

DOI: 10.15593/2499-9873/2020.1.04

УДК 005.7

**В.Н. Бурков¹, О.В. Логиновский²,
О.И. Дранко³, А.В. Голлай²**

¹ Институт проблем управления им. В.А. Трапезникова РАН, Москва, Россия

² Южно-Уральский государственный университет, Челябинск, Россия

³ Московский физико-технический институт, Москва, Россия

МЕХАНИЗМЫ УМНОГО УПРАВЛЕНИЯ ПРОМЫШЛЕННЫМИ ПРЕДПРИЯТИЯМИ

Излагаются математические модели механизмов умного управления, которые могут быть использованы в организационной системе управления промышленными предприятиями.

Для повышения эффективности управления предложены следующие механизмы: механизм распределения ресурсов (механизм прямых приоритетов, обратные приоритеты, конкурентный механизм, механизм открытого управления), механизм активного опыта (механизм усреднения мнений экспертов, механизмы, основанные на медианных схемах), механизм внутренних цен, ценообразование и механизмы налогообложения, механизм оптимизации цепочки поставок, механизм выбора ассортимента, механизмы стимулирования (стимулы для индивидуальных результатов, коллективные результаты и механизм оплаты бригады), интегрированных механизмов.

Ключевые слова: промышленные предприятия, умное управление, организационное управление, механизмы управления, разработка механизмов, механизм распределения ресурсов, механизм внутренних цен, механизм оптимизации цепочки поставок, механизм выбора ассортимента, механизмы стимулирования.

**V.N. Burkov¹, O.V. Loginovskiy²,
O.I. Dranko³, A.V. Hollay²**

¹ V.A. Trapeznikov Institute of Control Sciences
of the RAS, Moscow, Russian Federation

² South Ural State University, Chelyabinsk, Russian Federation

³ Moscow Institute of Physics and Technology, Moscow, Russian Federation

THE MECHANISMS OF SMART MANAGEMENT FOR INDUSTRIAL ENTERPRISES

In this article you can find some mathematical models of the smart management mechanisms that can be used in the organizational system of management of production corporations.

The following mechanisms can be used to improve the management effectiveness of this system: the resource-allocating mechanism (the mechanism of direct priorities, the reverse priorities, the competitive mechanism, the mechanism of open management); the mechanism of active expertise (the mechanism of averaging experts' opinions, mechanisms based on median schemes); the mechanism of domestic prices; cost-cutting pricing and taxation mechanisms; the supply chain optimization mecha-

nism; the assortment selection mechanism; incentive mechanisms (incentives for individual results, collective results, and the brigade payment mechanism); integrated mechanisms.

Keywords: industrial enterprises, smart management, organizational behavior control, control mechanisms, mechanism design, mechanism of domestic prices, resource-allocating mechanism, supply chain optimization mechanism, assortment selection mechanism, incentive mechanisms.

Introduction

The management of industrial enterprises and organizations is becoming an increasingly difficult task. To solve it, we need not only new approaches, methods and models for the management of industrial enterprises [1–5], but also effective management mechanisms that are useful for the leaders of these enterprises in practice. Such mechanisms can be called the mechanisms of smart management. The emergence of ideas for the development of smart management mechanisms and their use in the management of industry and economy is reflected in several scientific papers [6–10].

The smart management mechanisms could change the attitude of workers towards:

- spending resources frugally;
- using the equipment effectively;
- using more efficient means of production;
- introducing methods and technologies for analysis and processing of information using computer technology.

In this regard, top managers of large manufacturing companies and corporations, as well as smaller industrial enterprises and organizations, need a set of adequate methods to:

- form priorities for certain periods of time [11];
- comprehensively analysis the dynamics of performance of industrial enterprises in comparison with competing enterprises in the relevant areas of production [12, 13];
- increase the adaptation of an industrial enterprise to the constantly changing conditions of management [14];
- enhance production logistics, with the latter focusing on the growing dynamics of finished product markets [15, 16];
- assess the external factors that affect the company possibly even greater than changes in factors within it [17];
- form a modern structure of the company with its focus on increasing the flexibility of personnel management, providing various kinds of resources, effective marketing research, etc. [18, 19];

- create the IT structure of the company, oriented preferably towards its own information and computer control systems, strategic management systems, as well as operational management and control as part of special software for the preparation and adoption of management decisions by owners and managers of industrial enterprises [20].

The description of these methods is presented in [1–5]. To all these methods it is appropriate to add methods and mechanisms for smart management.

1. The Mechanisms of Smart Management

As known from the organizational behavior control theory [5, 6], the smart management mechanisms play a significant role. There are several dozens of such mechanisms, some of which affect the full cycle of the management of industrial enterprises and corporations.

We can group such mechanisms into specific categories among which are the following:

1. Non-manipulative mechanisms.

These are the mechanisms that allow employees to truthfully state the results of their work.

2. Coordinated mechanisms or responsibility education.

The coordinated mechanisms are the mechanisms that make it beneficial to implement commitments or plans, i.e. an honest reflection of the results of work brings greater benefits to the employees than in any way embellished.

3. Advisory mechanisms.

The advisory mechanisms make it possible to produce recommendations (advice) to the decision-maker (DM). It can be computer expert systems or groups of experts. There are two types of advisory mechanisms: passive advisers and active advisers. Passive advisers are not responsible for the effectiveness of their advice. Active advisers make a comparison of the effectiveness of the adviser's recommendation with the decision of the DM under the appropriate incentives.

4. Developing mechanisms.

The developing mechanisms incentivize the development of an industrial enterprise (cost reduction, introduction of innovations, new production technologies, etc.).

Based on these smart management mechanisms, as well as on other developments in industrial consulting, the Institute for Control Sciences of the Russian Academy of Sciences and the consulting firm ROEL-CONSULTING have created a unique integrated technology to increase the efficiency of enterprises and regions. It is based on three fundamentals:

- program-target approach;
- project management;
- complex of smart mechanisms.

Below you can find some mathematical models of the smart management mechanisms that can be used in the organizational system of management of production corporations.

The following mechanisms can be used to improve the management effectiveness of this system:

- the resource-allocating mechanism (the mechanism of direct priorities, the reverse priorities, the competitive mechanism, the mechanism of open management);
- the mechanism of active expertise (the mechanism of averaging experts' opinions, mechanisms based on median schemes);
- the mechanism of domestic prices;
- cost-cutting pricing and taxation mechanisms;
- the supply chain optimization mechanism;
- the assortment selection mechanism;
- incentive mechanisms (incentives for individual results, collective results, and the brigade payment mechanism);
- integrated mechanisms.

2. The Mechanisms of Smart Management

Based on the requests of n consumers in the amount of s_i ($i = 1, \dots, n$), some resource is allocated in the quantity R . If $\sum_{i=1}^n s_i > R$ (deficit), then it is necessary to determine the amount of resources allocated to the i -th consumer by the rule x_i .

If the priority of the bids is equal, then, obviously, $x_i = \gamma s_i$ and therefore (all bids are proportionally "cut" by multiplying by $\gamma < 1$).

If the priorities of each consumer A_i are given, then the following choices of the resource-allocating mechanisms are possible:

a) The mechanism of direct priorities

The allocation is carried out according to the rule

$$x_i = \min \{s_i, \gamma A_i s_i\},$$

where γ is a common parameter for all consumers, and it is determined from the condition (the entire resource is distributed):

$$\sum_{i=1}^n x_i = R, \quad (1)$$

(the entire resource is distributed).

This mechanism fulfils the principle "the more you ask – the more you get", which cannot provide a correct solution.

b) The mechanism of reverse priorities

This mechanism is based on the assumption that the less the resource consumer needs, the more his bid is justified. In accordance with this, the distribution of the resource is carried out according to the rule

$$\min \left\{ s_i, \gamma \frac{A_i}{s_i} \right\}, \quad (2)$$

where the number γ is defined, as in the mechanism of direct priorities, from the condition (1).

It follows from (2) that it is unprofitable for a consumer to submit a very small or very large bid as she will receive the maximum resource if her bid satisfies condition

$$s_i = \gamma \frac{A_i}{s_i}.$$

Thus, the equilibrium set of consumer strategies is

$$s_i = \sqrt{\gamma A_i}, \quad (3)$$

with $x_i = s_i$.

From (3) we find γ :

$$\sqrt{\gamma} = \frac{R}{\sum_{i=1}^n \sqrt{A_i}}.$$

The equilibrium of strategies of consumer (3) is that in case of deviation from them, the consumer will be allocated less resources.

c) The competitive mechanism.

This mechanism is applied in those cases when bid for a resource cannot be cut down but they are accurately calculated by consumers for the implementation of specific projects. Under these conditions, the center conducts a contest of bids. Those who win the contest fully receive the required resource, and those who lose do not receive anything.

The implementation of this mechanism works as follows. Consumers inform the center of their bids s_i , as well as their valuations of the resource w_i . Then, for each consumer the following index of efficiency is calculated

$$e_i = \frac{w_i}{s_i},$$

and then the bids are fully satisfied in the decreasing order of the efficiency index.

The disadvantage of this mechanism is the possibility that consumers may report a great valuation to get the resource, whereas, in reality, they do not have it. Therefore, in the actual implementation of the competitive mechanism, an effective system of control and appropriate sanctions are necessary;

d) The mechanism of open management.

In the mechanisms discussed above, consumers can achieve a better distribution of the resource by distorting the information, thus the center does not receive reliable data on consumer requests. The idea of an open management mechanism is to create incentives for consumers to report their real valuations in the bid.

One of the possible mechanisms of open management is a step-by-step division of the resource equally among all consumers. If the requests of some consumers are satisfied, then they are excluded from further distribution, while the resource of the center is adjusted to the already distributed volume, and the distribution proceeds between the remaining consumers.

When at some stage an equal distribution between the remaining consumers does not satisfy any of them, then all these consumers get an equal part of the resource, and the mechanism stops.

With this mechanism, some consumers receive the resource completely in accordance with their bids, so they do not have an incentive to distort their real valuations. Unsatisfied consumers cannot increase the resource allocated to them by either increasing or decreasing their bids. Thus, when allocating resources in accordance with the mechanism of open management, the center receives reliable information about the real valuations of consumers.

3. The Mechanism of Domestic Prices

Domestic prices are prices used in intra-company settlements between departments of the same company or enterprises that are part of a single holding. In the case of vertical integration, domestic prices allow the distribution of profits from the sale of products between the units involved in its creation at different stages. In the case of horizontal integration, the internal price mechanism is designed to determine the intra-firm price for the products (or other performance results). Let $v_i(z)$ be the function of the optimal production depending on the internal price in a department i .

Then,

$$V = \sum_{i=1}^n v_i(z)$$

is the supply curve.

We look for z such that

$$zV - \sum_{i=1}^n zv_i \rightarrow \max.$$

Let v_i' be the actual output of each department, then zv_i' is the payment (reward) to each department.

This mechanism ensures the reliability of the information reported: the department's report the true function of the optimal production, as each division receives a reward in proportion to the volume of output released by it, and the price is common for all departments.

4. The Supply Chain Optimization Mechanism

The supply chain is a collection of flows of raw materials and/or finished products from production place and/or purchases to points of sale to customers through intermediate points - warehouses, logistics centers. The supply chain optimization mechanism is applied at the stage of medium-range planning of material flows. These mechanisms allow to coordinate and optimally distribute finished product streams to sales markets, find the most profitable sources and distribution routes, determine production medium-range planning, plan sources and methods of raw materials delivery, and determine a rational strategy for working with warehouses. Mechanisms for optimizing supply chain are used in scenario modeling of business development, in particular, in calculating the economic effect of opening/closing warehouse, sales or production division, in particular, the effect of vertical integration. Using these mechanisms, transnational corporations increase profits by transferring production to countries with lower costs. These methods and their mathematical models are described in detail in the scientific literature [11].

5. The Assortment Selection Mechanism

The mechanism of assortment selection is an effective way of conducting assortment policy (which products to produce, the output of which products to increase and to reduce, etc.).

Let z_i be the prices of a product, v_i - volumes of production, d_i - marginal costs (note that along with the production costs, the costs of increasing output and marketing capacity should be considered), then

$p_i = z_i v_i - d_i v_i$ is marginal profit,

$r_i = \frac{p_i}{d_i v_i}$ is marginal profitability,

$O = \sum_{i=1}^n d_i v_i$ is total costs (working capital).

We need to find v_i^* such that

$$p_i = z_i v_i^* - d_i v_i^* \rightarrow \max,$$

subject to $\sum_{i=1}^n d_i v_i^* \leq O$ (restriction on circulating assets).

This model is analogous to the well-known ransack problem, the algorithm for solving which is as follows: we select the maximum possible volumes of products according to their descending order r_i , and the assets are distributed among the products of the chosen assortment.

6. Incentive Mechanisms

These mechanisms serve as a tool for coordinating the interests of the center and facilities and ensure the conditions for the fulfilment of the plans established by the center.

a) Incentives for individual results.

Let $f_i(v_i)$ be the function of incentives (this can be the size of the bonus, the piece rate, the share of profits).

We need to find v_i^* such that

$$\sum_{i=1}^n f_i(v_i^*) \rightarrow \min,$$

subject to $p_i + f_i(v_i^*) \geq 0$.

Thus, it is beneficial to implement the plan with minimum payments from the center.

b) Incentives for collective results.

This mechanism is used when the center does not observe the action of each agent separately, but knows only a certain general result of the collective activity of all agents.

Let $d_i(v_i)$ be the function of costs of agents, V is the result of the collective activity (total output).

We need to find v_i such that

$$\sum_{i=1}^n d_i(v_i) \rightarrow \min,$$

subject to $\sum_{i=1}^n d_i(v_i) = V$.

The center compensates the agents for their costs in the amount of $d_i(v_i)$ when the agents reach the result v_i . Otherwise, the compensation is zero.

c) The brigade payment mechanism

These mechanisms are aimed at increasing the efficiency of the work of the collective unit (site, department, shop, brigade, etc.). The basis for the brigade payment mechanism is the allocation of the bonus fund based on the labor participation coefficients (LPC) of the department's employees.

Let F be the bonus fund defined by the center,

k_j ($j=1, \dots, K$) is the performance indicators of the departments (the values of the indicators are set in a relative scale, e.g. as a percentage of the maximum possible value),

$$LPC_i = \sum_{j=1}^K k_j,$$

where the summation is of the values of the i -th department.

Then the bonus of departments is determined by the formula

$$P_i = \frac{F}{\sum_{j=1}^n LPC_j} LPC_i.$$

Conclusion

At the moment, cutting has increased the complexity of managing industrial enterprises. This complexity is caused by an increase in the number of relations with external counterparties, an increase in the dynamism of the external environment, the rapid growth in the amount of information in management, the shortening of the development and introduction of new products and technologies, the expansion of potential sales markets to a global scale, etc. All this leads to ineffectiveness of classical methods, built on decision-making by a person who is not able to handle such large information flows.

There is a need to involve computer systems capable of processing these information flows, that is, the introduction of smart management, the concept of which is based on the widespread introduction of mathematical methods and models in the management process.

The proposed classification of mechanisms is not complete, it only indicates the direction of development of this area of knowledge and actualizes the issue of developing models and methods of smart management.

Список литературы

1. Коренная К.А., Логиновский О.В., Максимов А.А. Интегрированные информационные системы промышленных предприятий: монография / под ред. А.Л. Шестакова; ЮУрГУ. – Челябинск, 2012. – 315 с.
2. Коренная К.А., Максимов А.А. Математические модели в управлении промышленными предприятиями: монография / под ред. А.Л. Шестакова; ЮУрГУ. – Челябинск, 2011. – 327 с.
3. Коренная К.А., Логиновский О.В., Максимов А.А. Управление промышленными предприятиями в условиях глобальной нестабильности: монография / под ред. А.Л. Шестакова; ЮУрГУ. – Челябинск, 2013. – 403 с.
4. Логиновский О.В., Максимов А.А. Корпоративное управление. – М.: Машиностроение, 2007. – Т. 2. – 624 с.
5. Логиновский О.В., Максимов А.А. Управление промышленным предприятием. – М.: Машиностроение, 2006. – Т. 1. – 603 с.
6. Бурков В.Н., Коргин Н.А., Новиков Д.А. Введение в теорию управления организационными системами / под ред. Д.А. Новикова. – М.: ЛИБРОКОМ, 2009. – 264 с.
7. Механизмы корпоративного управления / В.Н. Бурков, И.А. Агеев, Е.А. Баранчикова [и др.]; ИПУ РАН. – М., 2004. – 109 с.
8. Бурков В.Н., Буркова И.В., Губко М.В. Механизмы управления: Управление организацией: планирование, организация, стимулирование, контроль: учеб. пособие / под ред. Д.А. Новикова. – М.: Ленанд, 2013. – 216 с.
9. Вентцель Е.С. Исследование операций: Задачи, принципы, методология. – М.: Высшая школа, 2008. – 208 с.
10. Smart management methods and mechanisms of industrial enterprises and organizations / V.N. Burkov, I.V. Burkova, Ya.D. Gelrud, O.V. Loginovskiy // Bulletin of SUSU. Computer Technologies, Automatic Control, Radio Electronics. – 2016. – Vol. 16, no. 3. – P. 93–101.
11. Mas-Colell A., Whinston M.D., Green J.R. Microeconomic theory. – N.Y.: Oxford Univ. Press, 1995. – 981 p.
12. Copeland T.E., Weston J.F. Financial theory and corporate finance. – 4th ed. – Boston: Addison-Wesley, 2004. – 960 p.
13. Новиков Д.А. Теория управления организационными системами. – М.: Изд-во физ.-мат. лит., 2012. – 604 с.
14. Shoham Y., Leyton-Brown K. Multiagent systems: algorithmic, game-theoretic, and logical foundations. – Cambridge: Cambridge University Press, 2008. – 504 p.
15. Nyhuis P., Wiendahl H-P. Fundamentals of production logistics: theory, tools and applications. – Berlin: Springer, 2009. – 336 p.

16. Christopher M. Logistics & supply chain management. – London: FT Publishing International, 2016. – 328 p.
17. Worley C.G., Williams T.D., Lawler E.E. The Agility Factor: Building Adaptable Organizations for Superior Performance. – US: FT Jossey-Bass, 2014. – 208 p.
18. Губко М.В. Математические модели оптимизации иерархических структур. – М.: Ленанд, 2006. – 264 p.
19. Baron R.A., Greenberg J. Behavior in organizations. – 9th ed. – New Jersey: Pearson Education Inc., 2008. – 720 p.
20. Turban E., Pollard C., Wood G. Information technology for management: advancing sustainable, profitable business growth. – John Wiley & Sons, 2015. – 386 p.

References

1. Korennaya K.A., Loginovsky O.V., Maksimov A.A. Integrirovannyye informatsionnyye sistemy promyshlennykh predpriyatiy [Integrated information systems of industrial enterprises]. Chelyabinsk, Publishing Center of SUSU, 2012. 315 p.
2. Korennaya K.A., Maksimov A.A. Matematicheskiye modeli v upravlenii promyshlennymi predpriyatiyami [Mathematical models in the management of industrial enterprises]. Chelyabinsk, Publishing Center of SUSU, 2011. 327 p.
3. Korennaya K.A., Loginovsky O.V., Maksimov A.A. Upravleniye promyshlennymi predpriyatiyami v usloviyakh global'noy nestabil'nosti [Management of industrial enterprises in conditions of global instability]. Chelyabinsk, Publishing Center of SUSU, 2013. 403 p.
4. Loginovsky O.V., Maksimov A.A. Korporativnoye upravleniye [Corporate governance]. Moscow, Mechanical Engineering. 2007. vol. 2. 624 p.
5. Loginovsky O.V., Maksimov A.A. Upravleniye promyshlennym predpriyatiyem [Management of an industrial enterprise]. Moscow, Mechanical Engineering, 2006, vol. 1, 603 p.
6. Burkov V.N., Korgin N.A., Novikov D.A. Vvedeniye v teoriyu upravleniya organizatsionnymi sistemami [Introduction to the theory of management of organizational systems]. Moscow, LIBROKOM, 2009. 264 p.
7. Burkov V.N., Ageev I.A., Baranchikova E.A. Mekhanizmy korporativnogo upravleniya [Mechanisms of corporate governance]. Moscow, IPP RAS, 2004. 109 p.
8. Burkov V.N., Burkova I.V., Gubko M.V. Mekhanizmy upravleniya: Upravleniye organizatsiyey: planirovaniye, organizatsiya, stimulirovaniye, kontrol': Uchebnoye posobiye [Mechanisms of management: Organization management: planning, organization, stimulation, control: a textbook]. Moscow, LENAND, 2013. 216 p.

9. Wentzel E.S. Issledovaniye operatsiy: Zadachi, printsipy, metodologiya [Operations Research: Objectives, principles, methodology]. Moscow, Higher School, 2008. 208 p.
10. Burkov V.N., Burkova I.V., Gelrud Ya.D., Loginovskiy O.V. Smart Management Methods and Mechanisms of Industrial Enterprises and Organizations. *Bulletin of SUSU. Series: "Computer Technologies, Automatic Control, Radio Electronics"*, 2016, vol.16, no. 3, pp. 93-101.
11. Mas-Collel A., Whinston M.D., Green J.R. Microeconomic theory. N.Y., Oxford Univ. Press, 1995. 981 p.
12. Copeland T.E., Weston J.F. Financial theory and corporate finance. Boston, Addison-Wesley, 2004. 960 p.
13. Novikov D.A. Teoriya upravleniya organizatsionnymi sistemami [Theory of management of organizational systems]. Moscow, Publishing House of Physical and Mathematical Literature, 2012. 604 p.
14. Shoham Y., Leyton-Brown K. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press, 2008. 504 p.
15. Nyhuis P., Wiendahl H-P. Fundamentals of Production Logistics: Theory, Tools and Applications. Springer, 2009. 336 p.
16. Christopher M. Logistics & Supply Chain Management. FT Publishing International, 2016. 328 p.
17. Worley C.G., Williams T.D., Lawler E.E. The Agility Factor: Building Adaptable Organizations for Superior Performance. FT Jossey-Bass, 2014. 208 p.
18. Gubko, M.V. Matematicheskiye modeli optimizatsii iyerarkhicheskikh struktur [Mathematical models of optimization of hierarchical structures]. Moscow, LENAND, 2006. 264 p.
19. Baron R.A., Greenberg J. Behavior in organizations. New Jersey, Pearson Education Inc., 2008. 720 p.
20. Turban E., Pollard C., Wood G. Information Technology for Management: Advancing Sustainable, Profitable Business Growth. John Wiley & Sons, 2015. 386 p.

Получено 07.11.2019

Принято 31.01.2020

Сведения об авторах

Бурков Владимир Николаевич (Москва, Россия) – доктор технических наук, профессор, заслуженный деятель науки РФ, главный научный сотрудник лаборатории активных систем, Институт проблем управления им. В.А. Трапезникова РАН (117997, Москва, ул. Профсоюзная, 65, e-mail: dan@ipu.ru).

Логиновский Олег Витальевич (Челябинск, Россия) – доктор технических наук, профессор, заслуженный деятель науки РФ, заведующий кафедрой «Информационно-аналитическое обеспечение управления в социальных и экономических системах», Южно-Уральский государственный университет (454080, Челябинск, просп. Ленина, 76, e-mail: loginovskiiiov@susu.ru).

Дранко Олег Иванович (Москва, Россия) – доктор технических наук, доцент, профессор кафедры «Инновационный менеджмент», Московский физико-технический институт (141701, Московская обл., Долгопрудный, Институтский пер., 9, e-mail: olegdranko@gmail.com).

Голлай Александр Владимирович (Челябинск, Россия) – кандидат химических наук, доцент кафедры «Информационно-аналитическое обеспечение управления в социальных и экономических системах», Южно-Уральский государственный университет (454080, Челябинск, просп. Ленина, 76, e-mail: gollaiav@susu.ru).

About the authors

Vladimir N. Burkov (Moscow, Russian Federation) – Dr. Habil in Engineering, Professor, Honored Scientist of the Russian Federation, Chief Researcher, Laboratory of Active Systems, V.A. Trapeznikov Institute of Control Sciences of the RAS (117997, Moscow, Profsoyuznaya st., 65, e-mail: dan@ipu.ru).

Oleg V. Loginovskiy (Chelyabinsk, Russian Federation) – Dr. Habil in Engineering, Professor, Honored Scientist of the Russian Federation, Head of the Department of Information and Analytical Support for Management in Social and Economic Systems, South Ural State University (764080, Chelyabinsk, Lenin av., 76, e-mail: loginovskiiiov@susu.ru).

Oleg I. Dranko (Moscow, Russian Federation) – Dr. Habil in Engineering, Associate Professor, Professor, Department of Innovation Management, Moscow Institute of Physics and Technology (141701, Moscow Region, Dolgoprudny, Institutsky Lane, 9, e-mail: olegdranko@gmail.com).

Alexander V. Hollay (Chelyabinsk, Russian Federation) – Ph.D. in Chemistry, Associate Professor, Department of Information and Analytical Support for Management in Social and Economic Systems, South Ural State University (764080, Chelyabinsk, Lenin av., 76, e-mail: gollaiav@susu.ru).

Библиографическое описание статьи согласно ГОСТ Р 7.0.100-2018:

Механизмы умного управления промышленными предприятиями = The mechanisms of smart management for industrial enterprises / В. Н. Бурков, О. В. Логиновский, О. И. Дранко, А. В. Голлай. – DOI 10.15593/2499-9873/2020.1.04. – Текст : непосредственный // Прикладная математика и вопросы управления = Applied Mathematics and Control Sciences. – 2020. – № 1. – С. 59–73. – Ст. на англ. языке.

Цитирование статьи в изданиях РИНЦ:

Бурков В.Н., Логиновский О.В., Дранко О.И., Голлай А.В. Механизмы умного управления промышленными предприятиями // Прикладная математика и вопросы управления. – 2020. – № 1. – С. 59–73. DOI: 10.15593/2499-9873/2020.1.04

Цитирование статьи в references и международных изданиях:

Cite this article as:

Burkov V.N., Loginovskiy O.V., Dranko O.I., Hollay A.V. The mechanisms of smart management for industrial enterprises. *Applied Mathematics and Control Sciences*, 2020, no. 1, pp. 59–73. DOI: 10.15593/2499-9873/2020.1.04 (*in English*)