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Reorganization of Existing Business-Information Model in Purpose to Improvement Production Process

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1. Introduction

Production processes supported by IT systems, improve the organizational structure of production with better insight into all aspects of production; and provide planning, monitoring and managing with all phases of production flows. The goal of this work is to investigate the current state of the production environment (working people, manufacturing resources, the material used ...) and suggest the information models which will improve the existing state.

The results of simulation experiments locate the congestion and bottlenecks of production, suggest and provide guidance for further development of complex information flows of production. Furthermore, that structure refers to the creation the production of feedback information generated in the actual environment, and thus become the correction factor to the production-entry zone.

It is assumed that within the information systems except than finished products that require a small number of business operations and phases, can be processed and inquiries about the complex finished products (where have lot of different production operations and materials needed to obtain the finished product). To make such a production cycle to be effective, it's requires a minimum level of knowledge about the creation and manufacture products by the external client that defines the query, because it is based on the confirmed offer runs a complex manufacturing process of projecting and managing of production flow to produce the ordered product. In this report wants to give the proposal a few information models that will automate and simplify making of business documents in order to reduce the time required for their production.

2. Conditions of construction of information-production structure

In current situation is also included set up information organization which is fundament for the further upgrading and updating with new information flows. By this, it's includes the definition of flow for automated creation of production business documents; for both internal and external business correspondence. Furthermore, with advanced production - business information systems with a high degree of automation it's allows the generation of complete documents or records (eg, queries, quotes, job orders, production reports ...) according to external inquiries by clients through the web interface.

With that is necessary and a minimum level of knowledge about the project layout and manufacture products by the external client that defines the query, because on the confirmed offer runs a complex manufacturing process of projecting and managing the production flow of the final product. It is also proposed to implement the subsystem for feedback production information which can have affect on the input values for the appointing calculations of the finished product. Through this subsystem it made a correction of the set current value to getting a new planning and calculation production parts. Implementation mechanism of the efficiency of production it can expect a significant influence on getting quick and accurate financial and statistical status of resources to additionally contribute to the management and establishing the development direction of organizational structure.

3. Basic Information model

In the first phase of building a information system there is only one database, which includes limited minimal elements for projecting and planning of production processes. Figure 1 shows the initial phase of information system under which they achieved the minimum requirements of the functioning of the productive structure (cost of materials and production resources). Under financial and material-financial system is provided capturing all input materials, articles, finished half products with the corresponding cost and the manufacturing specifications for the finished product. It's also included the creation offer to customer basic on the elements and inquiries through the making production calculations.

Through such a basic system the time required to produce a final offer request conditional on the complexity of the finished product. Increasing the number of necessary operations and different materials to produce the finished product is conditioned by the increase in working time required to produce final offer. From this existing base model is created order, work order for production, and complete final activities at the finished work order (post calculation estimates, billing and complete material and financial reports).

On daily bases production comes to the greatest congestion in the preparation of project offer and daily reporting about actual production activities; financial and results about the production efficiency. Increased number of inquiries on a daily basis requires significant expenditure of time working people for their preparation, and with that it's open space for the introduction of additional information subsystem for the automated preparation of production calculations. Except the final offer, from this subsystem is also expected to give automated the time listing of all production stages and production operation, and complete listing of all materials which is a implement in final product.

From this record will be created an orders for the necessary materials and any additional external manufacturing operations that cannot be realized in own production structure. From the manufacturing subsystems is created a work order which becomes the final document; which included all information about projecting and making final products with all operations and materials at each production stage.

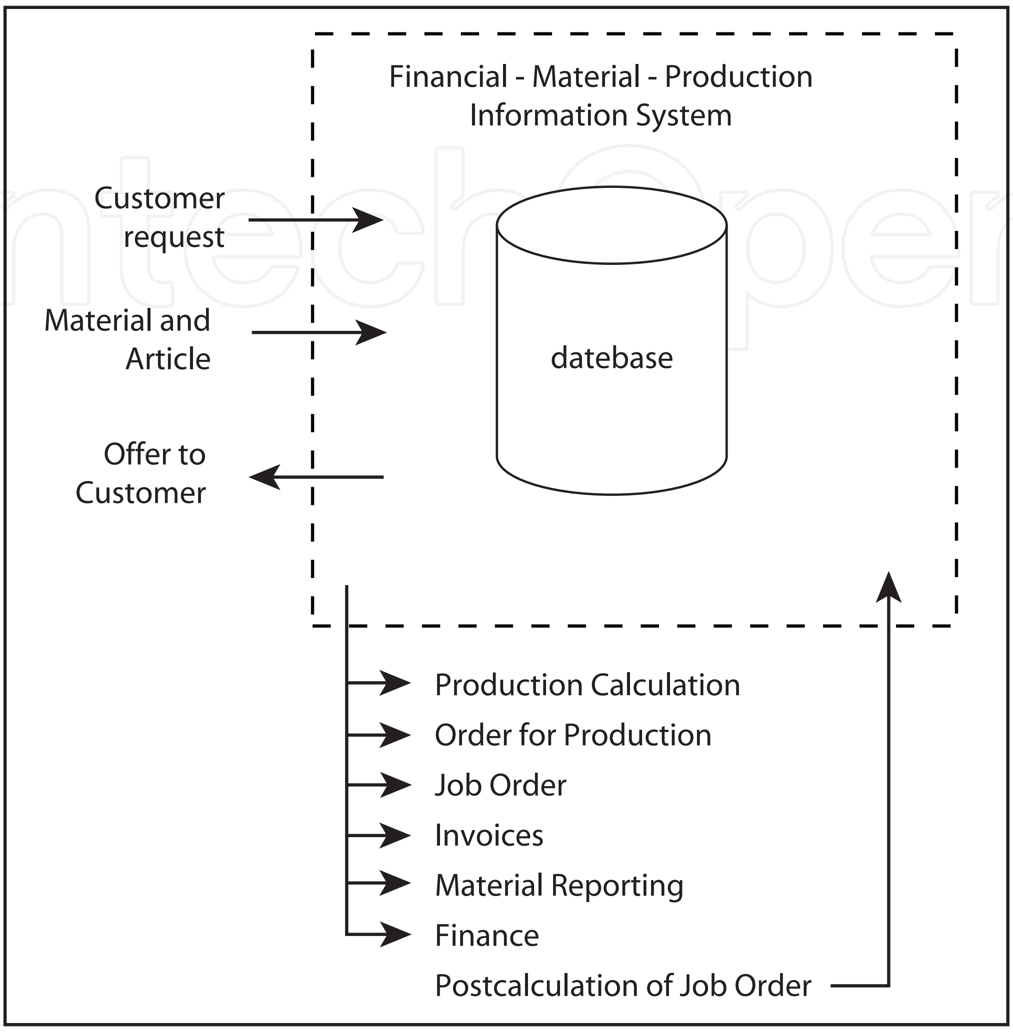

Fig. 1. Basic information - production model

4. Model of integrating between various information systems

In introducing the information subsystem for developing an automatic calculation part, more time becomes available for persons working in the production sector which can then be used for improving the quality and additional production control. Figure 2 presents an organizational scheme with an automation and calculation part which was expanded from the subsystem base.

A new, expanded organizational production scheme was obtained based on two different information systems – financial-material (serves for a complete financial part which includes prices of material, production activities and resources, creation of all business documents and reports) and production (development of working versions of tenders, complete production planning, time and status reports of individual activities – work orders).

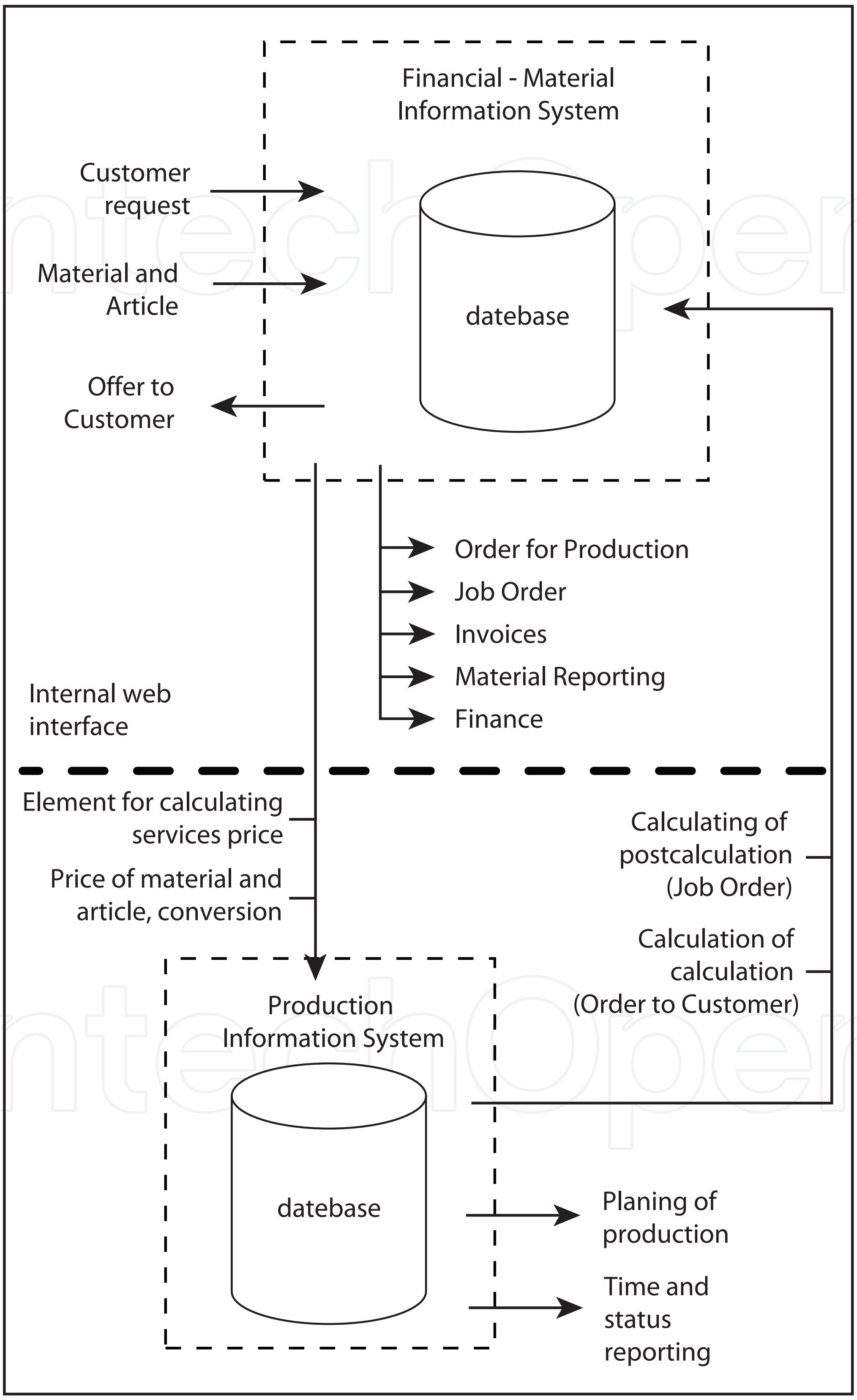

Fig. 2. Integration between different information systems

The integration part which links the two information systems communicates by transferring information for production, i.e. current prices of materials, articles, resources as well as the appropriate conversion of necessary elements for the production cycle. The integrated interface enables the transfer of necessary information for the production calculation considering that in such a scheme those elements are entered through the financial-material sector integrated in an appropriate information system.

From the production part, the final project yields a final calculation of the work order and the results are sent for finalization into the financial-material system. In the construction of a model presented in Figure 2 requests by the production organization itself had to be taken into consideration. They refer to the transition period of training workers in other sectors. Training refers to acquisition of knowledge which defines the final product in the maximal capacities of the organization itself, and expanded with other elements that can be upgraded to the existing product.

Considering that such knowledge is broad and concrete it is inevitable that a significant amount of time for their acquisition is necessary as well as for their actual application. The period of training can last for several years because of the work activities which are present on a daily basis, and the existing information structure which has to be in place.

In comparison with the basic model, production planning, time and status reports were introduced. This includes a variable digital display of the load of all production resources through a varied period of time; from daily to weekly planning using an automatic system of confirming an offer as an order. The internal web interface transfers the automatic calculations according to clients' requests through the financial-material information system. In that way the existing communication between the client and production organization is maintained. Completed post calculations are also transferred according to the financial system for the final processing of the work order.

Further enhancement in the restructuring of the existing links and appropriate activities which can accelerate communication with the external client and communication within the organization itself is shown in the model in Figure 2. Figure 3 represents a significant reorganization primarily through communicative activities with external clients which take place directly through the production system. In order for the presented model to become active in the organization it is necessary to carry out a reorganization of work activities and knowledge of people participating in the production process. This is evident in positions in the production structure from which the final offer emerges.

In the previous model (Figure 2) the final document is generated in the financial-material system to which the entire calculation part for the ordered product is transferred. This leaves the possibility for correcting the suggested price (adding workers or changing the amount of particular material for the production itself) of the production system.

However, such a possibility has to exist in the production system itself. The suggested model in Figure 3 clearly shows the reorganization of links in positions of creating orders and work orders for the purpose of reducing the time necessary for their development and in reducing possible mistakes in transferring between two information systems.

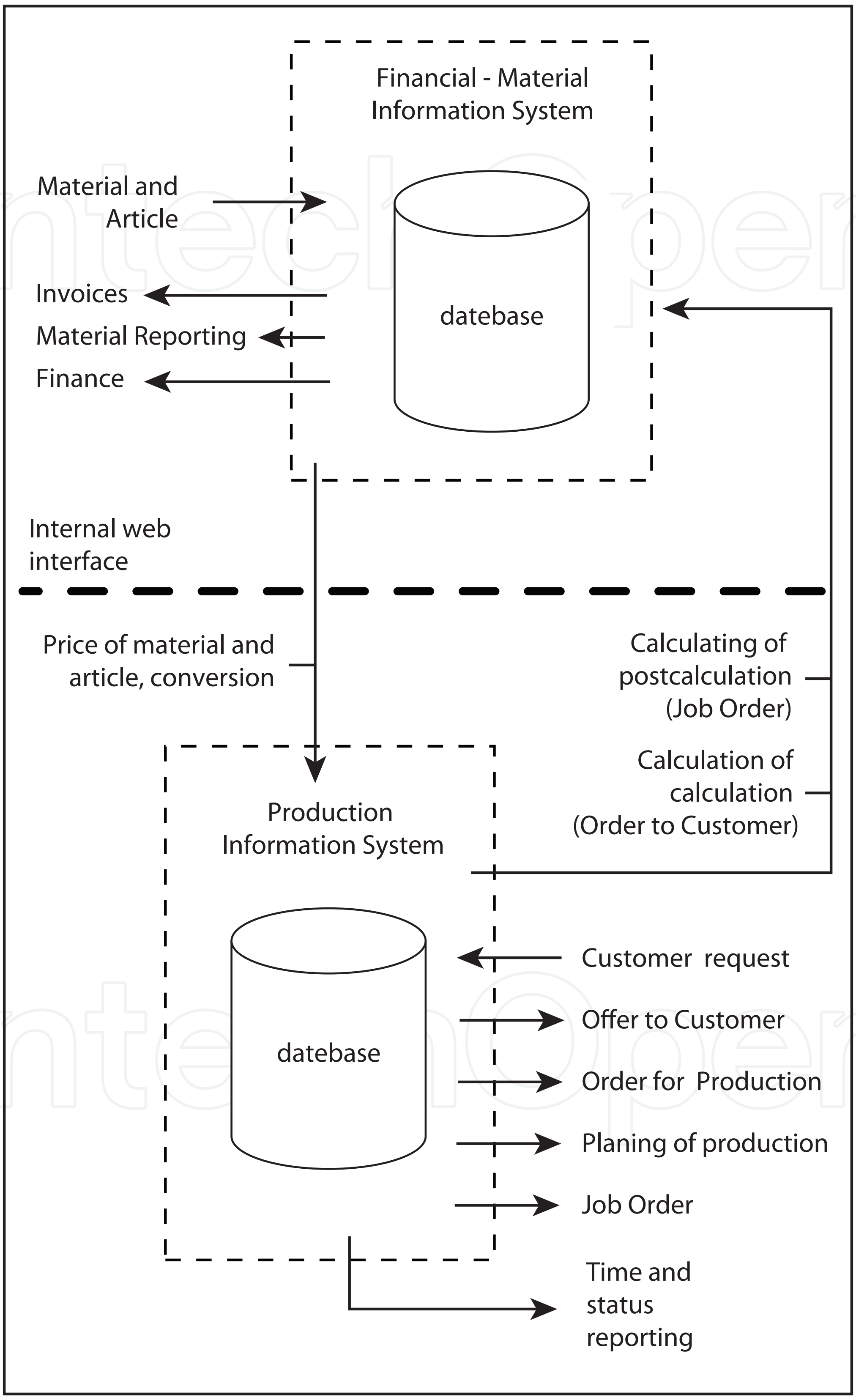

Fig. 3. Extended integration between different information systems

4.1 Analysis of the complex financial-production information model

The advanced way offers possibilities of direct – automatic communication in the client-production communication through which the calculations are generated as valid business documents. At that level, the client must take responsibility of correctly defining elements for the finished product (e.g. through a web interface), since based on those specification an automatic project for the finished product is created. An offer is generated based on the confirmed order and work order as well as complete production planning of resources.

Having such a system enables the client to see and monitor all the production processes defined. Information systems without such options of "openness" towards clients (independent work specification and product monitoring) are extremely complex and demanding, and their implementation is possible only in rare systems which already have and existing automatic structure of the Figure 3 type.

Only organizations like that can expect an increased number of orders and work orders which opens an area for further quality investment into production resources and training of people who can manage such complex production structures. Figure 4 presents a highly computerized production model in which the interaction of the system with the external client is minimal. This enables rapid information searches which will manage further business activities on the client's side. Such a model enables independent creation and change of desired input parameters by the client with immediate results for the desired inquiry.

Such an advanced business organizational model yields extra work time which can be further directed to planning, development and control of the final product for the purpose of obtaining a more quality and more competitive product. This also leads to room for creating new products whose construction is based on the existing base by extending it to new production resources. By expanding the production capacity and resources there is a possibility for selecting different production directions in order to obtain a cheaper yet high quality product as well as obtaining a sequence of cost-effectiveness of various technological production flows.

With the existence of a module for planning and monitoring production it is possible to visually control the suggested processes and resource occupancy, and thuds influence their change and reorganization (automatic re-calculation for the resources of necessary time and people). In such a way production management becomes simpler, controlled and transparent making the time for locating production congestion and delay almost minimal.

5. Information models support by feedback production information

To make the information system was more comprehensive and effective; it is further proposed the implementation of subsystems for feedback generating information that can further affect the input values for the appointing calculation of the finished product. Through this subsystem performs the correction of the set current value, which affects the gain of the new planning and calculation production parts. Permanent changes in factors

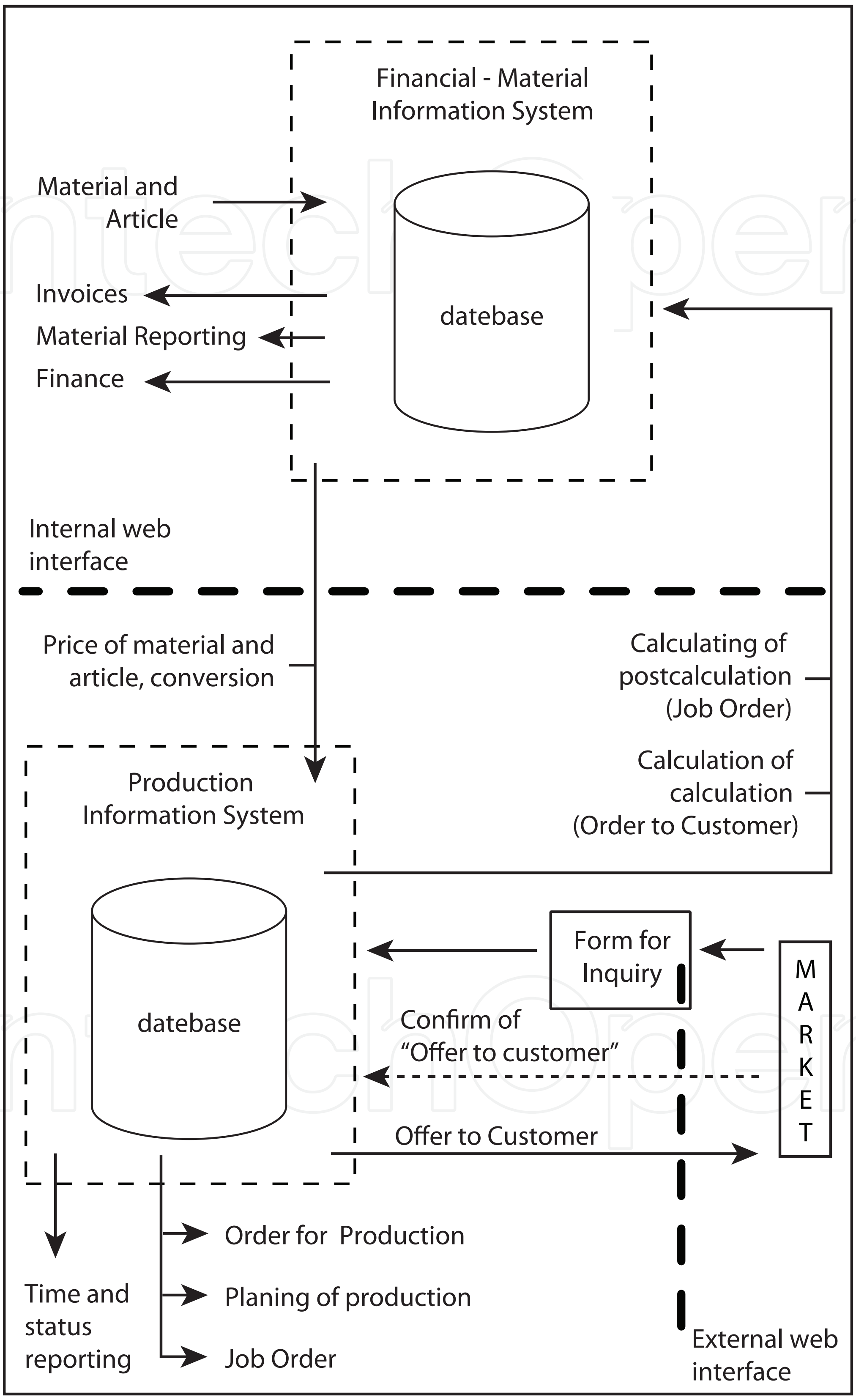

Fig. 4. Complex integration between different systems with web interface to market

that influence on overall calculation of the final product determines introduction of mechanisms which will be based upon on actual changes in the elements for calculating production costs. Except a fixed set of elements (cost articles, semi products, materials, resources, amortization costs) are important factor is set working hours for all manufacturing operations in the development of the final product. How is the final product complex, in its production is related to several dozens of different operations. This is precisely the space within which occurs a continuous change, and it is necessary to introduce mechanisms that will be registered this time changes, and based on these corrected set of input values. Implementing additional mechanisms affect the efficiency of production to obtain more accurate production time for each working phase, and thus financial - statistical state of resources for stable production lines and establishing new directions of development of the organizational structure.

5.1 Improving production capacity with production information feedback

Susceptibility to constant change of elements which influence the calculation of the final product calls for the introduction of a mechanism on which real changes of factors for the calculation of production costs will be based. In addition to set elements (article price, work in process, materials, resources, cost depreciation) the set working times for all production operations in the finalization process have an important role. Since the final product is complex, its production is related with dozens of different operations. This is the area within which constant changes occur and where it is necessary to introduce mechanisms which will record such time changes based on which it will correct set input values. The result of that is the new corrected calculation which represents the actual state of the production resources in a particular structure. Figure 5 shows the model of production flow organization which can collect actual production information for correcting the set values.

In an ideal structure, automatic tools for selecting, analysis and transfer if information into the basis can be implemented, however the lack of such tools is evident in the resources for developing such complex operations (several different mechanical activities), which is why the production line is sometimes interrupted. It is on such resources that the embedding of tools based on manual duration production activities by workers involved in the production process is anticipated. In combining automatic and manual tools at the level of the entire production, all necessary production information can be obtained (real time, delays, problems) which significantly increase the existing structure. Furthermore, such tools can be used in status reports of each work order through the model of monitoring the production flow for each product. In such a way the production flow becomes transparent and monitoring becomes visible through planning models and the organization of production processes.

The model in Figure 5 encompasses the production environment within which the system for gathering production information is implemented. Setting up such a system demands considerable investment and taking responsibility of all participants in production operations by being independently engaged and in controlling for improving the quality of the final product.

Depending on the content of the work order is defined workflow and sequence of individual operations on the resource for making the product. Depending upon the operating times of individual phases is calculated the time occupancy of resources, and its planned occupancy of on a daily (short term) and over daily (long term) basis. This means

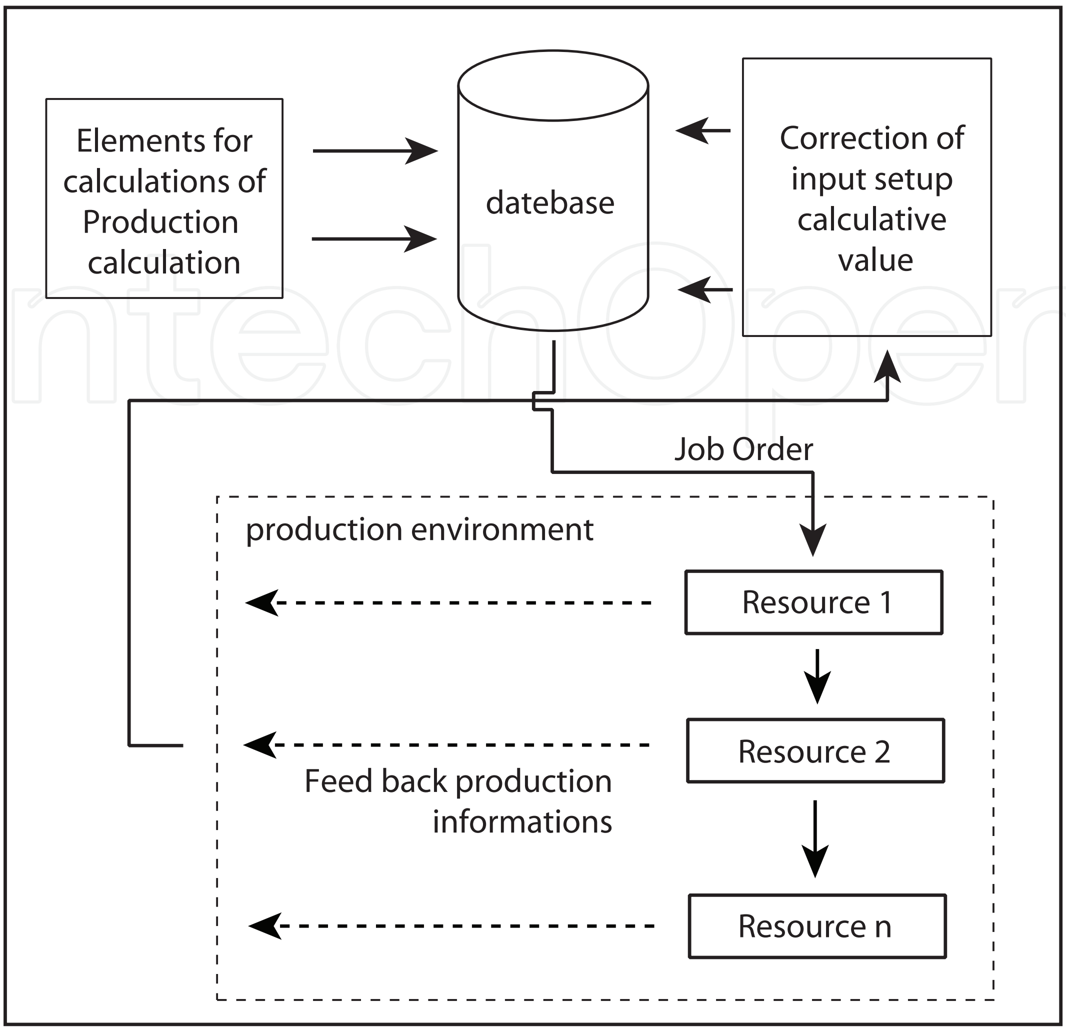

Fig. 5. Model of feedback production information

that the same work order to occupy a different time-workload of particular resources after entering corrective factors received with backward connections. It wills also feedback production information will impact on change workflows in manufacturing the product in terms of seeking alternative and profitable work processes. With that comes to correcting the total cost of production, and thus to more competitive on the market.

In such a model, the input for calculating the production of the final product can be done by the external client (Figure 4) or internally by the person in charge within the organization (Figure 1, 2, or 3). Further creation of business documents is automatically generated based of the entered production elements.

6. Simulation experiment of production processes

Simulating the manufacturing processes and business activities with corresponding resources, the goal is locating the congestion and bottlenecks with the proposal and reference to the solutions that to optimize production flows. Furthermore, the simulation of production is expected to set up connections that define the production cycle with effective results in terms of competitive price and quality ratio of finished product. Also, simulation of production flows suggests to new proposals and solutions for improving, standardizing, managing and planning process through support of information systems. Results of the simulation research is expected to obtain the order of cost effectiveness individual resources, and make the necessary investment to renew (extend or reduce) the productive capacity of the organization.

According to the presented organizational models an IT system was constructed which experimentally correlated production resources, materials, work time, supporting production activities and appropriate financial values. Production processes encompass necessary materials and logs which define particular production orders, and new production resources which expand the existing organizational structure. At the end of the production process there is always a new product, show on Figure 6.

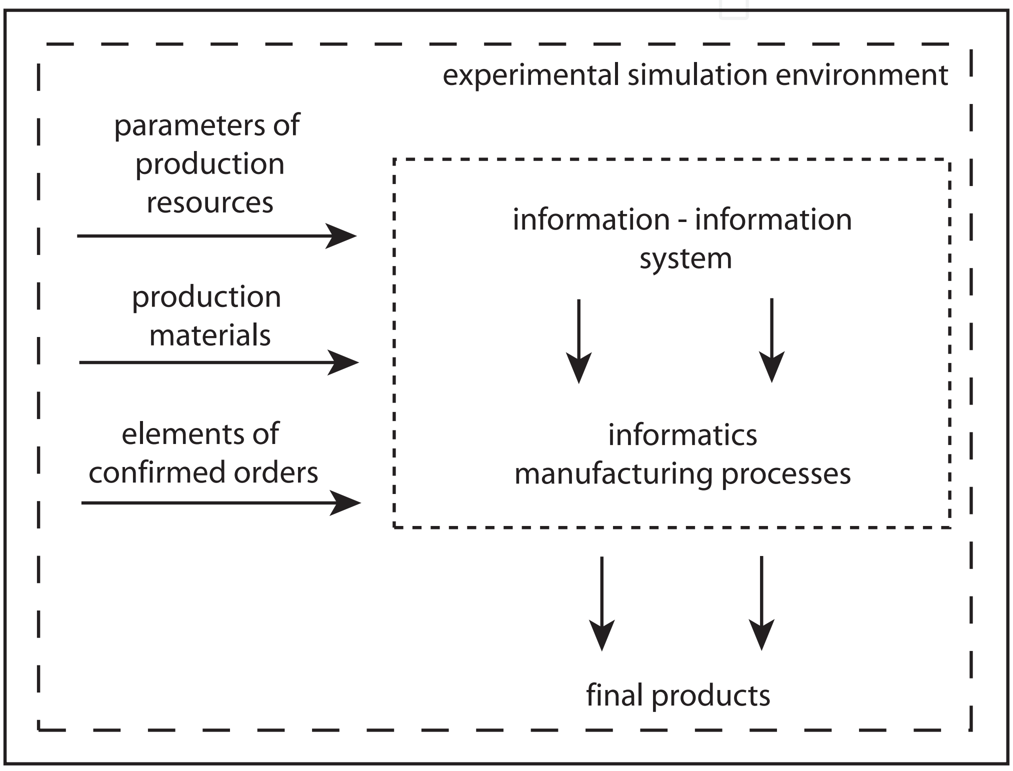

Fig. 6. Model of experimental simulation process

In information defined resources are installed a real properties of production, and is set informatics description of the working environment within which the simulation was tested. Research has focused on projecting of virtual manufacturing of components with all parameters and defined the production norms. The results of simulations of production contribute to the establishment of new ways to manage the existing work processes, and upgrading on overall planning of the production cycle. This tends to find a stable production plan, which is characterized by flow without delay from one side, and on the other side the financial profitability and competitiveness in the total price of the product. With simulation is also possible a planning and designing the working environment which is actual realization is predicted in future for a particular time period. With this approach it influence on opening and planning of new workplaces, on new organizational structures, and to increase the level of knowledge for managing production. Applying such approach allows the predictions of new work structures without causing damage and material costs.

The goal is to automated generating production flows for a new product with a focus in finding the most profitable working operations and corresponding resources. Studying the bottlenecks of production requires the collection of accurate data about all production components, working people and materials from real production conditions. This allows the finding of extreme risk situations and the maximum production capability of the entire work environment, and therefore projecting a coordinated set of production elements in production.

For a successful simulation of production processes it is necessary to establish correct and realistic elements which make up the entire production flow. Through the simulation method, new ways to maximum production capabilities, improvement, upgrading and planning processes, and thus highly risky situation are placed in a controlled production framework. One information-simulation system tested at variable changes production amounts of 1000, 5000, 25000, 100000, 50000, 1000000 and 200000 items. By simulation of the production flow, the financial change of the total costs of a particular financial amount on value of the materials used wanted to be established.

quantity	total cost [finance value]	material cost [finance value]	ratio of total production cost and cost of material
1000	9149	3489	0.3814
5000	22235	9921	0.4462
25000	83615	42078	0.5032
100000	317541	162677	0.5123
500000	1565364	805857	0.5148
1000000	3125113	1609831	0.5151
2000000	6244662	3217779	0.5153

Table 1. Result of simulation testing

The results obtained through simulation testing can establish the relationship of the total work of the production resources with the appropriate work activities and on the other hand with the necessary raw materials for obtaining a finished product. It is expected that the results obtained will yield new production processes which can be influenced in a sense of improving and optimizing the production flow. Furthermore, simulation and assessment of products in a product cycle elements which demand change of existing value standards can be located. Such standards can cover appropriate completion time of particular operations, financial values allocated to a particular resource or through necessary number of work activities on a particular resource. The aim was to investigate to what extent, how and in which time come up significant difference in the change ratio of the value of the material in the production process with a total production value of the product.

Table 1 shows the results of simulation experiments with different quantities of products in production, and the total value of the product, the share prices of materials and ratio of price change for individual quantity.

Experimentally, a different number of completed products in a series were tested (series of 1000, 5000, 25000, 100000, 50000, 1000000 and 200000 products), in order to find the proportion of change of financial value of the total costs and material costs of each series. Total costs include all production activities which describe the production of a product:

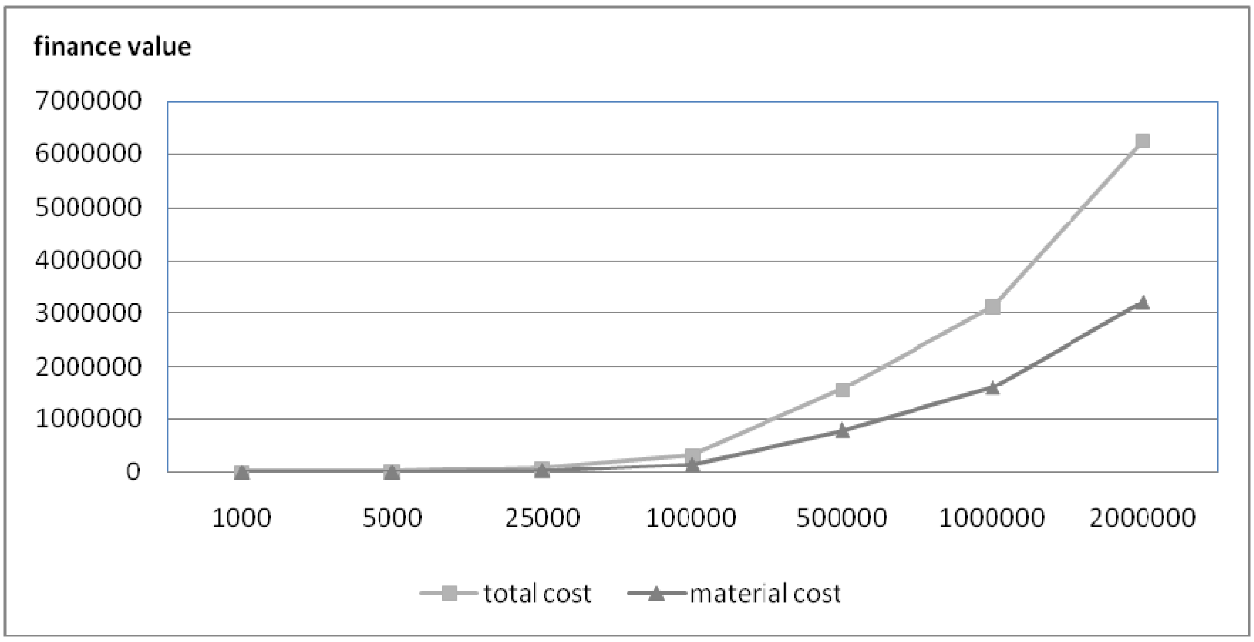

Fig. 7. Changes of finance value on different qualtity

price of working resource and appropriate activities, price of production operations, necessary materials in the production process. In simulating changes of prices for the appropriate series, the proportion of change by which the accuracy and control of cost of the production process of a product can be anticipated.

Figure 7 indicates changes in financial value of a particular series for the entire production costs and materials costs in the production process. From the data obtained, it can be concluded that with the increase in the number of articles in a series there is a higher proportion of total costs and material costs, taking into consideration that the proportion was stabilized in the last series where there was the largest number of products. On the production series of 1000 unit total value of production without the cost of materials amounted to 61.86% of the total cost, on a series of 5000 pieces was 55.38%, for 25000 units was 49.68%, of 100000 pieces is 48.77% for 500000 was 48.52%, for 1 million amounted to 48.49%, and for 2 million has measured 48.47%. It may be noted that the biggest difference between the total cost of production and the share price of materials was up to the quantity of 25000 units, and then there was a stabilization and slight decrease in the ratio.

Figure 8 presents a curve indicating changes in the proportion of total production costs and costs of materials for all experimental series. According to the model and the results it can be concluded and predict that it will further increase production quantities to maintain the current ratio, with a slight change in the share prices of materials in total cost of production. Only in production to 25000 units was recorded considerable changes in the ratio of total production and share materials, and it is area for new further research to develop a new product. It is possible to use the suggested model as a control mechanism in production processes which encompass relating the group of products. At the level of production organization it would be necessary to design models for each group of specific productions in appropriate series for obtaining proportions as control value mechanisms.

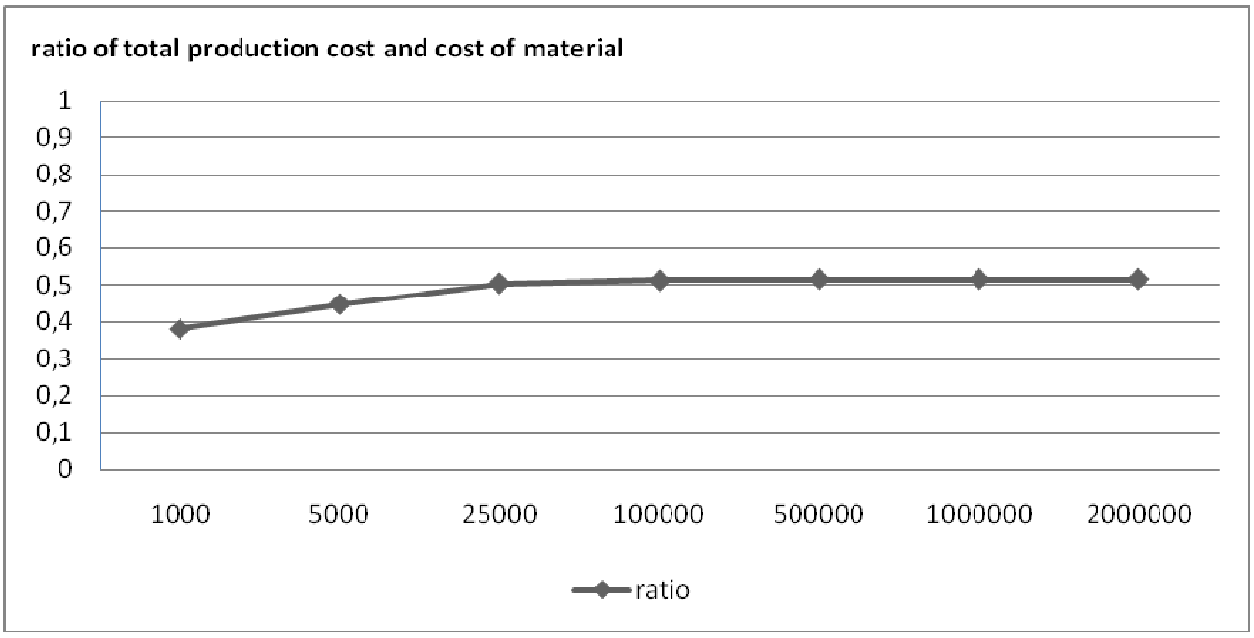

Fig. 8. Change of ratio of total production and cost of material

Analyzing the obtained results, it can be concluded that the total cost of materials on small quantities of one thousand pieces has a smaller share in total price of the product (38.14%), and increasing the amount of two million pieces of material share price increases (51.53%). It's determined that the share prices of materials in the total costs of production has stabilized on quantity of 100000 pieces at 51.23%, for 500000 pieces on 51.48%, and for one million on 51.51%. It also imposes the conclusion that in production of large quantities at one moment comes to stabilizing the ratio of materials cost and total production costs. The moment in which will be stabilized this ratio also depends on the necessary replacement components required in production, or about possible terms of delivery; which condition the additional production capacity. That change of terms of delivery determines the activation of additional production resources, either from its own structure, or from external sources. Compliance the defined terms of planning on the individual resources and departments inside the production structure is one of the main elements of stability in production process.

Further research should be based on the use of new materials and currently available information - production technology. It is also possible that some new materials with good quality characteristics do not satisfied requirements of the market in high production quantities, but in a small zone of production be acceptable. It is also one of the main directions of development of digital - information productions, making a complex and unique products in the minimum quantity (even 1 product) whose realization is fully automated. This includes an acceptable competitive price of finished product.

7. Conclusion

The suggestion for further development of Figure 4 opens up an area for introducing complex mechanisms for reporting on production flows, where the dependency of external inquiries on actually confirmed production offers has to be research, in search for reasons unacceptable on the side of the client. It is also suggested that internal tools be introduced which will construct the inquiry and based on them certain conclusions can be made for new strategic decisions. This opens up a new area for improving production, introducing the system of real simulation of workers according to the effort and productivity in the organization. The system of analysis, comparison and monitoring has to be based on set and realistic values in both information systems, and the results obtained are expected to open new areas for investments.

Such a mechanism demands immediate interaction between users through a web interface with desired time periods and loads in needed resources and workers, comparative prices of production calculations with the post-calculation part, total inquiry calculation, accepted offers, visual representation and numerical values. The results influence daily business decision-making as well as strategic directions in improving the business system. The implementation of such a tool on the existing information structure is possible at the level of the basic model shown in Figure 1, but since such a system does not have qualitative quantitative information from the production of a product itself, adequate conclusions on the production flow is not possible. A concrete application of the suggested mechanism in its full use would be through the model described in Figure 2 where independent inquiries can be placed either to the financial or production system, and can be most outright with targeted inquiries through the integration of both system of the production structure.

8. Acknowledgment

The process of developing complex information structure through the suggested scheme is based on organization structures and resources with high ICT standards. As the existing structure developed, the relationships became more complex and the level of applied knowledge for its maintenance became higher. The last of the suggested models on Figure 4 presents a self-learning structure. Its maintenance requires current knowledge which is constantly subject to further upgrade and change. In that respect the likelihood of survival of structures based on informatics descriptions of production processes is the greatest as is the modification of existing capacities for developing new products based on market demands.

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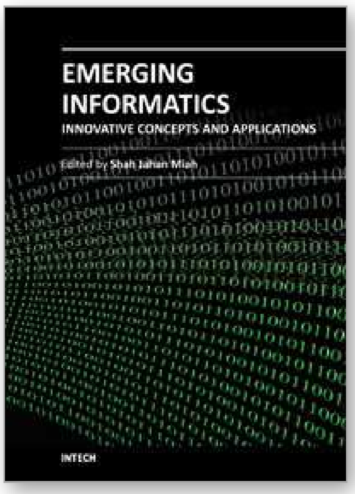

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The book on emerging informatics brings together the new concepts and applications that will help define and outline problem solving methods and features in designing business and human systems. It covers international aspects of information systems design in which many relevant technologies are introduced for the welfare of human and business systems. This initiative can be viewed as an emergent area of informatics that helps better conceptualise and design new world-class solutions. The book provides four flexible sections that accommodate total of fourteen chapters. The section specifies learning contexts in emerging fields. Each chapter presents a clear basis through the problem conception and its applicable technological solutions. I hope this will help further exploration of knowledge in the informatics discipline.