexibility in terms of order arrangement</td>
</tr>
<tr>
<td></td>
<td>Flexibility in terms of delivery arrangements</td>
</tr>
<tr>
<td></td>
<td>Quick reaction to queries (short delivery time for queried goods)</td>
</tr>
<tr>
<td>Quality of spare parts</td>
<td>Quick order confirmation</td>
</tr>
<tr>
<td>Communication</td>
<td>Reliable statements about delivery time</td>
</tr>
<tr>
<td></td>
<td>Information in cause of delay</td>
</tr>
<tr>
<td></td>
<td>Competent technical consulting</td>
</tr>
<tr>
<td></td>
<td>Competent order consulting</td>
</tr>
<tr>
<td></td>
<td>Clear numbering of spare parts</td>
</tr>
<tr>
<td></td>
<td>Quick and reliable dealing with queries</td>
</tr>
<tr>
<td>Costs of spare parts supply</td>
<td>Low prices of spare parts</td>
</tr>
<tr>
<td></td>
<td>Low costs for supplying</td>
</tr>
</tbody>
</table>

**Process structure of spare parts logistics**

The main process of spare parts logistics can be divided into two components: customer-driven processes and support processes. Customer-driven processes cover all activities in direct connection with the customer’s order fulfilment: order processing, distribution and query management. Support processes have no direct connection to the customer’s order, but they support the customer-
driven processes. Supporting processes are, for example, spare parts procurement, storekeeping and spare parts documentation. The detailed processes are shown in the list below:

(1) **Customer-driven processes:**
- Order processing
- Order transmission (transmission of the purchasing order data from the customer to the supplier).
- Order taking (taking over the purchasing order data into the order processing system of the supplier).
- Order adaptation (adaptation of the order data to the company’s own order processing system: adaptation and completion of the data structure to the supplier’s data structure and order controlling).
- Order conversion (converting of the controlled and completed data into picking data).
- Order picking.
- Order despatch.
- Distribution
- Query processing

(2) **Support processes:**
- Procurement.
- Storekeeping.
- Documentation.

**The matrix**
The combination of detailed customer requirements and the process structure leads to a quality matrix as shown in Appendix 5.

Every field of the matrix represents a measurement point (MP) that yields the contribution of the examined activities/processes to the fulfilment of the customer’s requirements. For example, MP 1.1 the customer requirement “Short delivery time” correlates with the length of the order transmission (a short order transmission time supports a short delivery time). Therefore, the metric for MP 1.1 can be “Length of the order transmission time”. Another example is MP 4.1-MP 4.6: the customer requirement “Correspondence between order and delivery in amount and kind” relates to the processes “Order transmission” (MP 4.1), “Order taking” (MP 4.2), “Order adaptation” (MP 4.3), “Order converting” (MP 4.4), “Order picking” (MP 4.5) and “Despatch” (MP 4.6). Thus every field can be filled with a metric that shows the contribution of the process/activity to the fulfilment of the customer requirement. “Quote of mistakes by the data adaptation” could be for example a metric in MP 4.3.
Hence, an appropriate system of metrics for the actual benchmarking investigation in any degree of distinction can be generated.

**Benchmarking metrics for the spare parts logistics**
The following figures represent an excerpt from the above mentioned survey in the German mechanical industry. It was finished in 1996 by the academic staff of the Institute of Business Administration/Department of Business Management at Darmstadt University of Technology. A total of 1,202 companies have been consulted, of which 41 participated in the project. Those enterprises possess the following characteristics:

- between 50 and 500 employees;
- sales on capital goods less than DM 100 million; and
- sales on spare parts between 1 million and DM 10 million.

In general, the survey showed only small use of metrics within the planning and controlling of spare parts logistics processes. Very few companies used metrics regularly. In most of those companies metrics had to be evaluated for the survey. The benchmarks described below show average values from the questioned companies.

**Benchmark metrics on delivery service**
The customer service level per order item (number of “in time” delivered order items/total number of ordered items) is about 84 or 74 per cent, referring to complete orders.

The order processing lead time for replenishment orders (time between order entrance and exit of the delivery from the company) is about 311 hours for replenishment orders and 21.5 hours for urgent orders. The total delivery time includes also the distribution time (time between the exit of the delivery from the company and delivery receipt at the customer). Distribution time for replenishment orders is on average about 2.8 days, for urgent orders about one day.

Performance statements about goods being damaged during transport or differences in kind and amount between order and delivery cannot be made explicit by direct measurement. Therefore, the complaint rates are used as indicators. The complaint rate per item (number of complaints items/total number of delivered items) is 4 per cent. Different causes are: customers’ mistakes in ordering (41 per cent), mistakes in order acceptance (11 per cent), picking mistakes (16 per cent), transport damages (11 per cent), and defective products (21 per cent). The high share of complaints caused by customers’ mistakes during purchasing, indicates the need for customer order consulting. In this connection it is important to take into account that investments in order consulting can reduce the expense of ordering mistakes and prevent the supplier’s image destruction because of wrong deliveries. Also, investments for a central order taking (orders can be given only to one department, not different departments at the supplier) reduces customers’ ordering mistakes.
**Benchmark metrics on costs of spare parts logistics**

The costs for order processing are about DM 633.00 per order and DM 139.00 per order item. All costs belonging to the order processing of a complete spare parts order were included.

Commission costs per order are averaging DM 67.00 and DM 13.30 per order item.

Storekeeping costs (costs of warehouse/number of stock items) are about DM 23.50 per stock item. Of the companies questioned, 31 per cent use their own spare parts store, 69 per cent have integrated the spare parts storage into the store of capital goods.

**Benchmark metrics to materials management**

The quality of materials management can be indicated by metrics such as turnover stock rates, average stock rates and the share of spare parts devaluation.

The turnover stock rate (sales/average store stock, valued by production costs) is 7.4.

The average store stock is about DM 8.3 million and the devaluation share (value of no longer saleable spare parts/sales of spare parts) is 7.8 per cent. Spare parts are considered as not saleable when they become obsolete or damaged during storage and transport.

Details of the benchmark metrics are given below (these are results of a survey of 41 suppliers of capital goods (Ester, 1997, p. 267)).

**The benchmark metrics to delivery service are as follows:**

- Customer service level per order item – 84 per cent.
- Customer service level per order – 74 per cent.
- Order processing lead time for replenishment orders – 311 hours.
- Order processing lead time for urgent orders – 21.5 hours.
- Distribution time for replenishment orders – 2.8 days.
- Distribution time for urgent orders – 1 day.
- Query proportion (referring to items) – 4 per cent.

**The benchmark metrics to costs of spare parts logistics are as follows:**

- Costs for order processing per order – DM 633.00.
- Costs per order processing per order item – DM 139.00.
- Costs of commission per order – DM 67.00.
- Costs of commission per order item – DM 13.30.
- Storekeeping costs per stockkeeping unit – DM 23.50.
The benchmark metrics to materials management are as follows:

- Turnover rate of stock – 7.4.
- Average store stock – DM 8.3 million.
- Devaluation share – 7.8 per cent.

Notes

1. In literature the benchmarking process is structured very differently. (See Bogan and English, 1994, p. 82; Pieske, 1995, p. 49; Spendolini, 1992, p. 51; Zairi and Leonhard, 1994, p. 51).


4. For the detailed derivation of customer requirements to the spare parts logistic see Pfohl et al., 1995.

References


Appendix 1. Development of a quality matrix

<table>
<thead>
<tr>
<th>Quality Features</th>
<th>primary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Requirements</td>
<td>secondary</td>
</tr>
<tr>
<td>Step 1</td>
<td>tertiary</td>
</tr>
<tr>
<td>primary</td>
<td>secondary</td>
</tr>
<tr>
<td>tertiary</td>
<td></td>
</tr>
</tbody>
</table>

**Figure A1.**
Appendix 2. Quality matrix for the development of a radio telephone

<table>
<thead>
<tr>
<th>Customer Requirements</th>
<th>Quality Features</th>
<th>primary</th>
<th>Operating</th>
<th>secondary</th>
<th>Portability</th>
<th>Electrical Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary</td>
<td>secondary</td>
<td>tertiary</td>
<td>Volume</td>
<td>Form</td>
<td>Weight</td>
<td>Electricity Consumption</td>
</tr>
<tr>
<td>1. easy to handle</td>
<td>1.1 easy to hold</td>
<td>1.1.1</td>
<td>easy to carry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2 easy to hold</td>
<td>1.1.3 easy to hold</td>
<td>1.1.4</td>
<td>because of comfortable size</td>
<td></td>
<td></td>
<td>1.4 sensitive to variation in temperature</td>
</tr>
<tr>
<td>1.1.5 stable to put down</td>
<td>1.2 non-tiring operation</td>
<td>1.2.1</td>
<td>1.2.2 appropriate size</td>
<td></td>
<td></td>
<td>Voltage</td>
</tr>
<tr>
<td>1.2.2 appropriate weight</td>
<td>1.3 operating</td>
<td>1.3.1</td>
<td>1.3.2 easy to operate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 operating principles easy to understand</td>
<td>1.3.3 ....</td>
<td>1.3.3 ....</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ....</td>
<td>2.1 ....</td>
<td>2.1.2</td>
<td>....</td>
<td>....</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Akao, 1992, p. 30

Figure A2.
Appendix 3. Relations between customer requirements and logistic processes in a LFD quality matrix

<table>
<thead>
<tr>
<th>Customer Requirements</th>
<th>Quality Features of Logistic Processes (Requirements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary</td>
<td>primary</td>
</tr>
<tr>
<td>secondary</td>
<td>secondary</td>
</tr>
<tr>
<td>tertiary</td>
<td>tertiary</td>
</tr>
</tbody>
</table>

**How?** (Process Structures)

**What?**

*Correlations*

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Figure A3.
### Appendix 4. Quality matrix for the evaluation of benchmarking metrics

<table>
<thead>
<tr>
<th>Quality Features</th>
<th>primary</th>
<th>secondary</th>
<th>tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main Process</td>
<td>Subprocess 1</td>
<td>Subprocess 2</td>
</tr>
<tr>
<td>Subgroup 1.1</td>
<td>Customer Requirement 1</td>
<td>MP 1.1</td>
<td>MP 1.2</td>
</tr>
<tr>
<td></td>
<td>Customer Requirement 2</td>
<td>MP 2.1</td>
<td>MP 2.2</td>
</tr>
<tr>
<td></td>
<td>Customer Requirement 3</td>
<td>MP 3.1</td>
<td>MP 3.2</td>
</tr>
<tr>
<td></td>
<td>Customer Requirement 4</td>
<td>MP 4.1</td>
<td>MP 4.2</td>
</tr>
<tr>
<td></td>
<td>Customer Requirement 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgroup 1.2</td>
<td>Customer Requirement 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer Requirement 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgroup 1.3</td>
<td>Customer Requirement 8</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Customer Requirement 9</td>
<td></td>
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<td></td>
<td>Customer Requirement 10</td>
<td></td>
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</tr>
<tr>
<td>Subgroup 2.1</td>
<td>Customer Requirement 11</td>
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<td></td>
<td>Customer Requirement …</td>
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</table>

Figure A4.
Appendix 5. Quality matrix for the evaluation of benchmarking metrics (MP = measurement point)

<table>
<thead>
<tr>
<th>Quality Features</th>
<th>Customer Requirements</th>
<th>primary</th>
<th>secondary</th>
<th>tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare Parts Supply</td>
<td>Delivery Service</td>
<td>1 Short Delivery Time</td>
<td>MP 1.1</td>
<td>MP 1.2</td>
</tr>
<tr>
<td></td>
<td>2 High Delivery Reliability</td>
<td>MP 2.1</td>
<td>MP 2.2</td>
<td>MP 2.3</td>
</tr>
<tr>
<td></td>
<td>3 Good Condition of delivered Goods (no Transport Damages)</td>
<td>MP 3.1</td>
<td>MP 3.2</td>
<td>MP 3.3</td>
</tr>
<tr>
<td></td>
<td>4 High Correspondence between Order and Delivery in Kind and Amount</td>
<td>MP 4.1</td>
<td>MP 4.2</td>
<td>MP 4.3</td>
</tr>
<tr>
<td></td>
<td>5 Flexibility in Terms of Order Arrangement</td>
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<td>6 Flexibility in Terms of Delivery</td>
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<td>7 Quick Reaction to Queries (Short Delivery Time for queried Parts)</td>
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<td>10 Reliable Statements about Delivery Time</td>
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<td>11 Information in Cause of Delay</td>
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<td>Costs of Spare Parts Supply</td>
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<td>14 Clear Numbering of Spare Parts</td>
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<td>15 Quick and reliable Dealing with Queries</td>
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<td>16 Low Prices of Spare Parts</td>
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<td>17 Low Costs for Supplying</td>
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Figure A5.