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DEVELOPING THE STRUCTURE OF DECISION-MAKING SUPPORT SYSTEM FOR MANAGEMENT OF THE PRODUCTION LOGISTICS OF AN INDUSTRIAL ENTERPRISE

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Podskrebko O. S. Developing the Structure of Decision-Making Support System for Management of the Production Logistics of an Industrial Enterprise

The article proposes the structure of decision-making support system (DMSS) for management of the production logistics of industrial enterprise, which will increase efficiency of production system (by reducing time for decision-making which are based on the information about actual stocks, planned downtime and losses), and will determine the cost of failed managerial decisions in order to eliminate the possibility of recurrence in the future. The main aspects of functioning of the proposed DMSS are illustrated on the example of the process of converter production of steel at a metallurgical plant, describing each of the units presented in the structure of the system. The author proposes a decision-making mechanism, based on close interaction between the modeling module, knowledge base, and databases, using which one can generate recommendations concerning the movement of one or another unit, which participates in the process of converter production of steel. On the basis of her own experience of developing the alike systems, the author proposes a group data processing, suggesting use of a personal interface for each category of users, which will attract the main participants in the production process to decision-making, collective formulation of new ideas. It is specified that improvement of efficiency of functioning of economic objects is possible, first of all, by means of a competent application and further perfection of information systems.

Keywords: *decision-making support system, modeling, knowledge base, production logistics, industrial enterprise.*
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Podskrebko Oleksandr S. *– PhD (Economics), Senior Lecturer of the Department of Economic Cybernetics, National Aviation University (1 Kosmonavta Komarova Ave., Kyiv, 03680, Ukraine)*
E-mail: *alexandr.podskrebko@gmail.com*
ORCID: *http://orcid.org/0000-0001-5282-4691*
Researcher ID: *http://www.researcherid.com/R-2235-2018*

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Подскребко О. С. Розробка структури системи підтримки прийняття рішень з управління виробничою логістикою промислового підприємства

У статті запропоновано структуру системи підтримки прийняття рішень (СППР) з управління виробничою логістикою промислового підприємства, яка надасть змогу підвищити ефективність функціонування виробничої системи (завдяки скороченню часу для прийняття рішень, заснованих на інформації про фактичні запаси, планові простої та втрати), а також визначити ціну помилки управлінських рішень з метою виключення можливості її повторення в майбутньому. Проілюстровано основні аспекти функціонування запропонованої СППР на прикладі процесу конвертерного виробництва сталі на одному з металургійних заводів, наведено докладний опис кожного з представлених у структурі системи блоку. Запропоновано механізм прийняття рішень, який базується на тісній взаємодії між модулем моделювання, базою знань, базами даних, на основі якої формуються рекомендації з переміщення того чи іншого агрегату, задіяного у процесі конвертерного виробництва сталі. Ґрунтуючись на досвіді розробки подібних систем, автором запропоновано групову обробку даних, яка передбачає використання персонального інтерфейсу для кожної категорії користувачів, що дасть можливість залучити основних учасників виробничого процесу до прийняття рішень, колективного формулювання нових ідей. Наголошено, що підвищення ефективності функціонування економічних об'єктів можливо, насамперед, за допомогою грамотного застосування та подальшого вдосконалення економічних інформаційних систем.

Ключові слова: *система підтримки прийняття рішень, моделювання, база знань, виробнича логістика, промислове підприємство.*
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Подскребко Олександр Сергійович *– кандидат економічних наук, старший викладач кафедри економічної кібернетики, Національний авіаційний університет (просп. Космонавта Комарова, 1, Київ, 03680, Україна)*
E-mail: *alexandr.podskrebko@gmail.com*
ORCID: *http://orcid.org/0000-0001-5282-4691*
Researcher ID: *http://www.researcherid.com/R-2235-2018*

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Подскребко А. С. Разработка структуры системы поддержки принятия решений по управлению производственной логистикой промышленного предприятия

В статье предложена структура системы поддержки принятия решений (СППР) по управлению производственной логистикой промышленного предприятия, которая даст возможность повысить эффективность функционирования производственной системы (за счет сокращения времени для принятия решений, основанных на информации о фактических запасах, плановых простоях и потерях), а также определить цену ошибки управленческих решений с целью исключения возможности её повторения в будущем. Проиллюстрированы основные аспекты функционирования предложенной СППР на примере процесса конвертерного производства стали на одном из металлургических заводов, приведены описания каждого из представленных в структуре системы блока. Предложен механизм принятия решений, основанный на тесном взаимодействии между модулем моделирования, базой знаний, базами данных, на основе которого формируются рекомендации по перемещению того или иного агрегата, задействованного в процессе конвертерного производства стали. Основываясь на опыте разработки подобных систем, автором предложена групповая обработка данных, которая предусматривает использование персонального интерфейса для каждой категории пользователей, что позволит привлечь основных участников производственного процесса к принятию решений, коллективному формулированию новых идей. Отмечено, что повышение эффективности функционирования экономических объектов возможно, прежде всего, с помощью грамотного применения и дальнейшего совершенствования информационных систем.

Ключевые слова: *система поддержки принятия решений, моделирование, база знаний, производственная логистика, промышленное предприятие.*
Рис.: *3.* ***Формул:*** *1.* ***Библ.:*** *15.*

Подскребко Александр Сергеевич *– кандидат экономических наук, старший преподаватель кафедры экономической кибернетики, Национальный авиационный университет (просп. Космонавта Комарова, 1, Киев, 03680, Украина)*
E-mail: *alexandr.podskrebko@gmail.com*
ORCID: *http://orcid.org/0000-0001-5282-4691*
Researcher ID: *http://www.researcherid.com/R-2235-2018*

In the modern conditions of doing business, characterized by increased competition, Ukraine's integration into the global economic space, severance of stable economic ties and creation of new production chains, special importance acquires the development of new and improvement of existing instruments of enterprise management, in particular the system for production management of industrial enterprises.

For industrial enterprises, the main attribute of which is flexibility and efficiency of the production management system, it is very important to remain competitive in the rapidly changing operating conditions. Therefore, special attention to the development and improvement of the information systems for support of decision-making in the management of a production system, in particular its logistical component, intended to reduce the self-cost of production, is an expedient necessity and a priority task for each industrial enterprise.

Problems of development and improvement of decision-making support systems are covered in the work of domestic and foreign scholars, e. g.: R. Accorsi, R. Manzini, F. Maranesi [1], V. V. Glushchevskyy [2], O. S. Hrynenko [3], E. O. Danylov [4], S. A. Daudov [5], G. Yu. Koblyanska [7], V. M. Kravchenko [8], O. I. Larychev [9], R. A. Rudenskyy [10], V. M. Tymokhyn [12], Yu. H. Lysenko [14], and others.

But despite the considerable volume of publications, it should be noted that the issues related to the development of decision-making support systems for management of the processes of production logistics of industrial enterprise, which would increase efficiency of operation of the system of production management as a whole, have not been worked out sufficiently.

The article is *aimed* at developing the structure of decision-making support system for management of production logistics of industrial enterprise, which will improve the quality of the decisions made and efficiency of the production system as a whole.

The dynamism of environment, increase in the amount of information that has to be processed, the complexity of tasks to be solved, due to the need to take account of the large number of interrelated factors that arise in the conditions of uncertainty and risk, stipulate the need to develop and implement systems that would improve the quality and timeliness of the decisions made. The class of such instruments include the decision-making support systems (DMSS).

In order to determine the characteristics and components of DMSS, we suggest several definitions.

DMSS are interactive automated systems that help the decision-making person to use data and models to solve poorly structured problems [10].

A DMSS is a system that provides users with access to data and/or models so that their decision-making can be bettered [6].

A DMSS is a system that is managed by one or more decision makers (DMP), which provides assistance in the actionable decision-making by providing an organized set of instruments that can help to structure decision-making situations and to improve the overall efficiency of the decisions made [11].

A DMSS is an appropriate software product that displays the economic knowledge of a professional, his/her skills and experience, and is used to provide a user with an advice-solution [13].

Thus, the DMSS itself are not designed to develop a solution, but helping a manager to use them correctly in different situations, especially when it is not possible or desirable to apply an automatic system for decision-making. These systems not only help to decision-making, but are useful to understand a particular situation.

The DMSS allows to increase the efficiency of managers of different levels, but is not a substitute for them. The main goal of the DMSS is establishing interaction between person and system during decision-making, rather than automatizing the decision-making process.

At present, and in the near future, improving the efficiency and quality of enterprise management can be achieved only through the use and further improvement of economic information systems that will provide for ensuring improvement of quality and efficiency of operational flexibility of managerial decisions [8; 10].

Almost all types of the DMSS are characterized by a clear structure, which includes three main elements [13]:

- user interface subsystem;
- database management subsystem (DBMS), knowledge bases;
- model base management subsystem.

Important are the consumer properties of the DMSS, which are mainly estimated by the following parameters [11]:

- quality of recommendations and decisions;
- correctness of the method of considerations used;
- interface quality (usability of the expert system);
- system efficiency;
- payback period;
- speed of the system. It is especially important in the operation of the economic system in real time;
- possibility to work in a computer network;
- acceptability of the system to the user.

Thus, the decision-making support systems are designed to improve the efficiency of the decisions made, especially with regard to management of the production management system of industrial enterprise, in particular its logistical component.

The *Fig. 1* presents the structure of the decision support system for management of production logistics of industrial enterprise, the main function aspects of which are provided by the example of the process of converter production of steel at a metallurgical plant. Therefore, it should be noted that the important factor that impacts the performance of the system of converter production of steel, is that the logistical component of the process (*Fig. 2*), accomplished by the run-in cranes, is carried out in manual mode by a shift master of the converter department, which relies on heuristic approaches and combinatorial algorithms not allowing to estimate efficiency of one's actions on the management of logistics of the process.

The block of data input allows to specify different characteristics of the process of converter production of steel (continuous steel casting). For example, setting and adding new tasks to the system, changing the availability of units or specifying the coordinates of their new location.

The block of modeling is directly responsible for modeling the process of continuous casting of steel, that is, with the help of imitation produces computational procedures.

The block of forming the multitude of variants through the exchange of information with modules of the block of modeling, databases and knowledge bases

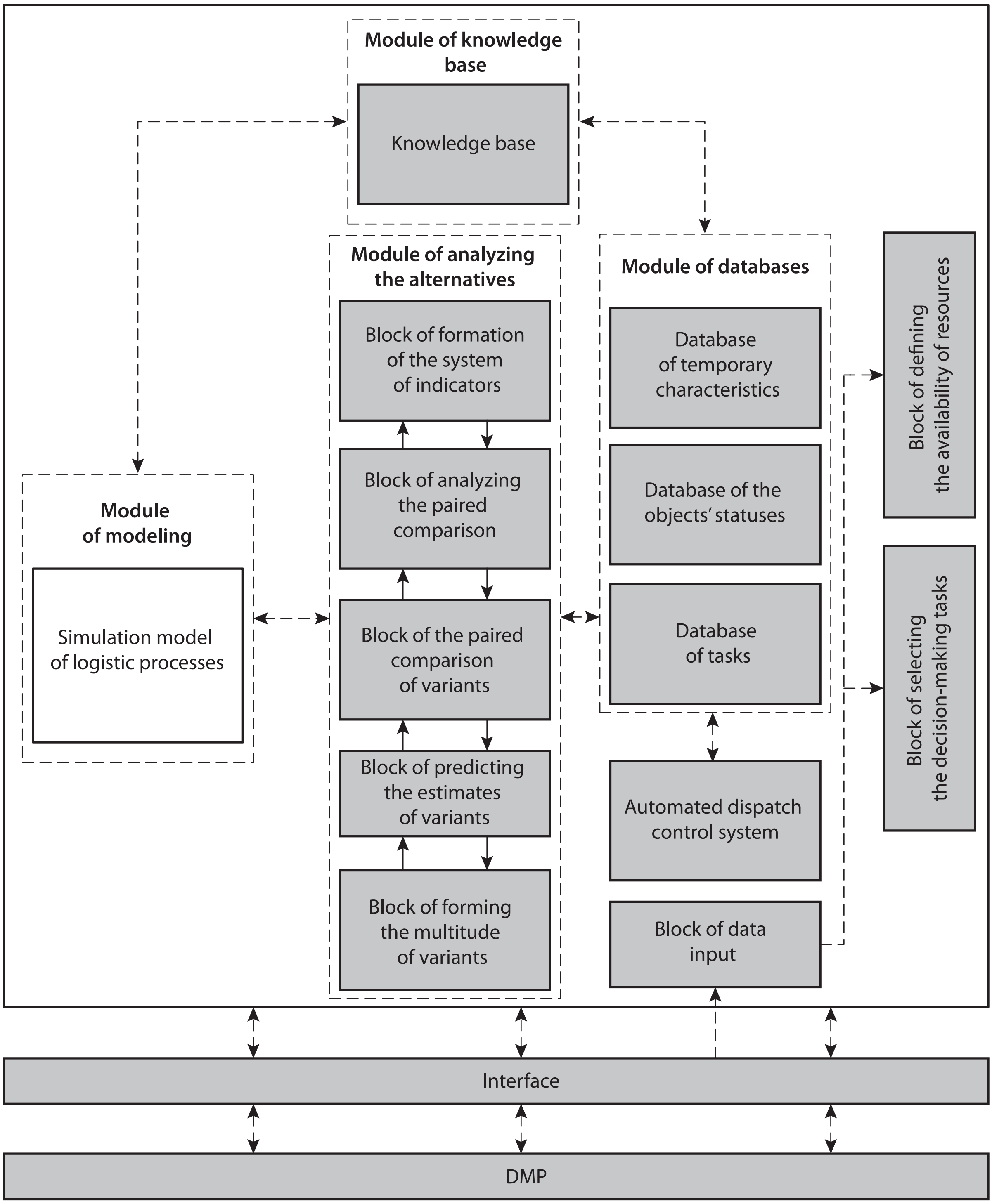

Fig. 1. Structure of the decision-making support system for management of production logistics of industrial enterprise

Source: developed by the author, based on [15].

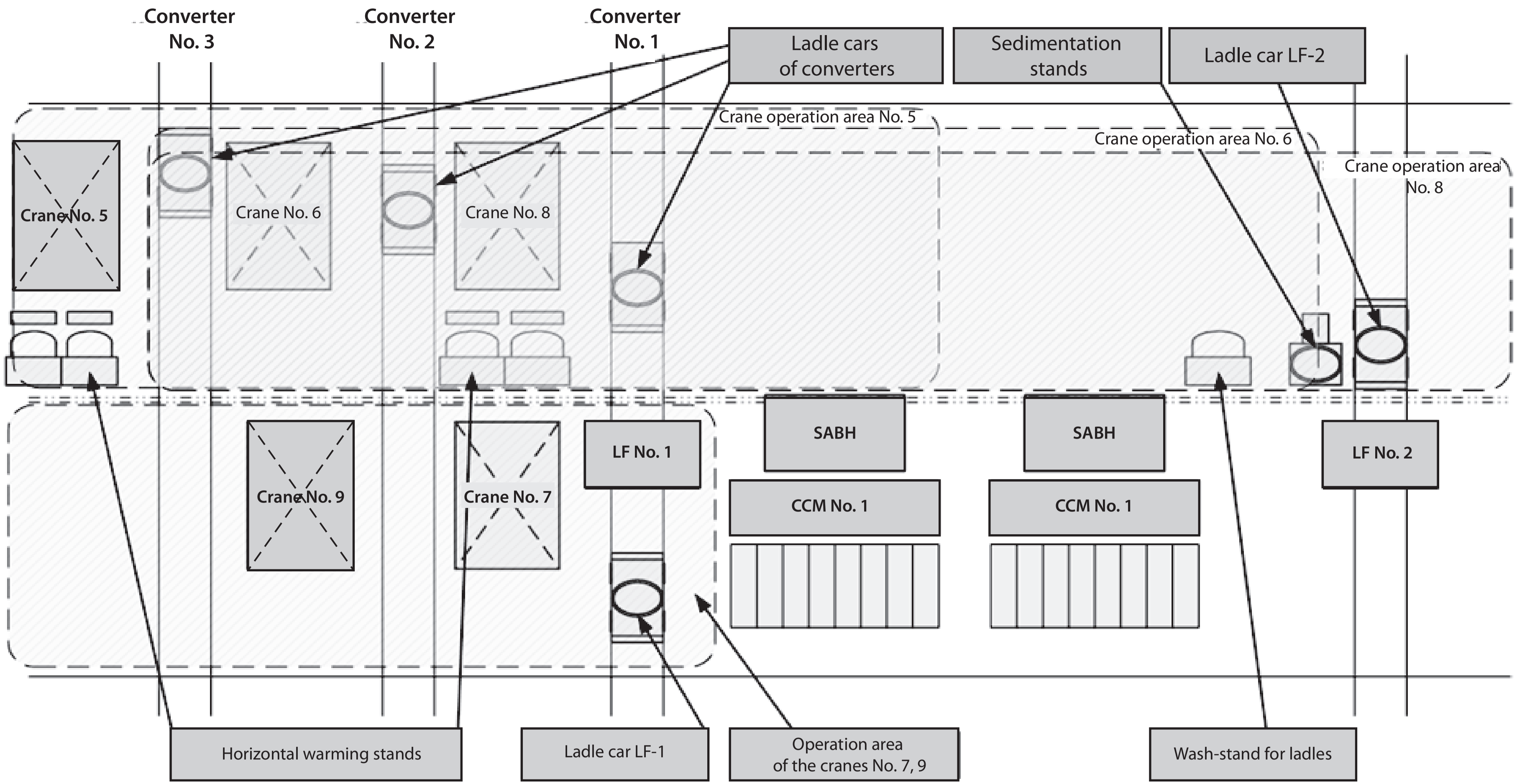

Fig. 2. The logistical component of the process of converter production of steel

Source: developed by the author, based on [15].

forms a set of different alternatives, which belong to the management of logistics operations, and passes them to the block of the paired comparison.

The block of selecting the decision-making tasks allows a decision-making person to select one of the possible sets of tasks. The system also provides the possibility of adding new tasks.

The block of formation of the system of indicators. The system requests the database for the indicators that are a kind of estimation of efficiency of the decisions made. One of such indicators is the quantity of the finished product, i.e. steel in tons. There is a set of available indicators so that each user can select the desired information. These indicators are grouped by category and by user profile. As categories are considered: consumption of energy resources for each unit, production output of steel, predicted values as to the quantity of produced steel, and energy costs.

The block of the paired comparison of variants is intended for the successive paired comparison of different alternatives and saving of comparison results.

The block of analyzing the paired comparison allows evaluating the advantage of some variants over others on the part of DMP. It is also useful for detecting errors in the available algorithms and finding more efficient new algorithms. This block is useful for obtaining the answer why the new algorithm will be the best of the suggested ones according to certain parameters.

The block of reports generation. Generation of reports is performed on the basis of saved data of each activity of DMP. If the shift master, upon his/her own experience, taking into consideration an inaccessible information system, etc., made a decision different from the recommended, this will be recorded to a report that also displays eventual deviations of the main indicators of the process efficiency of the converter production of steel. Thus, each decision receives a certain estimation.

The decisions made, succeeded in increasing the efficiency indicators, are passed to the block of analyzing the pair comparison which, by means of information exchange with the modules of databases and modeling, allows generating a report on the new efficient decisions and to give recommendations for improving the existing algorithms.

The module of databases contains the following kinds of databases: tasks, statuses, temporary characteristics. These databases directly exchange information with the module of knowledge base, the modules of modeling and decision-making.

The database of the objects' statuses contains all possible statuses of the converter department units. E. g., for a crane: busy, free; for a ladle car: with bucket, without bucket, bucket with metal, etc. A change of the object's status occurs by means of information exchange with the automated dispatch control system (ADCS).

The database of temporary characteristics receives the data of the time spent on the execution of each operation of the process of converter production of steel taking account of different grades of steel. It also stores operational data on the process of the continuous steel casting through the exchange of information with the ADCS.

The database of tasks contains a set of operations that were not performed in view of the unavailable resources (units). It also stores the priorities for each backlog operation and the time-out data, as well as data of idle units.

The knowledge base is a set of rules that are composed by using the service words IF, OR, AND, THEN, OTHERWISE, to perform a specific action at the time of the execution upon particular condition. In the knowledge base the system of productions or rules has the following appearance:

$$\text{IF } a \text{ AND } b \text{ OR } c \text{ THEN } d \text{ AND } e \text{ AND } f \text{ OTHERWISE } g \text{ AND } h, \quad (1)$$

where a, b, c – particular conditions, while d, e, f, g, h – particular actions.

The example of grammatical rules in the model of converter production of steel looks as follows:

IF <condition of the crane No. 6 = «free»> THEN <recommended to transport the bucket from the ladle car of the converter No. 1 to the ladle car LF No. 2>.

When a resource that is required to perform an operation is freed, by exchanging information between the modules, a recommendation is generated according to the defined priority as to performing a particular action.

The *Fig. 3* shows the mechanism of interaction of the module of knowledge base with the modules of modeling and databases where, with the help of information exchange between the modules, the decision is generated concerning the movement of one or another unit, which participates in the process of converter production of steel. The module of decision-making plays an important role in determining which task with the same priorities from the totality of tasks in the task base, provided that the tasks with the same priorities are more than one, must be performed first, which be the second, etc.

The decision-making mechanism for the status of the ladle car of converter No. 1: «bucket with metal» is presented in the Fig. 3.

For the status of the ladle car of the converter No. 1: «bucket with metal», first of all is determined the status of LF-2, through request to the database of the objects' statuses, if the LF-2 has the status free, then the status of the crane No. 6 is to be determined, if its status is free, it is recommended transportation by the crane No. 6 of the bucket with metal from the ladle car of the converter No. 1 and the ladle car LF-2 with the change of the status of the crane No. 6 to «busy» for the time of transporting the bucket, the ladle car of the converter No. 1 changes to free, that is, it goes into the status of «without bucket», the ladle car LF-2 is changed to busy. After completion of transportation the status of the crane No. 6 is changed to «free», the data are transferred to the model of logistic operations. In case the crane No. 6 is occupied, the database of tasks is modified by adding the necessity of carrying out measures on transportation of the bucket with metal from the ladle car of the converter No. 1 to the ladle car LF-2.

If the status of the LF No. 2 has the value of busy, then the status of the sedimentation stand No. 2 is being checked, in case the checked sedimentation stand is free, the status of the crane No. 6 is to be determined. If the crane is free, it is recommended to transport the bucket with metal from the ladle car of the converter No. 1 to the ladle car LF-2. In another case, the task of transporting the bucket from the converter No. 1 to the LF No. 2 or to the sedimentation stand is added to the database.

It should be noted that the totality of such mechanisms for interaction of the module of knowledge base with the modules of modeling and databases will allow, with use of information exchange, to synthesize the most efficient sequence of logistic operations in the process of converter production of steel.

The author also assumes the possibility of group data processing, allowing all members of the decision-making group to work under equal conditions, have constant access to all available information, and observe all the changes that occur.

The group processing of data allows all team members updating of the edited data, prompt suggestions as to the decision-making, and collectively formulate new ideas. At the same time, information that is not necessary for other team members does not appear on their screens.

CONCLUSIONS

Thus, the proposed decision-making support system for management of the processes of production logistics of an industrial enterprise allows to develop the most effective strategy of behavior of all participants in the process of converter production of steel, including the shift master, who directly manages all units, which will reduce time for decision-making based on the information about actual stocks, planned downtime and losses, as well as will ensure intensification of work of the staff engaged in the production process, helping to determine the price of error in managerial decisions in order to eliminate the possibility of its recurrence in the future. ■

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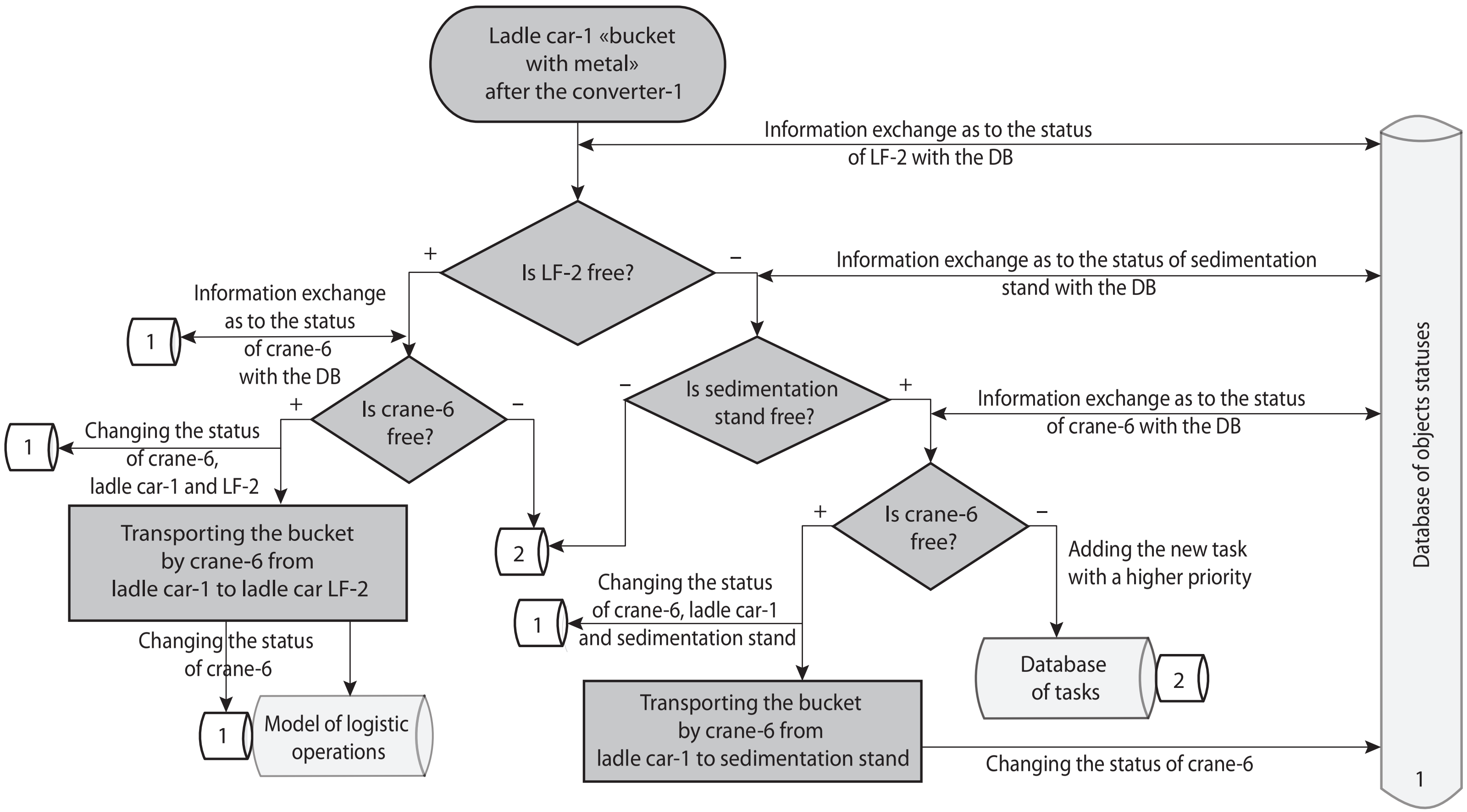

Fig. 3. The decision-making mechanism for the status of the ladle car of the converter No. 1: «bucket with metal after the converter-1»

Source: developed by the author, based on [15].

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