Improvement Method of Subcontract Phase of Production Process in IT Production Management System – Case Study

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Abstract. A subject of the paper is a model of production process in IT production management system, presented in simplified form of items flow diagram through technological operations and stores between operations.

Observational research as well as data error reports created for administrator of IT production management system, were carried out under real conditions of company of producing machine parts. This research provided with the knowledge about quality of information given to the IT system users involved in planning process, manufacturing control and production management.

The aim of the paper is to improve a subcontracting phase of the analyzed model of the production process in IT system and its graphical presentation in the form of items flow diagram.

The presented diagram illustrates improved flow of items through technological operations and stores between operations in the production process, improving in this way planning process, manufacturing control and production management by providing better quality information.

Keywords: Organizational method · Scientific research methodology
Organizational problems solving · Subcontracting phase · Improvement method
Production process model

1 Introduction

Based on historical data, a statement can be made, that from the beginning of their existence, human beings had an ability to organize and manage their activities. It was closely related to the intentional use of the tools necessary to perform day-to-day activities. Awareness of a possibility to manage operations more efficiently and a need to use better tools, has contributed to the development of innovation in the area of organization and management.

Organizational activities, carried out in a spontaneous manner, depending on the innate abilities of leaders were not a part of any methodological framework. The origins of a scientific approach can be found among ancient thinkers who proclaimed the principles of efficient operation, which is a generalization of a practical experience in various fields of activity: economic, administrative, military, exploratory.

R. H. M. Goossens (Ed.): AHFE 2018, AISC 792, pp. 375–385, 2019.
https://doi.org/10.1007/978-3-319-94000-7_38

2 Main Directions and Theories of Improving Organization

Making a review the main directions and theories of organization and management, one can say that the classic approach at the problems of the organization included two main directions: scientific management, focused on the organization's employees and on ways of improving their productivity, and administrative management, focused on the organization and on the ways of making it more effective and efficient [2–7, 15, 16, 18].

Most of theoreticians of the classical view focused on controlling and standardizing the behavior of these units. On the contrary, the behavioral approach focused on individual attitudes and behaviors and on group processes. Behavioral perspective has provided important conclusions from the field of motivation, job satisfaction, stress, leadership, group dynamics, organizational policy, human conflicts and organizational structure [2–7, 15, 16, 18].

During World War II, special teams were formed, whose task was to support an army to use war resources more efficiently and more effectively. This approach uses the quantitative methods in management, hence the name quantitative perspective.

Quantitative perspective can be divided into two directions: quantitative management theory and operational management [3, 16].

Quantitative management theory focuses on the development of mathematical models which represent a simplified model of the system, process or relationship. Mathematical models of quantitative management theory often provide support for decision making processes and solving management problems.

Operational management is used to assist organization in effective production of products and services.

Approaches to management: classical, behavioral and quantitative, although each of them has different assumptions and often may give different results, can still complement one another. A proper understanding of management requires sometimes an approach which integrates all other approaches. Such perspective can be divided into systemic and situational [3, 16].

Systemic perspective assumes treating organization as a whole, that is an mutually connected sets of functioning units.

The second type of approach to management – situational – suggests that universal theories such as classical, behavioral and quantitative approach, are not applicable, because every organization is different, and decision making and behavior of the Management are conditioned by unique elements, characteristic only for a given organization.

3 Organizational Method

Colloquially the method is referred to a way of proceeding, intentionally, consistently and systematically used; a set of activities and resources used to achieve a goal; a way of performing a task, solving a problem; a set of general assumptions accepted in specific research. Mikołajczyk [14] defines this term as "a rational and systematic proceeding, which is used to do or to say something".

An interesting concept of a method is presented by Martyniak [10], who says that "a method cannot be too sharply drawn, because excessive precision annihilates it. A method should determine the way it behooves us to follow and it should pave several possible routes, maximizing the chances of success in problem solving with the current state of knowledge".

Lis [8] explains these concepts with the following words "by a method we mean a procedure used to achieve a particular purpose, a conscious and repeatable manner, systematically applied in all cases of a given type. (…) A technique, in this case, means defining tangible resources, such as tools, equipment, patterns, diagrams, etc. applicable in a given type of work. These tools may include here all kinds of forms, diagrams, physical models, mathematical models or specialized equipment, etc.".

Martyniak [9] analyzing a method at different levels of generalization, indicated the correlation between method and technique, saying that at the highest level, a method is close to a general rule, such as the one resulting from an organizational cycle of Le Chatelier. At a lower level, there are methods of modeling, and at the lowest, the routine ways – patterns of action, which can be represented by strict schemes that is techniques [11, 13].

In many cases can be found a term "scientific method", meaning such which "is used regularly, often in investigation of different problems, using results of research to create theoretical generalizations or empirical verification of set hypotheses" [10].

A scientific method is therefore a general scheme of research proceedings, which should include more specific (detailed) patterns, that is techniques of proceeding with regard to the analyzed reality.

"Organizational method is a systematized proceeding, based on scientific principles of research, which is intended to solve problems" [10]. Achieving this goal is facilitated by the use of organizational techniques, by which it should be understood the specific patterns of conduct. They consist of two basic elements:

- research instrument in form of a graphical model, physical model, mathematical model and specialized equipment,
- manner of using this instrument to complete the assumptions of the method.

4 Sources of Contemporary Scientific Research Methodology

The great seventeenth century philosopher, René Descartes, in the Discourse on the Method, presented rules pertaining to methods of conducting scientific research, gathering information and reaching synthesizing solutions. They are nowadays accepted as universal and used in various areas of knowledge.

The major rules of methods, according to Descartes, are expressed as follows [1]:

- The first rule says that assessment of facts (research subjects) should be reliable, and the investigator should record only the facts, and not what he considers as facts. This is a principle that is applied in establishing the facts for a diagnosis of a status quo, and then in solving problems and formulating reliable conclusions about the status quo (critical assessment and analysis), and creating projects of changes.

- The second rule it is a method of analysis, which is regarded as a scientific method of recognizing the reality. Introduced for the first time by Taylor to investigate the course of work, this method allowed to accurately recognize the reality, to determine deficiencies and to design a new reality.
- The third one it is a universal method of scientific synthesis used in all fields of knowledge, but also in the classic Le Chatelier's organizational cycle [6, 19] when creating concept of a new organization.
- The last one it is a principle of strict registration and inspection for the sake of creating new reality. The acceptance of this rule is proven by the fact of creation of numerous techniques for event registrations in a graphic, tabular or mathematical form.

Every rule of the Cartesian method has an equivalent in methods empirically developed by the authors of the scientific basis of management organization, which can be defined, with certain extent of generalization, as diagnostic, analytical, synthesis, and maintenance and control phases of the research method.

The use of the seventeenth-century methods of rational, Cartesian's conduct combined with practical experience of the turn of nineteenth and twentieth century, contributed to formation of a classical method of organizational proceeding. A starting point for a general method of organizing activities were Taylor's works, who proposed for a manufacturing facility management a cycle of conduct, called an "elementary analysis" or "methodology of work process research". The first organizational methodology involved the following steps [10–12]:

- division of investigated process into the smallest elements,
- observations and measurements,
- filtering analysis, which aimed to keep essential elements in the process and to eliminate any unnecessary ballast,
- organizing the process and determining standard times of realization.

It was reflected in a so-called "organizational cycle" of Le Chatelier, which for many years was the basis of organizers' proceedings. It consisted of five stages [9, 11, 13]:

- choosing a goal to be achieved,
- analyzing resources and conditions which have to be used (created) to achieve that goal,
- preparing the resources and conditions which were found necessary,
- completing the goal according to a plan,
- controlling the results.

A study of working methods consists of recording, analysis and evaluation of existing or designed work practices. The goal of the study is to find and use the most effective methods of work. The set of activities related to the study of the methods of work includes [8, 10–12]:

- selection of a goal and object of research,
- gathering (registration) the facts,
- critical analysis and evaluation,
- designing a new method,

- implementation of the new method,
- monitoring of the development of the new method.

5 Typology of Methods of Organizational Problems Solving

In the literature of the subject the terms "strategy", "methodology" and "approach" are used interchangeably to define a general method of organizational problems solving.

The first typological attempts distinguished: classical, diagnostic, social, systemic, prognostic and situational approaches [10].

Another classification [14, 16, 17] encompasses three basic approaches called analytical method, synthetic method and situational method.

In the analytical method (diagnostic) a base of creation is a detailed analysis of existing system components. It is based on collecting and registration of characteristic features of the existing organizational solution. A current state is a starting point for a future project, which in the most cases comes down to a rationalization of organization and assumes solving the deviation and optimization problems.

In the synthetic method (prognostic) the starting point is a concept of a new (ideal) system, usually completely different from existing ones. All preliminary stages are skipped here, and taken into consideration are functions (goals) of a new system.

Situational approach is understood as a need to adjust the organization to internal and external conditions of its functioning. That makes it impossible to discuss the universal ways of creating and managing organizations.

An interesting attempt to systematize the methods of organizational problems solving is its "strategic" division into two groups: ideological and structured. The ideological methods, which incorporate the essential idea of organizational proceeding, could be called an "approach". The structured methods, containing further specification of steps (stages, phases) of conduct and possibly a specification of principles, methods, techniques and indications corresponding to individual steps, would be called "general methodology" [10].

The general methodology of solving organizational problems, may be based on three types of approaches [16]:

- descriptive-improving,
- functional-modelling,
- diagnostic-functional.

A descriptive-improving approach is characterized by the fact that the leading position in organizational proceedings is taken by registration of an actual state. An example of such approach is Taylor's elementary analysis. In this approach, empirical data collected in a course of observation is subjected to a critical analysis and evaluation in order to find possibilities of improvement.

General methodology of organizing, based on descriptive-improving approach, is usually called in literature a classical or diagnostic approach.

A major role is played by registration of facts and critical analysis and evaluation of a current state, that is why a lot of attention is paid to sources and methods of gathering

information. In methodologies based on a descriptive-improving approach, the source of information of critical importance is believed to be the functioning of the analyzed organizational system. Data regarding this issue is obtained with a use of various methods and techniques such as direct and indirect observation, interview.

A functional-modeling approach – an organizer is thinking here: what purpose does an organization system serve? This approach prefers the method of idealization. An example of this approach in organizing is a method of ideal solutions of Nadler.

General methods of organizing, based on a functional-modeling approach, in the literature are usually given the name of systemic methods. Their creation is associated with limitations of descriptive-improvement approaches. First attempts to overcome the limitations were undertaken together with a use of operational research to the analysis of organizational systems. Construction of mathematical optimization models determined a major change in a scope, selection and methods of gathering information about analyzed organizational systems. The entering values of economic parameters to a previously constructed general model, allowed to define the optimal organizational solutions.

Another trend, beside operational research, which paved the way for functional-modeling approach in organizing, was value analysis. Starting point for changes in an analyzed system should be not as much the registration of an existing situation but the identification of functions performed by the system.

A diagnostic-functional approach – a critique of functional-modeling approach and difficulties and even failures in its practical application caused the methodological concepts to emerge, which sought to accommodate a descriptive-improving approach with a functional-modeling approach. The combination of Taylor's classical approach with Nadler's concept of ideal solutions gave rise to a new organizational approach, which used identification and analysis of functions of organizational systems, and even the method of idealization in finding optimal solutions, starting from a detailed description and analysis of the existing state.

To conclude the above presented general methods of solving organizational problems, it can be attempted to systematize organizational activities containing certain stages, for which the starting point is a formulation of a goal and the final point – obtaining positive results. Basic steps consist therefore of the following four phases [16]:

- identification of the problem and diagnosis,
- searching for solutions,
- making a decision,
- evaluation of effects of changes.

A diagnosis phase aims at formulating a problem as a result of analysis and diagnosis of the existing state. It defines the research objective and constraints that may occur in its solving, criteria that will be taken into account in evaluation of solutions' variants. This phase also encompasses a preliminary study, which task is to determine the nature, size and complexity of the problem and finally the scope and nature of changes that should be implemented as a results of the research procedure.

A research phase – collected, compiled and analyzed information and resulting conclusions are the basis for creating variants of concepts of problem solutions. This

phase should also include an initial assessment and selection of variants of applicable concepts and their arrangement according to previously accepted criteria.

A decision making phase includes choosing one of the previously compiled and evaluated variants of solutions. The chosen variant should be carefully designed and implemented in practice.

An assessment phase is related to observation of functioning of the new solution and a revision, if needed.

6 Subcontracting Phase in IT Production Management System

A subject of the paper is a model of production process in IT production management system, presented in simplified form of items flow diagram through technological operations and stores between operations.

To properly understand the essence of the discussed process, it should be clarified that each phase of the production process in the IT system consists of three elements: a production line and two stores, one located in front of the line (shop store) and another one behind the line (store). In the store in front of the line there is a material, components or semi-finished products depending on phase of the production process, and in the store behind the line there are finished products (items) within a specific phase of the production process. The production line is a set of technological operations defined as a one-way flow.

The material needed for production in the IT system is moved from the main warehouse to the appropriate shop store in front of the production line within the specific phase of the production process. Then a production order for the line is opened. At the same time a purchase order (PO) is placed for a subcontracting operation for the products (items) manufactured on the production line mentioned above. After the subcontracting operation performed the items are received to the warehouse in the IT system, and strictly speaking they are registered in the shop store in front of the line. Finished products (items) are registered in the store behind the line or directly in a shop store in front of production line next phase of the production process, when the items are further processed. The process mentioned above is shown in the Fig. 1.

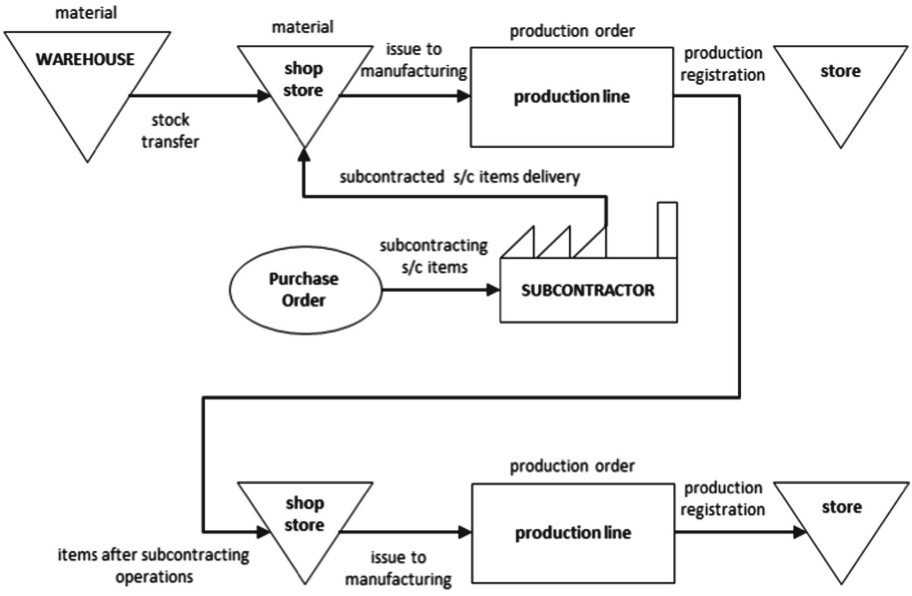

Fig. 1. Items flow diagram in a model of production process in IT system (subcontracting phase - current state)

Analyzing the production process model one can notice a lack of detailed information about various stages of the subcontracting process in the IT system. The generalness level of the process gives only a possibility to read from the placed purchase order (PO) information about the items quantity sent to subcontracting, on the other hand there is no data on the items quantity, that have returned from the subcontracting, because the receiving to shop store process of the items does not change the stock level. The coming back from subcontracting items are not issue to production like other materials or components, but they "disappear" during the shop store process receiving, and a cost of the subcontracting service is included in the production line costs.

Should be clarified here what the product structure (bill of material) looks like. The final product, for the production process phase mentioned above, has got two components in its structure: a material and the subcontracting item with a prefix "s/c". Setting parameters in the IT system contributes to the fact that the finished product registration in the store behind the production line causes an automatic diminishing of the material level in the shop store. The s/c item stock level in the shop store is not diminished by the IT system, its inventory is always null. From a production planning point of view, subcontracting process control in the IT system is inaccurate.

7 Improvement Method of Subcontracting Phase in IT System

The new improved model of the production process in the IT system must provide information on various stages of the subcontracting process from the point of view of the IT system mentioned.

Figure 2 presents a proposal to improve the mentioned process. The material needed for production in the IT system is moved from the main warehouse to the appropriate shop store in front of the production line within the specific phase of the production process. Then a production order for the line is opened. At the same time a purchase order (PO) is placed for a subcontracting operation for the products (items) manufactured on the production line mentioned above (items with the prefix "s/c"). The material located in the shop store (in front of the line) is now moved to the store (behind the line) so to the finished product store within this phase of the production process, along with a note on subcontracting. A case when the material for production is located in the store of finished products, it is a signal that an error, anomaly appeared in the IT system in a normal situation. Usually it is caused by human factor. Now in the new model it is an information the material was sent to the subcontractor. This is the information of both qualitative and quantitative nature because it provides information of fact that the real shipment was done, and about the volume as well.

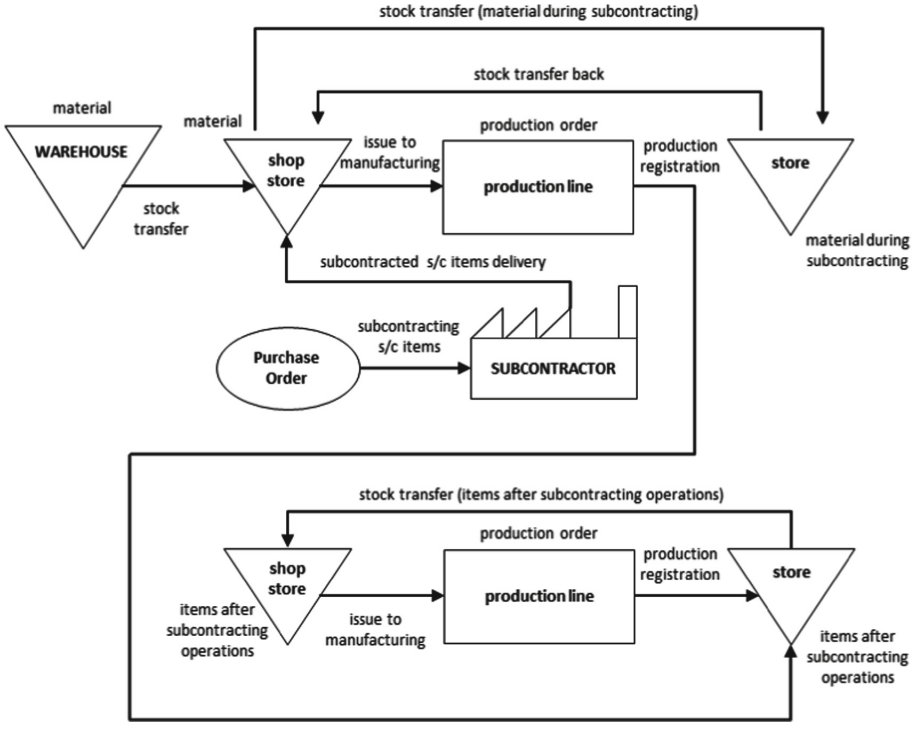

Fig. 2. Items flow diagram in a model of production process in IT system (subcontracting phase - improved state)

After the subcontracting operation performed the items are received to the shop store in the IT system and "disappear", and a cost of the subcontracting service is included in the production line costs. At this point it is necessary to move the material back from store (finished products store) to the shop store (in front of the line). The material returned to the right place from the IT system point of view. The finished product registration in the store behind the production line causes an automatic diminishing of the material level in the shop store. The subcontracting item stock level in the shop store is not diminished by the IT system, its inventory is always null. An originality is now the place where the finished products are registered now in the IT system, in fact the products that have just returned from the subcontracting. They are registered now in the store of finished products next phase of the production process along with a note on subcontracting. The case is analogical that was described earlier about the material moved (stock transfer) to the finished product store. It is of course the signal that an error, anomaly appeared in the IT system in a normal situation. Now this information provides knowledge that the items returned from the subcontracting service and they are available for the next phase of the production process. Parameter settings in the IT system make the material, components, semi-finished products can be released for production only from shop store, so move the items returned from subcontracting from the store to the shop store remains to be done.

8 Conclusions

Presented in the article the model of the production process in the IT production management system, shown in simplified form of items flow diagram through technological operations and stores between operations, provided with the knowledge about quality of information given to the IT system users involved in planning process, manufacturing control and production management.

A specific principle of the IT system operation, settings parameters and lack of knowledge about a way of subcontracting phase of the production process conducting in the IT system caused that the original model was designed in a very general way. The IT system did not provide detailed information about each stage of the subcontracting process. The concept of making material and subcontracting items transfer between shop store and store provides quantitative and qualitative information of particular stages of the subcontracting process. The items flow through technological operations and stores between the operations, is now more readable and precise. It contributes to easier and more effective planning, control and management of not only the subcontracting process in the IT system, but also other related processes.

To improve the operations in the IT system, the analytical (diagnostic) approach was used, also known as a descriptive-improvement approach. The carried out analysis of components and operation principles of the existing production process in the IT system model, was based on collection and registration distinguishing features of the current solution. The empirical data gathered during observation is subjected to critical analysis and evaluation in order to find opportunities for improvement. The current state had become a starting point for designing the future project.

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