

Development of Manufacturing Systems Based on Integration With Controlling As A Competitive Advantage of Industrial Companies

K.V. Pershina, A.E Gorokhova, Iu.N. Popovskii, V.D. Sekerin, Ph.M. Tarabrin

Abstract: An objective need in the development of methodological approaches to the formation of a model for the integration of controlling and manufacturing systems for the operating conditions of industrial enterprises arises in the era of progressive globalization. A model of the interaction among the concepts of controlling, quick response manufacturing, and world class manufacturing is proposed, which allows to reduce time losses. Such a complementary model of controlling will allow to take time costs into account, detect economically unviable actions, and direct efforts to eliminate them.

Index Terms: industrial enterprises, production management, manufacturing systems, controlling, world class manufacturing, quick response manufacturing, economically unviable actions.

I. INTRODUCTION

There is a unique situation at the moment, where no country can live in complete isolation from others any longer. This is why domestic enterprises are forced to operate in the conditions of the new economy, competing with numerous players in the global market and striving to improve their positions.

Due to this, the modern conditions of the instability of the economic environment dictate new requirements for management methods at industrial enterprises. The lack of information and insufficient information exchange between the production and management sectors result in resource losses, time-specific parameters of manufacturing systems worsen, and soundness of managerial decisions worsens as well.

Besides, the situation is complicated by geopolitical factors that affect the Russian economy. Due to this, the number of bankruptcies and their intensity increased in the real sector of the economy. Following the results of 2017, the number of bankruptcies in the industrial sector increased by 8.2 % compared to 2016 [1]. Due to this, new instruments for the development of industrial enterprises are required, focusing on involving hidden internal reserves into economic circulation. A modern way to solve this problem is to develop and implement a model for the integration of production systems and controlling in the production environment as the basis for the efficient production organization, which allows to detect deviations of production and financial costs and

make changes in manufacturing.

II. METHODS

An analysis of the state of time costs accounting at industrial enterprises using the evaluation algorithm developed by the authors was conducted, considering the criteria for using time resources in combination with other enterprise resources, and a conclusion was made that the time resource was virtually not accounted for at all analyzed objects or accounted at a static level with recording the work duration without the subsequent analysis of the detected deviations.

Based on the data obtained from the NVAA analysis at the enterprises under study, the share of economically unviable actions and the time spent on them amounted to more than 50 %. This indicates that time is used inefficiently in the production process because more than half of it is spent on actions that do not add value to products. The identified losses confirm that the production process is built inefficiently.

The indicator of time losses per worker and the ratio of the time used by one worker are introduced in order to secure the data comparability. It was revealed that the ratio of the time used by one worker confirmed the inefficient organization of the production process because values from 0.34 to 0.54 per worker had been obtained at the analyzed enterprises. This means that only 34 – 54 % of the employee's time is spent on work.

This problem can be solved by developing manufacturing systems based on an integrated model with controlling. The formation of this model will allow to increase the efficiency of industrial enterprises by identifying hidden internal reserves, accumulating unique analytical data, and taking sound managerial decisions.

The WCM (World Class Manufacturing), QRM (Quick Response Manufacturing), and other manufacturing systems were explored during the study. A theoretical research of the WCM concept efficiently applied at Japanese enterprises revealed the core factors limiting the WCM implementation at Russian enterprises. The application of advanced foreign concepts allows Russian enterprises to improve their image in the domestic and global markets [2 – 5].

The QRM system is a promising area focusing its attention on a time resource as a key parameter for an enterprise. A peculiarity of QRM is concentration and analysis of all operations (both production and office ones) [6, 7].

However, the following weakness has been revealed: the QRM has instruments of

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K.V. Pershina, Moscow Polytechnic University, Moscow, Russia.
A.E Gorokhova, Moscow Polytechnic University, Moscow, Russia.
Iu.N. Popovskii, Moscow Polytechnic University, Moscow, Russia.
Ph.M. Tarabrin, Moscow Polytechnic University, Moscow, Russia.
Third Author name, LLC RCNTEC, Moscow, Russia.

control in its functionality that do not allow to determine the level of use of a time resource at an enterprise with due quality. This necessitates the integration of the time resource with other resources of the enterprise as a system that will allow to analyze how the reduction in time will influence the performance of the enterprise.

As a result, it is suggested to implement the integration of controlling, QRM and WCM. The formation of a model for the integration of the proposed concepts will allow to fully eliminate the wasted time from the production process [8].

The following key elements of the model are chosen: WCM and QRM systems, which allow to eliminate difficulties in manufacturing and controlling aimed at systematizing the results obtained. This study reveals that these elements contribute more to the identification and involvement of free reserves in the operation, mobilization of profit, and better efficiency in the use of resources [9].

The integration of the developed model into the existing enterprise management model is presented on Figure 1.

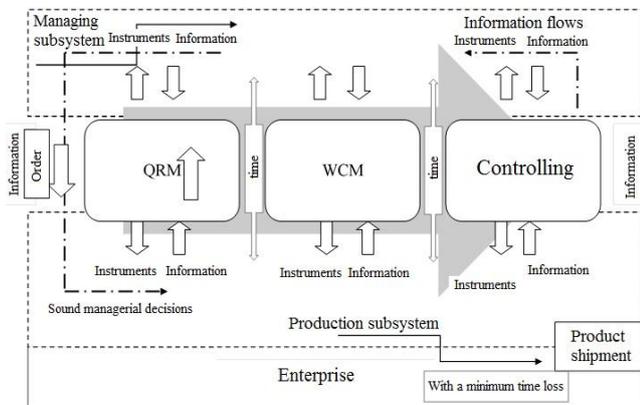


Fig. 1. Integration of the model at the enterprise

III. RESULTS

The recommendation of this model is universal and can be used at enterprises in various sectors. As shown in Figure 1, office and manufacturing operations are conducted in parallel. The developed model allows to interconnect these subsystems through a single goal – the desire to cut time losses. The information flows generated in the course of the model operation enable making sound managerial decisions that facilitate production with the minimal time losses.

Application of this integrated model allows to monitor the time spent on production, keep records, analyze viable, semi-viable and unviable actions, and identify a trend to cut time losses.

An emphasis must be made on the basic element of the proposed model – controlling – because of all possible controls (for example, planning and budgeting, consulting, compiling various financial reports), the internal control is a key instrument to help most timely and reliably evaluate the efficiency of the key business organization processes [10,11]. Introduction of the proposed model is advisable for several reasons: reduction in the total duration of manufacturing and shipping; increase in the number of items produced per unit of time; cheaper production for all components; payback on development costs, more expensive equipment; nearing the

compliance with a smart enterprise.

IV. DISCUSSION

Before the implementation of the presented model (Figure 1) in the structure of total time, the time spent on economically unviable actions amounted to the largest share – 59.22 %.

After the integration of the model into the manufacturing process, the economically unviable actions will be reduced to 44.21 %, which yields a positive result. Deploying the model helps save resources:

- reduction of electricity consumption by 13.77 thous. rub.;
- reduction of fuel consumption by 127.96 thous. rub.; and
- reduction of labor costs by 740.90 thous. rub.

In turn, the integration model of controlling and manufacturing systems contributes to the following:

- multiple increase in labor productivity due to the better motivation (by 25 %);
- reduction in the time of orders execution;
- better quality of products, which leads to overcoming the competitors;
- higher profits as a result of changes in the above factors; and
- better competitive advantages.

Besides, the developed model allows to establish the soundness of the taken managerial decisions, which can be confirmed by solving the following system of equations (Table 1).

Table 1. Efficiency of decisions taken using an integrated model of manufacturing systems

Equation	Notations	Value
$0,5 \cdot \frac{I_{c1}}{I_{c0}} + 0,3 \cdot \frac{I_{r1}}{I_{r0}} + 0,2$	I – information, I _{c0,1} – completeness, I _{r0,1} – trustworthiness, I _{f0,1} – relevance	+18.2 0 %
$T = 0,4 \cdot \frac{t_1}{t_0}$	T – time, T _{0,1} – time before, after	+11.0 4 %
$0,3 \cdot \frac{P_{c1}}{P_{c0}} + 0,2 \cdot \frac{Pr_1}{Pr_0} + 0,5$	P _{c0,1} – prime cost, Pr _{0,1} – profit, R _{0,1} – return	+6.2 %
$S = 0,1 \cdot \frac{Z_1}{Z_0}$	S – saving, Z _{0,1} – resources	+1.10 %
Efficiency of the sound managerial decision		+30.4 %

The efficiency of sound managerial decisions increases by 30.4 % following the use of the proposed model.

It has been revealed based on the study of manufacturing systems that time management is a significant area of increasing the production efficiency. As a result, it has been proposed to introduce time parameters based on the controlling subsystem in the manufacturing system, including NVAA analysis, which allows to assess the effect of reducing the use of time on company performance.



V. CONCLUSION

In addition to the study of theoretical foundations of manufacturing systems, the research into practical implementation in the conditions of operation of domestic industrial enterprises indicates the need to develop a model for the integration of manufacturing systems and controlling. As such, the development of the model is theoretically and practically justified in the current conditions.

The introduction of the proposed model will allow industrial enterprises to reach a new level of their development, thus approaching the operation criteria for a smart enterprise through improving quality, reducing costs, reducing production time, accumulating analytical data, and restructuring the management model.

As such, the efficiency of the industrial enterprise operation is directly dependent on the management efficiency and hence on the efficiency of managerial decision-making resulting in the corresponding socioeconomic effects. The proposed model drives the industrial enterprise development in case of its efficient implementation.

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