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THE FRAMEWORK FOR THE SUPPLIER QUALIFICATION SYSTEM FOR THE WORLD LEADER HOME APPLIANCES INDUSTRY

KWALIFIKACJA DOSTAWCÓW NA PODSTAWIE SYSTEMU OBOWIĄZUJĄCEGO W ZAKŁADACH ŚWIATOWEGO LIDERA BRANŻY AGD

Abstract

The aim of this study is to analyze and evaluate the supplier qualification system used in production plants of the world leader in the household appliances industry and to present proposals for improvement actions. The concern uses the "20 Steps Procedure", which is a set of guidelines for each stage of qualifying suppliers of components for production processes. It systematizes individual activities and sets the powers and responsibilities of the departments involved in various phases of the qualification process. This article describes its three phases. An important element of the procedure is a detailed supplier auditing system. It is necessary to be sure that a supplier has an effective management system and controls its production processes, and that the manufactured elements meet all the concern's requirements.

The presented system of supplier evaluation and qualification seems to indicate a rather cautious approach of the concern to the admission of new suppliers of components or semi-finished products. Criteria used in this area are very critical, but formulated in a very clear and transparent manner, understandable both for the company's auditors and for current and future suppliers.

Keywords: assembly, outsourced processes, components quality, supplier qualification, component suppliers, auditing

Streszczenie

Celem niniejszej pracy jest analiza i ocena systemu kwalifikacji dostawców, stosowanego w zakładach produkcyjnych światowego lidera branży AGD i przedstawienie propozycji działań doskonalących. W koncernie wykorzystywana jest „Procedura 20 kroków" będąca zbiorem wytycznych dotyczących poszczególnych etapów kwalifikacji dostawców komponentów do procesów montażu. Systematyzuje ona poszczególne działania oraz wyznacza uprawnienia i odpowiedzialności działów biorących udział w różnych fazach procesu kwalifikacji. Niniejszy artykuł opisuje jej trzy fazy. Ważnym elementem procedury jest szczegółowy system auditowania dostawców. Niezbędne jest uzyskanie pewności, że dostawca ma efektywny system zarządzania oraz kontroluje swoje procesy produkcyjne, a produkowane elementy spełniają wszystkie wymogi koncernu.

Przedstawiony system oceny i kwalifikacji dostawców wydaje się wskazywać na dosyć ostrożne podejście koncernu do dopuszczenia nowych dostawców komponentów czy półwyrobów. Kryteria. stosowane w tym zakresie, są bardzo krytyczne, jednakże sformułowane w sposób bardzo jasny i przejrzysty, zrozumiały zarówno dla auditorów koncernu, jak i dla obecnych i przyszłych dostawców.

Słowa kluczowe: montaż, procesy zlecane na zewnątrz, jakość komponentów, kwalifikowanie dostawców, dostawcy komponentów, auditowanie

1. Introduction

The aim of this study is to analyze and evaluate the supplier qualification system used in production plants of the world leader in the household appliances industry and to present proposals for improvement actions. The supplier qualification system presented later in this work is used in the process of central purchasing carried out for the entire concern. The conducted analysis shows suggestions of improvement actions, the implementation of which at the group level is probably impossible.

Effective qualification of suppliers is an essential element of the management system, having a significant impact on the quality of the delivered products. Until the 1920s, the concept of quality management did not exist in factories and other companies around the world. It is obvious, that in order to avoid

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complaints, the supplier verified the functional features of the delivered products. However, there are no data or studies that would confirm that these activities were carried out in a systematic manner.

In the 20th century, Walter Shewhart conducted pioneering research on the statistical description of variability in production, and on this basis, assumptions for statistical process control, and then statistical quality control, were developed. These methods were used by the US arms industry during World War II. Thanks to William Edwards Deming, a student of W. Shewhart, in the late 1940s, Japanese engineers became interested in quality control. In Japan, he conducted a series of lectures on statistical process and quality control. This stage is considered to be the beginning of the development of a new approach to product quality. Jospeh Juran also promoted the knowledge of statistics and quality in Japan.

The success of Japanese companies drew the attention of American entrepreneurs who began to look for the source of their failures. However, the popularization of quality management in the United States and Europe took place in the 1980s [1]. In 1986, the International Organization for Standardization ISO, based in Geneva, established the international standard ISO 8402: *Quality — Vocabulary*, and on its basis in March 1987 a series of international standards ISO 9000: *Quality management and quality assurance standards* was issued. Thanks to these standards, the concept of quality ceased to be associated only with a material product or service, and the role and importance of the quality of systems as well as the quality of processes taking place in the company and the way of managing them began to be noticed. The use of the process approach is one of the main elements that differentiate the set of standards of the 9000:1994 series from the ISO 9000: 2015 series standards in force until today.

There is a principle in the Japanese management philosophy that only well-educated employees who use good materials and work with good equipment can produce a good product that can be sold at a favorable price. The same principle also applies to services. This means that the selection and evaluation of suppliers plays a significant role in the enterprise and is an important factor in its success.

In an industry such as that represented by the concern that owns considered management system, the added value to a large extent arises outside the organization. The producers actually "only" function as assembly plants.

Many elements determining the quality of the final product (e.g. washing machines) are created in other companies. The uninterrupted course of processes in the production plant is only possible thanks to a perfectly functioning supplier management system.

The supplier management process must meet various expectations, and the requirements for the enterprise can be associated with the following groups [2][3]:

- customer expectations,
- comprehensive links between all interested parties,
- requirements resulting from standards,
- legal requirements,
- technological progress.

Only effective supplier management can ensure the long-term success of the enterprise [4][5].

This study provides an overview of the "20 Steps Procedure" used in the concern production plants, containing guidelines for qualifying suppliers, as well as a description of the principles related to auditing component suppliers. The presented rules of conduct were analyzed and assessed, on the basis of which proposals for improvement actions were presented.

2. Presentation of the company's activities

The company whose system was analyzed is one of the world's largest producers of household appliances and devices for professional use. The manufactured products are refrigerators, dishwashers, washing machines, vacuum cleaners and cookers. The concern's customers buy yearly about 40 million products in 150 countries. The company implements innovative solutions, designed with the use of comments, observations and ideas of customers in such a way as to meet their requirements. This assessed company can represent the other world class companies with their products and distribution facilities.

The group's quality management system is based on the requirements of several international standards. including ISO 9000, 14000, 18000 / 0HSAS, TS 16949, QS 9000, VDA 6.1-6.3 standards. Each of the plants has an individual management system, independent of central procedures.

Below (Fig. 1.) is the PDCA circle related to material supply in the concern's production company. The supplier qualification process is a centrally controlled process carried out by the central Procurement Department.

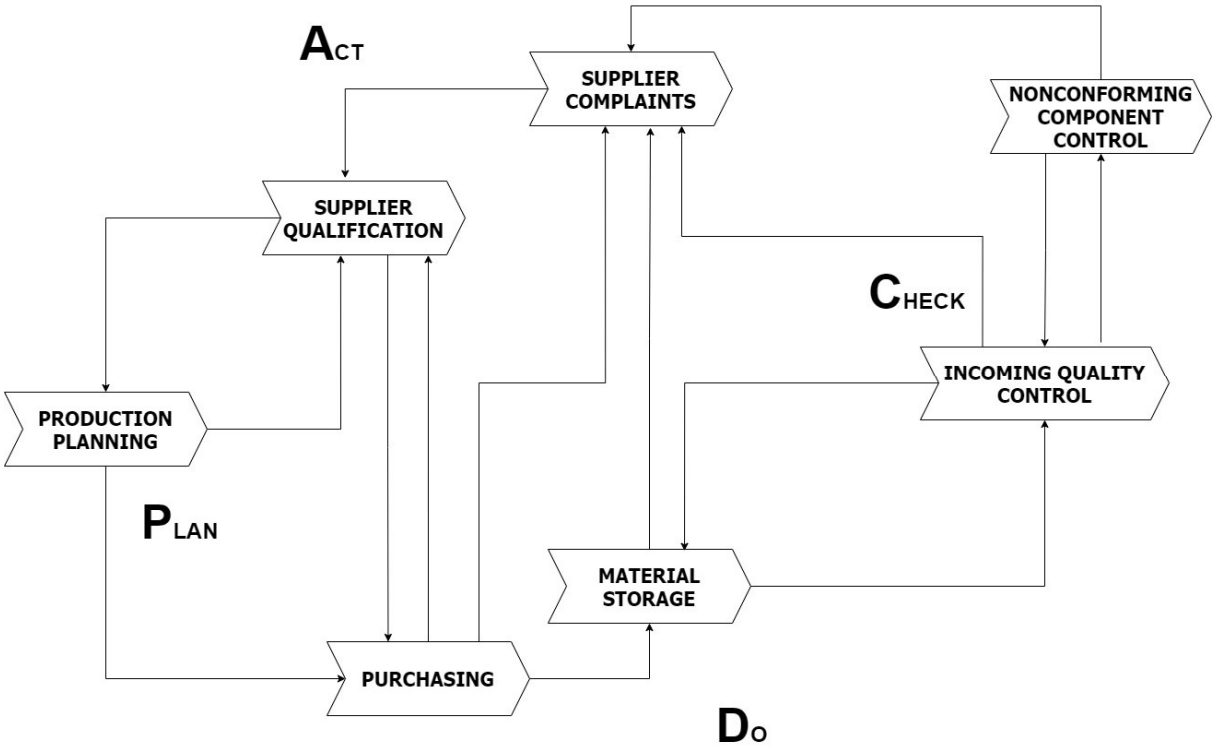

Fig. 1. PDCA circle related to material supply in a production company (source: own study).

3. Presentation of the "20 Steps Procedure" used in the concern

The "20 Steps Procedure" is a set of guidelines for each stage of supplier qualification. It systematizes individual activities and sets the powers and responsibilities of the departments involved in various phases of the qualification process.

The procedure itself can be divided into three phases (Fig. 2.).

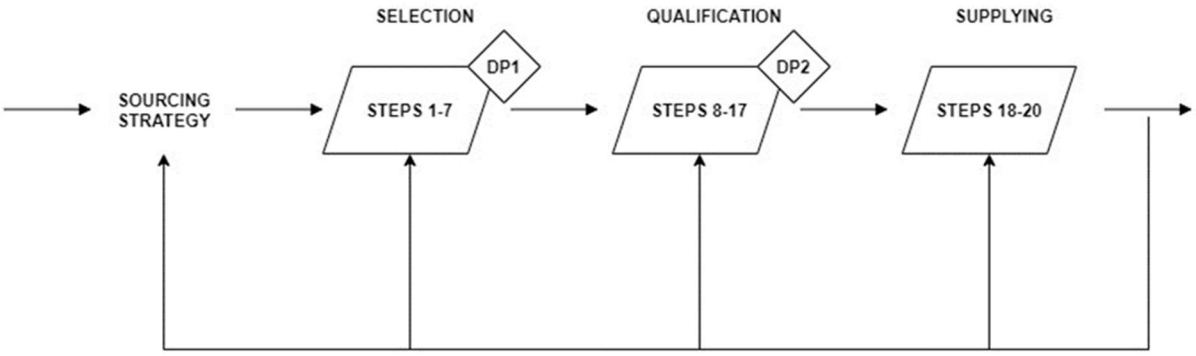

Fig. 2. The phases of the "20 Steps Procedure" (source: own study)

The first phase is "Selection" which covers steps 1-7, the second phase is "Qualification" which covers steps 8-17, the third is "Supplying" which covers steps 18-20. Between the individual phases there are the so-called "Decision points" - moments at which decisions are made to go ahead with individual suppliers.

These phases are preceded by step 0, the purpose of which is to specify the necessary requirements. Costs, component, quality and logistics requirements are defined. These activities involve employees of the Purchasing, Quality, R&D and Logistics Department.

The list of steps is presented collectively in the table below (Tab. 1.).

Table 1. Phases and steps of the “20 Steps Procedure” (source: own study).

Phase	Step	Description
1	-	**Selection**
	1	Market analysis
	2	List of potential suppliers
	3	Valuation
	4	List of selected suppliers
	5	GSQA (Global Supplier Quality Assurance) procedures. Supplier's information and response
	6	Supplier profile - purchasing process
	7	Initial quality audit
2	-	**Qualification**
	8	Specification review
	9	Delivery and contract
	10	Pre-production quality plan
	11	Samples and test results
	12	Component and sampling
	13	Supplier development
	14	Component homologation
	15	Testing under production conditions. Homologation.
	16	Supplier process audit
	17	Contract finalization. Component approval.
3	-	**Supplying phase**
	18	Production start
	19	Ongoing business assessment
	20	Supervision

Step 1: "Market analysis"

At this stage, global markets are reviewed to track current and future trends that will indicate where the appropriate supplier of individual components should be sought. Market analyzes, trade newspapers, and other sources of information are reviewed and may be of assistance at this stage. An in-company study "Commodity Analysis; Commodity Strategy and Action Plan” is also a helpful tool. The Procurement Department is responsible for carrying out these activities, which, through market analysis, indicates the potential sources of supply of individual components.

Step 2: "List of potential suppliers"

The purpose of this step is to prepare a list of at least three potential suppliers who may be able to provide the required components at the appropriate price, quality and cost. At this stage, the lists of current suppliers and market analyzes prepared in Step 1 are reviewed. Financial analysis is also part of the procedure. These activities, as in the case of Step 1, are also performed by the Procurement Department, and their result is a list of recommended potential suppliers.

Step 3: "Valuation"

In this step, the total cost of sourcing components from suppliers is estimated, including production costs, logistics, etc. Additionally, the supplier is informed about the requirements. They get basic information about the part requirements such as quantity, quality, packaging, batch size and availability. The supplier quotes the tooling, production costs, price per item and prepares a schedule. The supplier also receives general requirements – RML, RoHS and Code of Conduct. The Purchasing, Logistics and Quality Departments participate in these activities.

Step 4: "List of selected suppliers"

At this stage, the Purchasing Department selects the suppliers that qualify for the selected supplier list. For this purpose, all information that has been collected so far at individual stages is reviewed and analyzed.

Step 5: “GSQA (Global Supplier Quality Assurance) procedures. Supplier's information and response "

At this stage, the supplier is informed about the procedures of the Quality Department and related measurements.

Step 6: "Supplier profile – purchasing process"

Its purpose is to obtain sufficient information about the supplier to assess its qualifications as a future business partner. According to the purchasing process, information is obtained such as: financial status, R&D capacity, supply and flexibility, social

and environmental policy. etc. To facilitate the acquisition of this information, the group provides the responsible persons with a special form. The obtained data is stored in a specialized database, provided if a decision is made to continue cooperation with a given supplier.

Step 7: "Initial quality audit"

The preliminary quality audit is carried out on the basis of the document "Supplier's initial process audit questionnaire". Its purpose is to assess the production processes of the selected supplier to demonstrate its ability to produce products of adequate quality. The supplier's factory is visited and the production process is assessed in accordance with the procedure described later in this article. On this basis, a report is prepared, containing a plan of corrective actions, which are monitored up to Step 14, if a decision made at DP1 is to continue cooperation.

DP1: Decision point

After completing all activities related to steps 1-7, in accordance with the "20 Steps Procedure", it is time to make the first decision regarding the continuation of the evaluation of the selected supplier and possible cooperation. In the procedure, this decision point is referred to as DP1. At this stage, the collected information is reviewed, assessed and a decision is made to continue cooperation. During the internal meeting, the Purchasing Department discusses the items to be delivered, discusses the list of suppliers and reviews the profile of the evaluated supplier, and analyzes the results of the preliminary audit. initial cost estimation, logistics solutions, other data (e.g. tools, specification agreements, packaging), RoHS data, possible profits, risk assessment. The plan of steps 8-18 is also reviewed and a decision is made whether to continue cooperation or not to qualify for a given supplier.

Step 8: "Specification review"

The purpose of this stage is to provide the selected supplier with the final and detailed specification of the component and the customer's requirements. The technical specification is checked for completeness. All documented requirements should result from the performance characteristics of a given component and the production process. Suppliers are provided with final drawings, delivery and quality specifications. At the end of this stage, the following documents are created: component specification, RoHS requirements, packaging requirements, quality and reliability requirements and other related specifications. The supplier confirms with his signature the specification and all requirements of the ordering party.

Step 9: "Delivery and contract"

At this stage, preliminary terms of delivery and quality agreement are established. The Purchasing Department determines all variable parameters, such as delivery times and their flexibility as well as quality parameters. Initial terms of delivery and quality agreement are negotiated and agreed.

Step 10: "Pre-production quality plan"

The purpose of this step is to plan and agree on qualitative preventive actions. The quality department defines the optimal quality assurance plan for a given supplier. The supplier must prepare a plan to meet these requirements. The plan must then be approved by the Quality Department.

Step 11: "Samples and test results"

The compliance of the specifications with the initial samples is checked. The test results report provided by the supplier is viewed. If a risk assessment is required, the status of the entire production process is checked. These actions may result in the notification of nonconformities and a request for corrective action.

Step 12: "Component and sampling"

The goal is to establish cooperation between the R&D Department and the supplier to verify the compliance of the specifications and the ability of the supplier's production process. Samples and test results are verified for compliance with the specification. There is also a process capability report prepared by the supplier.

Step 13: "Supplier development"

The concern supports the supplier in the full implementation of the quality assurance plan and preparation for the process audit. Substantive assistance is provided if the supplier's knowledge in this regard is not sufficient. An action plan is prepared to support implementation. At this stage, the final process maps, the MSA quality control and analysis plan, and the documented risk analysis – process FMEA are created. To complete this step, all preventive actions following the pre-audit must be fully implemented by the supplier.

Step 14: "Component homologation "

At this stage, it is checked whether the analyzed component meets the specified requirements. The compliance of the manufactured component with the specification is verified. Tests are performed to check functionality, reliability, safety, etc. The RoHS compliance (if required) and the CE mark (if required) are verified. The result is a homologation report, RoHS certificate (if required) and a CE file.

Step 15: “Testing under production conditions. Homologation."

This step is followed by verification of the feasibility of the assembly and testing of the assessed elements during assembly. Tests are performed under production conditions. It is checked whether an initial qualitative input inspection will be necessary. As a result of these tests, approval for use, approval for the pilot batch and entry inspection procedures are issued.

Step 16: "Supplier process audit".

This stage is to confirm that the supplier can deliver his products in accordance with the group's requirements. An audit and assessment of the correct production processes at the supplier is performed, including verification of the correct implementation of the quality assurance plan (Step 10). Unsatisfactory results are reported in the CAR report (required corrective actions) and the supplier is given a deadline within which he must prepare a corrective action plan.

Step 17: "Contract finalization. Component approval"

During this step, all conditions are finalized and agreed. Supply chain is planned. The terms of the contract are negotiated and agreed, this applies to the schedule, its flexibility, procurement procedures and quality parameters are established. The logistics arrangements are also being finalized. The results are purchase order acceptance and contract finalization. It is also confirmed that the component meets the production and use requirements. If so, its status is changed to "approved" in the BOM.

DP2: Decision point

At the end of the "Supplier Qualification" phase, it is time to make another documented decision about the fate of the supplier participating in the qualification process. During the Procurement meeting, relevant information is reviewed and analyzed, and then a decision is made to proceed with the "20 Steps Procedure". During the decision meeting, the following are discussed: verification of completeness of the specification. Pre-production quality assurance status. Process audit results, component / application test results. Approvals CE marking, RoHS compliance, contract and agreement review, ordering procedure and logistic solutions, financial justification review, corrective actions required, start of production, decision to continue The result is a DP2 report approving the introduction of the component into production and listing the delivery on the list suppliers.

Supplying phase

Step 18: "Production start"

The purpose of this stage is to initiate production and start deliveries. An order and a transport order are placed.

Step 19: "Ongoing business assessment"

At this stage, the supplier and component production are monitored and managed. The reliability of deliveries is controlled. An entry inspection is performed. Line rejects are monitored. The implementation of improvement projects is checked. The results of these activities are reports on the ongoing evaluation, analysis and implementation of improvement projects.

Step 20: "Supervision"

This is the last step of the "20 Steps Procedure". This step includes overseeing the implementation and results of corrective actions by the supplier as per the audit results.

The result is an update of the results of the process audit.

4. Supplier auditing system

4.1. Supplier pre-audit

The first audit during the implementation of the "20 Steps Procedure" discussed above takes place at Step 7 of the “Selection” phase. It is an initial audit aimed at assessing a potential supplier, confirming its ability to meet the requirements, especially those related to ISO 9001: 2015. It is necessary to be sure that the supplier has an effective management system and controls its production processes, and that the manufactured elements meet all the concern's requirements.

The questionnaire is based on the following standards: ISO 9001: 2015, ISO / TS 16949 and QS 9000.

The purpose of the pre-audit is to understand the potential supplier's system of operation, to check that there are correct management methods throughout the organization and to identify possible critical points.

The table below (Tab. 2.) presents the system of awarding points for individual criteria:

Table 2. Scoring system for audit questions (source: internal corporate documentation).

Answer	Points	Justification	Corrective actions
No	0	Required but not included in the management system	Yes
Yes, but	1	Included in the management system but implementation needs improvement	Yes
Yes	2	Effectively used in the management system	No

Upon completion of the audit, on the basis of the scores obtained, the potential supplier is qualified to one of two groups. The classification system is presented in the table below (Tab. 3.).

Table 3. System of classification of suppliers (source: internal corporate documentation).

Score	Status	Criteria	Comments
A	Acceptable	> = 75% as the average level for all sections and a minimum of 1 point for each question	Supplier confirming compliance with audit requirements. Also demonstrating high self-discipline and excellent process management.
B	Not acceptable	<75% as the average level in all sections or not a minimum of 1 point was obtained for each question	The supplier does not meet the requirements

The audit is performed by sampling, the purpose of the auditors is not to find non-conformities, but to demonstrate compliance on the basis of random spot checks in the areas examined. The following sections are assessed:

Management – in this area, the maximum number of points that a potential supplier can obtain is 20. The questions concern the following issues: “Does the supplier have a current ISO 9001 or similar certificate (e.g. ISO / TS 16949), issued by an accredited organization, in terms of products/services?"; "Have internal and external quality targets been set based on customer feedback and other data?"; "Is there a quality cost measurement system that monitors the costs of internal nonconformity, prevention, and control and testing?"; "Have objectives been analyzed and action taken if objectives have not been met (internal objectives and consistent actions also need to be considered)?"; "Have specific improvement projects been implemented and are they properly measured and verified in terms of effectiveness?"; "Were internal audits carried out according to the schedule and were the causes of nonconformities analyzed and corrective actions taken?"; Are there periodic management reviews with the active participation of the management? ”; "Is there a system for checking the causes of nonconformities (internal and external) and have appropriate corrective actions been taken to eliminate them?"; "Is the effectiveness of corrective actions adequately verified (including goals, trends, PDCA method, etc.) to prevent duplication?"; "Was there a system for identifying training needs and were all the people whose activities influencing the quality trained?".

Quality planning – the maximum number of points that can be obtained in this section is 8. Questions related to this area are as follows: "Is the process of implementing a new product started, which covers the following issues: customer requirements review, customer and supplier relations, feasibility studies, tool planning, FMEA, identification/control of critical points, MSA, control plans and diagrams, sample identification, evaluation of process capability and usage of appropriate statistical methods, evaluation of product lifetime, management of the above changes? ”; "Is the organization able to conduct an FMEA?"; "Can the potential supplier perform statistical process capability studies and use statistical process control methods?"; "Is there an effective system for approving/evaluating components and, if necessary, production processes prior to production at the supplier's facility?".

Purchasing – a maximum of 6 points can be achieved in this section. The questions are: "Is there an effective system for ongoing monitoring of the supplier's production capacity and is a quality management system required?"; "Is there a defined process for obtaining and evaluating samples from the supplier?"; "Are suppliers required to inform the organization of any changes to the delivered product?".

Production control – in this section, the maximum number of points to be earned is 20. The questions are as follows: "Are there workplace procedures and instructions available?"; "Do the procedures (or control plans) contain requirements for production, inspection, testing, start production, approval and product, process and tool changes, with recorded results?"; "Have special processes been identified and appropriate metrics identified?"; "Are the appropriate statistical methods (SPC) required by the control plans in place?"; "Are materials, products and relevant components kept in segregated and labeled uniform batches at all production levels, including final storage?"; "Is the product traceable from procurement to the delivery to the customer?"; "Do the inspections and tests carried out at each stage have a clearly marked status?"; "Is there an effective system for handling the product, its storage, packaging, delivery and protection?"; "Is the working environment clean and well-organized"; "Is there an effective system for monitoring product output quality through statistical audit of ready-to-ship products?".

Calibration and maintenance - in this section it is possible to receive a maximum of 6 points. The questions are: "Is there a system that ensures that the appropriate measurement and test equipment is properly calibrated, on time, in accordance with international standards and MSA (Measurement Systems Analysis)?"; "Is there a planned maintenance system for all equipment, including schedule, defined criteria, frequency and responsibility and records?"; "Is there a spare parts management system for key production equipment, including their identification and availability?".

4.2. Supplier process audit

A process audit can be initiated by both the customer and the supplier. The decision to audit a given supplier is made on the basis of strategic data analysis. The current supplier who has made significant organizational changes or moved production to another location is also subject to audit. The supplier may request a reassessment of the management system in order to increase the scores or change the category awarded in an earlier audit. Suppliers whose manufacturing and delivery history shows low quality of material / components and / or services are also subject to audit. The same also applies to suppliers who have not been audited in the last three years.

The objectives of a process audit are as follows:

- deepening the supplier's understanding of the customer's processes and expectations;
- improving the supplier's operations based on the analysis of statistical variability of input and output data from each process area;
- applying statistical techniques to the supplier's products and processes;
- maintaining an appropriate management methodology throughout the supplier's organization, which also has a significant impact on the level of quality costs.

The form includes a sheet that summarizes the nonconformities identified during the audit and an appendix with specific requirements that can be used to document the necessary corrective actions during post-audit meetings.

The scoring system is as follows (Tab. 4.).

Table 4. Scoring – process audit (source: internal corporate documentation)

Answer	Points	Justification	Corrective actions
No	0	Required / high risk but not included in the management system	Yes
Yes, but	1	Included in the management system but implementation requires improvement	Yes
Yes	2	Works effectively in the management system	No
N/A	-	Not applicable	-

The auditor records his observations in the questionnaire. Nonconformities will be included in the audit summary, as long as the answer to a given question obtained less than 2 points and requires corrective action. Auditor comments may also be attached to responses that scored 2 points, but are not seen as a requirement for corrective action. Such comments are recorded in the appropriate column and may become a source of corrective action if the full specification is not provided or the requirements are not met prior to the commencement of deliveries.

As a general rule, all questions must be assessed. The exception is when the question does not entirely relate to the assessed organization. Example: the supplier produces components in the assembly technique, then SPC is not expected and scores NA (not applicable), if the supplier has a small production company and cannot afford to implement SPC, but the production characteristics require this technique, then scores 0 points. The decision to consider certain aspects as NA must be made during the audit preparation phase and must be agreed with the team prior to the audit and recorded on the evaluation sheet and as a commentary to the question in the report.

The decision to accept responses to certain questions as NA must be made during the audit preparation phase and agreed with the audit team prior to the audit and recorded as a comment on the evaluation form next to the relevant question. It is important that the audit team evaluates and scores any question that has not been allocated to the NA category. If for some reason the audit cannot be completed, a further visit is necessary so that all questions are assessed.

When questions are asked about information on procedures, the questions are usually assessed against whether there are instructions and whether they are adequate ("Do the procedures / work instructions / control plans list requirements for inspection, test and record results?"). If the instruction is inadequate or non-existent, a score of 1 or 0 is given. If the instruction is adequate but not implemented, the scoring will be on the question: "Do workers act in

accordance with work instructions or other relevant requirements?".

Additional explanations of the scoring rules:

- 0 points are awarded when a requirement exists but is not addressed in the management system or not implemented, or there is a serious failure in the management system, or there is a high risk to the customer.
- 1 point is awarded when the issue is in the management system, but its implementation requires improvement or the requirement is not consistently implemented.
- 2 points are awarded when a requirement is fully met and perfectly performed.

Nonconformities must be assigned to specific questions (otherwise they may duplicate in the summary). If the same nonconformity occurs for two different questions, the audit team must decide which one it has the greater connection with and rate the question with 1 or 0 points. The latter question, which also corresponds to the same nonconformity, will be scored 2 points unless any other nonconformity is found which affects the scoring. The described situation stems from the assumption that the supplier is not punished twice for the same failure. Comments appear when there is no evidence of nonconformity or a threat to the customer is discovered.

The classification system is similar to the pre-audit, but the classification criteria have been slightly tightened. The rules are illustrated in the table below (Tab. 5.).

Table 5. Rules for the classification of suppliers (source: internal corporate documentation)

Score	Status	Criteria	Comments
A	Acceptable	>= 80% in all sections except a minimum of 85% for section 3.0.	Supplier confirming compliance with audit requirements. Also demonstrating high self-discipline and excellent process management.
B	Unacceptable if immediate improvements are not planned and implemented	<80% in all sections except <85% for section 3.0.	The management system processes reflect significant nonconformities in the aspects assessed. The supplier cannot be considered for new / additional ventures if he fails to implement effective improvement actions within the appropriate timeframe.

The part of the form that contains the audit questions is divided into 9 sections. The thematic division and the maximum number of points that can be obtained in each section are presented in the table below (Tab. 6.).

Table 6. Thematic sections of the audit questionnaire (source: internal corporate documentation)

Section	Assessed area	Points
1.0	Strategy and planning	22
2.0	Purchasing	12
3.0	Production supervision	32
4.0	Monitoring and measurement	22
5.0	5.1 Identification and traceability 5.2 Raw material management 5.3 Personnel and training	12
6.0	Maintenance	10
7.0	Calibration	14
8.0	Supervision of documents and records management	12
9.0	Corrective actions and improvement	20
	Total	**156**

The questionnaire contains several dozen detailed questions that would be difficult to quote in full. Therefore, the topics of individual sections are presented in the summary below:

1.0: annual quality objectives, quality costs, specific improvement processes and their measures, quality plans, supervision of the specification and its changes, supervision of changes in products and processes, FMEA and corrective actions;

2.0: supplier assessment, monitoring of the current supplier assessment, procedures for corrective actions in the supplier classification process, purchase specifications, delivery approval system, supply change management system;
3.0: work procedures and instructions, process diagrams, on-site instructions, working according to instructions, special processes, measures and criteria for starting production (startup), organization of the work environment, statistical methods, process capability, control cards, warehouse and logistics procedures, packaging process control;
4.0: input product verification procedures, traceability, inspection and test procedures, output inspection, product audit data analysis, inspection records;
5.1: identification and traceability system;
5.2: homogeneous batches stored separately, adequate storage and FIFO;
5.3: identification of training and training needs, personnel competences;
6.0: maintenance system planning, frequency of maintenance, maintenance records. identification and availability of key spare parts, consideration of TPM methods;
7.0: inspection, measurement and testing of measuring equipment; conditions for carrying out calibration, appropriate criteria; calibration in accordance with international standards; calibration at the appointed dates, as required; appropriate storage of measuring equipment; appropriate actions after the discovery of uncalibrated equipment;
8.0: document control system, engineering and process control and change management system, withdrawal of invalid documents from use, supervision of records, retention time of records, availability of records;
9.0: corrective actions, procedures to identify the causes of nonconformities, analysis and implementation of corrective actions, management of complaints, verification of the effectiveness of corrective actions, use of nonconformity reports for preventive actions, use of information on corrective and preventive actions during management review.

A positive audit result is valid for two years. After this period, the audit results expire and a new audit is required. Result B, obtained as a result of the audit, indicates the need to immediately prepare a corrective action plan. If, after performing corrective actions, the supplier process audit results are still unacceptable, an alternative supplier should be sought.

Upon completion of the audit, the supplier must receive a written report prepared by the audit team, which is an official record of the audit activities. The report should contain the results of the process audit and impose the requirement to carry out the necessary corrective actions to remove or correct the identified weaknesses. Ideally, the report should be submitted to the supplier at the end of the audit, or presented to the supplier within two weeks after the end of the audit.

5. Supervision over the implementation and corrective actions of suppliers

Upon receipt of the report, the supplier should respond with a corrective action plan within 30 days. A process audit is not considered complete until the supplier has identified the most effective and practical solutions to nonconformities identified during the audit and identified the methods of implementing these solutions. The supplier is responsible for initiating corrective actions for all detected nonconformities. This means indicating the causes of nonconformities, taking corrective actions and long-term corrective actions. The supplier should indicate the extent to which this problem has had an impact on its past business and what will be required to correct it. Corrective actions whose success will depend on revolutionary changes in the supplier's resources or drastic changes in the behavior or capabilities of individuals are unacceptable. The supplier is responsible for the preparation of a written response to the lead auditor within the agreed time, including all corrective actions. An initial corrective action plan should be prepared within 30 days of receiving the final report. Reports on the implementation progress of corrective actions should be sent to the lead auditor on a quarterly basis.

Upon receipt of the corrective action report, the audit team leader is required to assess the adequacy of the supplier's response and ensure that corrective actions have been defined for each nonconformity. Additional information should be provided by the supplier, thus confirming that it is working on schedule and that the problems are minimized as the corrective action progresses.

It is possible to conduct a surveillance audit to verify the effectiveness and adequacy of corrective actions that cannot be verified by telephone calls or written documentation. Such an audit does not require the presence of the entire audit team, can be carried out in one day and should focus on corrective actions.

Depending on the need, periodic supervision visits can be carried out to ensure that the results of the process audit have not decreased. Another process audit may be necessary if there is a deterioration in the quality of the supplier's performance.

6. Analysis and evaluation of the supplier qualification process and proposals for improvement activities

The analysis of the supplier qualification process, carried out above, indicates the possibility of introducing changes of an improving nature in order to improve the course of the process. As part of the consultations with representatives of the concern, no information was obtained on the effectiveness indicators of the supplier qualification process.

Undoubtedly, the first improvement action, that should be proposed, is to establish measures of effectiveness (efficiency) of such a process, to set goals for these measures in a given period, and to constantly monitor trends, thanks to which the introduction of other improvement actions could be assessed in terms of their adequacy. Such measures could be, for example:

- ratio of the number of suppliers qualified for each of the categories at the assumed time of the procedure to the number applying for the supplier status;
- ratio of the number of suppliers whose status has decreased to the global number of suppliers on the qualified list for a given assortment.

After introducing process effectiveness indicators, as well as examining their trends for a period of at least twice the average time of supplier qualification, improvement projects can be implemented, based e.g. on the Six Sigma methodology, i.e. consisting of the phases of defining the issue to be improved, making appropriate measurements, aimed at assessment of the actual state, making detailed analyzes to indicate the stages of the project, their products and acceptance criteria. The next phase is the phase of implementing the adopted solutions. The last phase is the phase of supervision, implementation control, along with the possibility of comparing the values of the measures and their trends, the status before the changes were introduced with those after the introduction.

As a result of the analyzes, the proposed improvement projects could be:

- simplification of the "20 Steps Procedure" – the procedure is very tedious, time-consuming and detailed. It provides a large amount of information about a potential supplier. However, it is not known whether such a large amount of information is used by the group. In the measurement and analysis phase of the improvement project, it could be proposed to reduce the supplier information that statistically has the smallest impact on the correctness of the decisions made in step DP1 and DP2. This is of course only possible when there is a sufficient amount of comparative data. which, with the use of an effective statistical tool, would indicate the directions for carrying out activities related to the re-engineering of the analyzed business process [6][7][8][9]
- introducing an electronic system of surveying potential or already qualified suppliers, operated, for example, via a web browser. The analyzed materials indicate a very precise and unambiguous formulation of the requirements for suppliers, however, getting to know all the issues that make it possible to properly disclose data to the concern is very time-consuming. It requires the supplier to read more than a few hundred pages of documentation. The introduction of the possibility of providing data by filling in electronic questionnaires, equipped with a context menu, drop-down lists, an extensive hint system (help), could reduce interpretative differences in terms of the group's requirements, as well as faster and more effective cooperation between the sales departments of suppliers (or customer service) and the group's central Procurement Department. The artificial intelligence methods can be also used for procurement process improvement [10].
- by expanding the IT system proposed above with the ability to track the supplier's profile in the group's system, i.e. quick access to the results of audits, data on agreed corrective or preventive actions, the ability to quickly enter information about current implementations, the ability to simulate the status that the supplier can obtain after introducing the anticipated changes to the system and production processes [11]. An interesting solution would also be the introduction of benchmarking lists so that the supplier could compare his status – the results achieved in individual criteria – with the average obtained by other suppliers of the indicated assortment.

7. Conclusions

The described concern, gaining experience in cooperation with various organizations, both suppliers, customers and partners, during several dozen years of operation in the business reality, has developed, among others, rules defining the processes of dealing with suppliers. They were built back in the times, when the standards the company uses today did not exist in their present form. Using best practices, this global organization anticipated most of the wording that can be found in ISO 9000, 14000, TS and other standards. Of course, it should be remembered that standardization bodies did not work in isolation

from the business reality. Bearing in mind the size of the organization, as well as the scope of operation in 150 countries around the world. one can confidently put forward a thesis that the concern and the rules prevailing in it could have a significant impact on the management systems used today in global corporations and could be reflected in the normative acts concerning management systems.

The presented system of supplier evaluation and qualification seems to indicate a rather cautious approach of the concern to the admission of new suppliers of components or semi-finished products.

Criteria. used in this area are very critical, but formulated in a very clear and transparent manner, understandable both for the company's auditors and for current and future suppliers. The "20 Steps Procedure", as well as the principles of auditing, are very precise and leave no doubts of an interpretative nature. This does not mean, of course, that the concern will not develop the presented methods of conduct as part of its improvement activities. In accordance with one of the principles of quality management: the concern provides an excellent tool for improving the supplier organizations and in return gains reliable, effective and loyal suppliers.

As presented in the analysis section, the supplier evaluation methodology used is very detailed and generates a large amount of information. Future considerations could concern analyzes related to the identification of the most significant data, the behavior or trends of which would indicate methods of qualifying and dealing with suppliers. In the current geopolitical situation, data that have not been taken into account so far may turn out to be particularly important, but may have a critical impact on the continuity of the supplier's customer processes [12] [13].

Bibliography

1. Shewhart Walter Andrew, William Edwards Deming. *Statistical method from the viewpoint of quality control.* Courier Corporation, 1986.
2. Kuczyńska-Chałada M., Odlanicka-Poczobutt M., Poloczek R. "Qualification of suppliers in a selected production enterprise." *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska* (2020).
3. Nowakowski T., Werbińska-Wojciechowska S. (2012). *Przegląd metod ocen i wyboru dostawców w przedsiębiorstwie*. Logistyka, Vol. 2, 945-955.
4. Zakrzewski B., Zakrzewska D. (2014). *Rola zaopatrzenia i metodyka wyboru dostawcy w działalności przedsiębiorstw przemysłowych*. Logistyka, Vol. 3, 6977-6999.
5. Wolniak R., Skrotnicka-Zasadzień B. (2008). *Wybrane metody badania satysfakcji klienta i oceny dostawców w organizacjach*. Wydawnictwo Politechniki Śląskiej.
6. Parthiban P., H. Abdul Zubar, Chintamani P. Garge. "A multi criteria decision making approach for suppliers selection". *Procedia Engineering* 38 (2012): 2312-2328.
7. Prabhu Sneha, Tugrul U. Daim, Dirk Meissner. "Effective Qualification of Suppliers in Manufacturing." *Innovation Management in the Inteligent World*. Springer, Cham, 2020. 181-198.
8. Sarkar Ashutosh, Pratap KJ Mohapatra. "Evaluation of supplier capability and performance: A method for supply base reduction." *Journal of Purchasing and supply management* 12.3 (2006): 148-163.
9. De-Pablos-Heredero, Carmen, Gonzalo Fernández-Valero, Miguel Blanco-Callejo. "Supplier qualification sub-process from a sustained perspective: generation of dynamic capabilities." Sustainability 9.5 (2017): 730.
10. Mehrdokht Pournader, Hadi Ghaderi, Amir Hassanzadegan, Behnam Fahimnia, "Artificial intelligence applications in supply chain management", *International Journal of Production Economics*, Volume 241, 2021, 108250, ISSN 0925-5273,
11. Jain Rajeev, et al. "Using data mining synergies for evaluating criteria at pre-qualification stage of supplier selection." *Journal of Intelligent Manufacturing* 25.1 (2014): 165-175.
12. Nunes Mauro Fracarolli, Camila Lee Park, Ely Paiva. "*Keeping key suppliers alive during the COVID-19 pandemic: artificial supply chain resilience and supplier crisis response strategies.*" Continuity & Resilience Review (2021).
13. Schiele Holger, Petra Hoffmann, Thomas Körber. "*Synchronicity Management: Mitigating Supply Chain Risks by Systematically Taking Demand Changes as Starting Point—A Lesson From the COVID-19 Crisis.*" IEEE Engineering Management Review 49.1 (2020): 55-62.