

Automation of records of production activity of organization due to application of M-way tree structure

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Abstract – Keeping records of production activity of small and medium-sized enterprises is realized by management of documents of work orders, requests and return receipts. Automatic generation of work orders can be realized by application of normative document, which represents specification of materials and work operations necessary for production of product unit. Work orders linking and application of M-way tree structure in the process of generation, enables automation of registering of production activity. It is possible to precisely define lacking amounts of semifinished products which are necessary for realization of production plan as well as to automatically generate work orders for their production. Linking of work order documents gives another possibility for generation of total requests for entire production series, which makes the control of production process easier. If above-mentioned principle of documents linking is expanded and mechanism for transferring of offer documents to the customer into series of work orders, it is possible to automate entire production process from the moment of customer's consent to the offer to the moment of selling.

I. INTRODUCTION

Production represents process of combination of production factors with the goal of making products which satisfy human needs. Factors which make production process are: material, energy, technology, time, capacity and production organization.

Regardless of the type of activity (command, serial or mass), production process is based upon production plan. Production plan contains information on the type of products and their amount, raw materials used in the production process, the type of processing machines and the type of labor necessary for successful realization of production process. Production plan also represents basis for setting of production cost. Final product, as the result of production process is prepared for distribution, and preparation process includes definition of selling price which includes production costs, as well as energy costs, labor, packaging and transport costs and other factors which have influence on selling price.

From the point of view of business information system, intended for small and medium-sized enterprises, production activity is defined with series of documents which describe production process. Each of them has influence on the state of one or more entities of the system: production, storehouse and customer.

In order to ensure simplicity of application, which represents external factor of software quality [1], it is necessary to structure documents according to mutual pattern.

Types of documents used for description of production activity within information system are:

- **Normative document**, which represents documents which contains information on amount of materials and work operations necessary for production of product unit.
- **Work order**, which represents document based on normative document, as well as the basis for making of production plan. Work order realization marks the ending of one phase of production cycle.
- **Request for material**, which represents document that defines raw materials consumption during the production process.
- **Material return receipt**, which represents document that is used for necessary correction and matching of potential difference between the amount of material defined by normative document and the amount of material used in the production process.
- **Receipt**, which represents document that places final production into the storehouse.

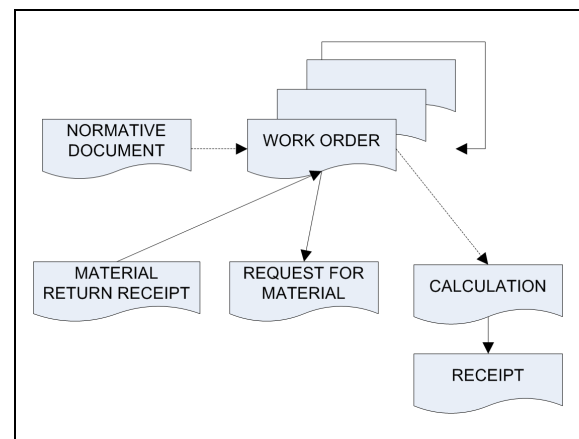


Figure 1. Interaction between documents which describes production activity of organization

- **Calculation**, which represents document that defines selling price of final product.

According to normative document, Fig. 1, work order document is generated, which is, according to available state of semifinished product, linked to other, automatically generated work orders.

Control of material consumption during production process is done with documents of request and material return receipt. Receipt for produced amount of final product is made in the ending of production cycle and work order closing out. In order for final product to be available for distribution and for automation of production to be complete, calculation of selling price must precede receipt document. Calculation document must be generated because of the fact that receipt burdens the storehouse, but it does not make further distribution possible, if selling price is not defined.

II. DOCUMENT STRUCTURING

Each document within information system contains heading and items. The heading contains information important for unambiguous identification, as well as link to some of the entities of the system: product, storehouse, or customer. Document items contain products and services, i.e. work operations, as well as rebates, margins, amounts, purchase and selling prices, according to the type of the document.

Normative document represents key document in the process of automation of registering of production activity of organization. There must be at least one normative document for each product from production selection. Key attribute of the heading of normative document is final product, whereas the items contain material and work operations necessary for production of product unit.

If there is normative document for material from normative document items, this material is considered to be semifinished product. This characteristic enables automatic generation of work order documents for lacking amounts of semifinished products. If this characteristic is generalized, it is possible to automate transferring of offer documents into series of work orders for production.

Automatic generation of documents due to application of normative for production gives us the following

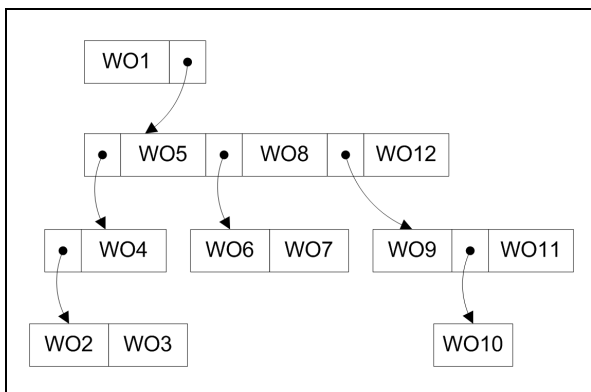


Figure 2. Linking of automatically generated work orders

structure (Fig. 2), whereas during the process of generation of work orders for each semifinished product you have to go through items of normative document and generate work order, if it is necessary.

Original document (WO1 in Fig. 2) generates unbalanced tree according to connections between normative documents and available amount of semifinished product in storehouse. There are two possible scenarios at the moment of automatic generation of work orders:

- you can generate work orders for production of lacking amount of semifinished product regardless of available state in the storehouse.
- you can generate work orders for production of amount which represents difference between necessary amount of semifinished product in order for production process to be successfully realized, and available amount in the storehouse.

Key is assigned to each generated work order. It is the number which follows the prefix WO in the Fig. 2. According to Fig. 2 we can conclude that:

- all key values belong to ascending order
- all values of keys in the nodes of left tree are lower than values of the key of observed node.
- all values of keys in the nodes of right subtree are higher than the value of the key of observed node.

According to [2], the structure with above-mentioned characteristics represents M-way tree.

Even though the balance of the tree has significant part in performances, in this case the tree is generated according to normative documents, whereas their mutual dependence is defined by user according to characteristics of each item from production assortment, so that the system does not balance the tree.

III. AUTOMATIC GENERATION OF WORK ORDERS

The process of automatic generation of work orders is based upon normative documents. During the process of processing of work order for each item of the document, it is checked if there is a normative for production, and if this is the case, available amount in the semifinished product storehouse is checked. If available amount of semifinished product is not sufficient for realization of production of item from original work order, work order for production of lacking amount of semifinished product is automatically generated. If this process is repeated for each item of original work order, as well as for each item of generated work orders, M-way tree of work orders is made by linking of documents.

According to [3] part of the process of automatic generation of documents can be presented by SDL diagram, Fig. 3.

Production plan demands extra effort in the process of definition of production normative. Machines and tools used during production process should be precisely

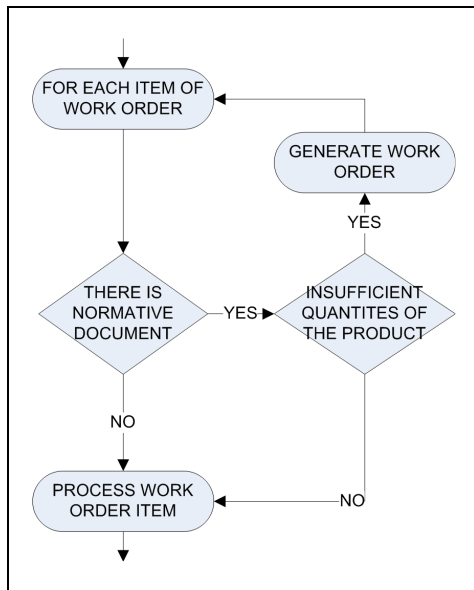


Figure 3. SDL diagram of the part of the process of automatic generation of work orders

defined, as well as the set of work operations executed by them, their mutual correlation and period of time needed for each particular operation. In order to avoid unnecessary multiplication of documents [4] and make the work easier, production scheduling is realized by linking of automatically generated documents. Therefore, information system recognizes original document and knows that its final stage depends on the realization of all automatically generated documents made during the process of making of original document. Part of the process of scheduling is transferred to user since three basic states are added to documents of work order. Work orders can be divided in three basic categories, i.e. states, so that precise registering of production activity would be ensured:

- open work orders,
- work orders in production,
- closed work orders.

Open work orders represent basis for generation of production plan. They give answer to the question what is going to be produced during the following production cycle and which material and semifinished products are needed for successful realization of production. Linking of production plan with available amount of raw materials in storehouse makes automation of purchase process possible, so that slowdown during the production could be avoided.

Arrangement of work orders in the category of work orders in production registers the beginning of production cycle. Requests and return receipt for material can be made only for work orders which belong to this category. The structure of M-way tree becomes even more significant since it enables automatic transferring of all suborders from open category to work orders in production category during the process of transferring of original work order from one category to another. Even though material request can be made separately for each work order, connection between original and

automatically generated work orders enables generation of the document of total request for material for original and all automatically generated work orders.

Transfer of work order from the category work order in production to category of closed work orders, ends production cycle for original and all automatically generated work orders. In case there are no documents of material requests for selected work orders, information system will automatically generate document of total request with amounts of material according to all linked work orders. Registering of production cycle ends with generation of documents of receipt and calculation for each work order.

Receipt document places produced amount of product in suitable storehouse, whereas produced amount of product is available for further production, construction or distribution due to calculation document.

IV. ADVANCING OF THE PROCESS OF AUTOMATIC GENERATION OF DOCUMENTS

Generalization of the principle of automatic generation of work order according to normative document and mutual linking of original and automatically generated work orders makes automation of registering of production in cases when production is intended for familiar customer, possible. According to items of offer document, which contain offered series and selling price, it is possible to generate series of work orders for production. In order to maintain high level of automation and enable automatic copying of change of state of linked documents during the change of the state of original document, work order must be changed and entering of document of work order which does not have defined article which represents final product in the title, must be enabled. Original document of work order, in this case, would contain items which would be copied from offer document, whereas the process of automatic generation of work orders and their manipulation would stay unchanged.

According to the type of production, changing of some characteristics of final product (such as length, color, structure) could be enabled according to special demands of customer, during the making of an offer. Such change would be made according to flexibility of existing production process and it would result with generation of new normative documents and their linking to offer documents. Normatives which are made according to customer's demands would be used in the process of transferring of an offer into the series of work orders for production, instead of normatives which were previously defined.

V. CONCLUSION

Automatic generation of documents of work orders and their linking into structure of M-way tree makes high level of automation in the process of registering of production activity of small and medium-sized enterprises possible.

Even though, generally speaking obtained M-way tree is not balanced, this structure enables effective approach to linked documents, which directly influences total performances of the system. The entire process is based upon normative document which directly influences all parts of production cycle, from production plan making to the request for materials which are used for final product making. Thus, user can more easily adopt knowledge necessary for correct system functioning.

Automation of management of documents used for definition of production activity of organization, and enabling the user to schedule production, as well as to correct the function of production cycle, easier introducing

of information system is enabled, as well as faster registering of production activity and significant support in the process of production management is obtained.

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