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PROCUREMENT PROCESS METRIC IN MEDIUM MANUFACTURING ORGANIZATION

Abstract: In this paper a procurement, purchasing and supply subsystem in medium manufacturing organization is analyzed. Using the process approach, the procurement is analyzed as a network of interconnected sub-processes that are directed towards achieving the defined objectives, as well as an organization itself. Applying Structural system analysis (SSA) the procurement sub-processes are identified. Process metric for determining the process quality is developed and presented. For each sub-process the deterministic characteristics for processes measurement as well as characteristics value were established. Proposed metric is the input for the development of models and software for evaluation and testing of the procurement process from the point of quality.

Keywords: Procurement, manufacturing organization, process approach, process metric

1. INTRODUCTION

Formal, modern, research in the field of procurement in manufacturing organizations have begun with the works of [1], [2], [3] and [4]. Further researches have been extended to the decision-making processes in procurement, the roles and impact of procurement centers, and the individual and organizational effects on the procurement [5-8].

During the last decades the traditional understanding of the procurement process as administrative functions [9-11] grew into a procurement strategy [12-15] which is based on developing long term relationships with the suppliers and continuous quality improvement, respect of delivery deadlines, reduce costs, and thus the high efficiency of procurement [16-19]. This transformation of the procurement process is established by global competition, together with the

increase of raw materials price, shortage of deficient resources, oil crisis, the global economic crisis, inflation, etc. The fact in the modern time is that an increasing part of income, more than 65% is spent on procurement of resources [20], especially in manufacturing organizations.

The main task of the procurement process is a regular supply at minimum cost, with achievement of seven major goals (7P): the right product/service, in the right quantity, under the right conditions, the right supplier, at the right time, with the right service, at the right place [21]. In this way the procurement provides the continuity of all processes within organization, and keeping the around the optimal value. To achieve the procurement objectives all the factors that determine market resources must be known.

Starting from key objective of the procurement to ensure continuity of production and economic business

systems, and its place and role in providing the necessary inputs, it is possible to identify the structure of all activities, or processes, which are continually performed, in a logical and useful way.

In this paper a procurement, purchasing and supply subsystem in medium manufacturing organization is analyzed. Process metric for determining the process quality is developed and presented.

2. ANALYSIS OF PROCUREMENT SUBSYSTEM

2.1 Conditions for the initiation of the procurement process

The process approach that is one of the eight basic principles of quality management systems (QMS) in ISO 9000:2000 has been used for the analysis of procurement subsystem in the production organization. The process model is the way who most organizations really work, as a set of connected inputs and outputs [22]. According to the process approach, the procurement is viewed as a network of interconnected sub-processes that are directed towards achieving the defined objectives. The requirements of ISO 9001:2000 that cover the procurement process are defined in paragraph 7.4.

2.1 Conditions for the initiation of the procurement process

Procurement is based on types of procurement types, as well as numerous external and internal factors. Knowledge of the market characteristics is a prerequisite for an effective procurement.

Procurement in the organization could be initiated by the contract or order, procurement plan, decisions on new product development, maintenance plan for equipment, procurement plan for consumable materials and resolving customer complaints.

Procurement process in the organization could be initiated if the

procurement is necessary and justified, or if:

- Procurement is provided in the annual procurement plan,
- Financial assets in the organization's budget are provided for procurement,
- Procurement is justified, when taking into consideration the quantity necessary for procurement and available quantities of inventories.

Organizational units for whose needs are carried out procurement, or authorized persons of the organizational units are usually the initiators of the initiation and implementation of procurement procedures. They should determine the need for any procurement, and then in defined deadlines submit their requests for initiation of procurement procedures.

2.2 Decomposition of the procurement process

The procurement process is not very precise, so therefore the decomposition of the procurement process varies from organization to organization. In some organizations, more attention is paid to planning of the procurement, in other selection of supplier, and in some organizations to both. Every organization finds the most suitable way, which depends on its size, structure, types of activities and development of communication.

Many authors presented a similar model of the procurement process [1, 3, 23, 24]. Using Structural system analysis (SSA) [25, 26] the procurement process is decomposed to the levels that are necessary for implementation, measurement, analysis and improvement of the procurement process, as well as quality management. In the paper the 7 most common procurement sub-processes in the manufacturing organizations are selected:

- Definition of the procurement

- requirements,
- Procurement planning,
- Suppliers evaluation,
- Contracting,
- Verification of procurement product,
- Reclamation to supplier and
- Implementation monitoring of the contract.

Procurement process is initiated by receipt of documents in which is defined the procurement product, and ends with the acceptance/installation of the procurement product and dues paid to the supplier, or the reclamation to supplier and enforcement contract procedures provided.

3. MEASUREMENT, ANALYSIS, AND PROCUREMENT PROCESS METRICS

After the identification of all procurement sub-processes, metric of the procurement process has been developed to determine the procurement process quality and its impact on the quality of the entire manufacturing organization, and therefore the organizational goals. Through process metric the characteristics of process metric were defined that effect on the quality process, and those relating to the procurement process effectiveness and efficiency and the whole organization [27,28].

The requirements of ISO 9001:2000, which is related to the measurement, analysis and process monitoring, are contained in Section 8 of standards.

8.1 General

The organization shall plan and implement the monitoring, measurement, analysis and improvement processes needed

- a) *to demonstrate conformity of the product,*
- b) *to ensure conformity of the*

- quality management system, and*
- c) *to continually improve the effectiveness of the quality management system.*

This shall include determination of applicable methods, including statistical techniques, and the extent of their use.

8.2.3 Monitoring and measurement of processes

The organization shall apply suitable methods for monitoring and, where applicable, measurement of the quality management system processes. These methods shall demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction and corrective action shall be taken, as appropriate, to ensure conformity of the product.

This means that monitoring and measurement processes can be integrated into the processes, in this case procurement, or defined as separate processes.

By measuring and monitoring of the procurement process characteristics the causes of unconformities were analyzed, d areas that requiring corrective action were identified, performances were improved and process efficiency was increased.

Data on effectiveness the procurement sub-processes have been determined on the basis of characteristics that are collected and formalized through the records. The characteristics, which determinate the score the procurement process, have been defined for the whole procurement process and sub-processes, and are shown in Table 1. Process data are collected monthly, quarterly, semiannually and annually.

Process characteristics are determined based on conducted survey among manufacturing organizations. For each procurement process characteristics are given in the table 1.

Table 1 – Procurement Process Metric Characteristics

| Process | Characteristics Label | Process Characteristics | What is measured |
|--|-----------------------|--|---|
| Define the procurement requirements | K 1.1 | Accuracy | Denied requests percentage based on accuracy |
| | K 1.2 | Time | Average time required to provide procurement decisions, calculated from the date of receipt the request requirements |
| Procurement planning | K 2.1 | Percentage of procurement plan realization | Total procurement contracts value in procurement plan/Procurement planning value |
| | K 2.2 | Percentage of realization | Contract realization value/Value of contract realization |
| | K 2.3 | Completeness | Procurement percentage value that requires a change in the approved procurement plan |
| | K 2.4 | Inventories level | Inventories value purchased in the reporting period/Inventories value purchased in the previous reporting period (x100) |
| Suppliers evaluation | K 3.1 | Deadline | Delayed deliveries percentage |
| | K 3.2 | Quality verification | Deliveries percentage with the inconsistencies established on the qualitative acceptance |
| Contracting | K 4.1 | Time | Average time required for the contract provision, calculated from the date of the providing procurement decision |
| | K 4.2 | Completeness | Changed the tender documents percentage after the announcement |
| | K4.3 | Procedure correctness | Accepted complaints percentage of potential suppliers |
| Verification of procurement product | K5 | Success | Inconsistencies percentage detected external control |
| Reclamation to supplier | K6 | Success | Successful reclamation percentage of the total complaints number after the identified inconsistencies in exploitation |
| Implementation monitoring of the contract | K7 | Success | Contracts percentage realized on time |

After selecting and adopting the procurement sub-process metric characteristics has evaluated the impact of these characteristics of the procurement sub-process score. Based on realized

survey among manufacturing organizations has determined a value of each characteristics. Characteristics values K2.1, K2.2, K2.3, K2.4, K1.1, K1.2 and K4.1 are measured monthly. Values of

other characteristics are determined annually.

The procurement process metric is shown in Table 2 for all procurement sub-processes, and then was given a table of procurement sub-processes: Define the

procurement requirements (Table 3), Procurement planning (Table 4), Suppliers Evaluation (Table 5) and Contracting (Table 6) that have more than one the process characteristic.

Table 3 – Procurement Process Metric

| Procurement Process Characteristics | | | | | | | Charact eristics score |
|-------------------------------------|-----|-----|-----|-----|-----|-----|------------------------------|
| K 1 | K 2 | K 3 | K4 | K5 | K6 | K7 | |
| Characteristics value | | | | | | | |
| 10 | 10 | 10 | 10 | 0 | 100 | 100 | 10 |
| 9 | 9 | 9 | 9 | 2 | 98 | 95 | 9 |
| 8 | 8 | 8 | 8 | 4 | 96 | 90 | 8 |
| 7 | 7 | 7 | 7 | 6 | 94 | 85 | 7 |
| 6 | 6 | 6 | 6 | 8 | 92 | 80 | 6 |
| 5 | 5 | 5 | 5 | 10 | 90 | 75 | 5 |
| 4 | 4 | 4 | 4 | 12 | 88 | 70 | 4 |
| 3 | 3 | 3 | 3 | 14 | 86 | 65 | 3 |
| 2 | 2 | 2 | 2 | 16 | 84 | 60 | 2 |
| 1 | 1 | 1 | 1 | >16 | <84 | <60 | 1 |
| 0,1 | 0,3 | 0,1 | 0,2 | 0,1 | 0,1 | 0,1 | Weight |

The average weight score or the procurement process score is obtained by defining of all procurement sub-processes characteristics values (from K1 to K7). Then, sub-processes scores from K1 to K4 are defined (from Table 3, 4, 5 and 6) - for appropriate characteristics values of these sub-processes find appropriate characteristics scores that is then multiplied by the appropriate weight.

For example: Procurement planning process score is obtained as
 $K2 = K2.1 \cdot 0,4 + K2.2 \cdot 0,2 + K2.3 \cdot 0,1 + K2.4 \cdot 0,1$

When sub-process score from K1 to K4 are calculated (Table 2), then the procurement process score is calculated on the same principle. For appropriate

characteristics values is found the appropriate characteristics score and multiplied with the appropriate weight. Finally, summing up all the obtained characteristics values for each process characteristics was obtained the procurement process score.

$$K = K1 \cdot 0,1 + K2 \cdot 0,3 + K3 \cdot 0,1 + K4 \cdot 0,2 + K5 \cdot 0,1 + K6 \cdot 0,1 + K7 \cdot 0,1$$

This procurement process score is compared with the planned or required procurement process score, which is obtained from the effect of the procurement process of the manufacturing organization objectives realization.

Table 3 – Define the procurement requirements Process Metric

| Process Characteristics Define the procurement requirements K1 | | Characteristics score |
|--|------|-----------------------|
| K1.1 | K1.2 | |
| Characteristics value | | |
| 0 | <5 | 10 |
| 0,5 | 7 | 9 |
| 1 | 10 | 8 |
| 1,5 | 12 | 7 |
| 2 | 15 | 6 |
| 2,5 | 17 | 5 |
| 3 | 20 | 4 |
| 3,5 | 22 | 3 |
| 4 | 25 | 2 |
| >4 | >45 | 1 |
| 0,5 | 0,5 | Weight |

Table 4 – Procurement planning Process Metric

| Process Characteristics Procurement planning K2 | | | | Characteristics score |
|---|-------|-------|-------|-----------------------|
| K 2.1 | K 2.2 | K 2.3 | K 2.4 | |
| Characteristics value | | | | |
| 100 | 100 | <5 | ≤85 | 10 |
| 95 | 95 | 10 | 88 | 9 |
| 90 | 90 | 15 | 91 | 8 |
| 85 | 85 | 20 | 94 | 7 |
| 80 | 80 | 25 | 97 | 6 |
| 75 | 75 | 30 | 100 | 5 |
| 70 | 70 | 35 | 103 | 4 |
| 65 | 65 | 40 | 106 | 3 |
| 60 | 60 | 45 | 109 | 2 |
| <60 | <60 | >45 | 112 | 1 |
| 0,4 | 0,2 | 0,1 | 0,1 | Weight |

Table 5 – Suppliers Evaluation Process Metric

| Process Characteristics Suppliers Evaluation K3 | | Characteristics score |
|---|-------|-----------------------|
| K 3.1 | K 3.2 | |
| Characteristics value | | |
| 0 | 0 | 10 |
| 2 | 2 | 9 |
| 4 | 4 | 8 |
| 6 | 6 | 7 |
| 8 | 8 | 6 |
| 10 | 10 | 5 |
| 12 | 12 | 4 |
| 14 | 14 | 3 |
| 16 | 16 | 2 |
| >16 | >16 | 1 |
| 0,35 | 0,35 | Weight |

Table 6 – Contracting Process Metric

| Process Characteristics Contracting K4 | | | Characteristics score |
|--|-------|-------|-----------------------|
| K 4.1 | K 4.2 | K 4.3 | |
| Characteristics value | | | |
| <30 | 0 | 0 | 10 |
| 35 | 1 | 0,5 | 9 |
| 40 | 2 | 1 | 8 |
| 45 | 3 | 1,5 | 7 |
| 50 | 4 | 2 | 6 |
| 55 | 5 | 2,5 | 5 |
| 60 | 6 | 3 | 4 |
| 65 | 7 | 3,5 | 3 |
| 70 | 8 | 4 | 2 |
| >70 | >8 | >4 | 1 |
| 0,25 | 0,25 | 0,25 | Weight |

In this paper are presents and treated only the deterministic characteristics of the procurement process. Further work in this field will be based on the determination

descriptive characteristics of the procurement process and its modeling by using fuzzy model.

4. CONCLUSION

Procurement process is analyzed monthly to ensure the continuing suitability, adequacy, effectiveness and efficiency of the procurement process, identified and corrected process defects, identified and indicated inconsistencies that is related to the requirements of health, safety,

environment, consumer, information, identified and corrected procurement process defects and evaluated opportunities for improvement and the need for changes in the procurement process.

Based on the developed procurement process metrics in following papers will be developed the model of the procurement process for medium manufacturing organization and software for evaluation and testing procurement process from the aspect of quality.

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