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MODELING THE MARKETING CHARACTERISTICS OF MARKET CAPACITY FOR ELECTRICAL AUTOMATION

The article is a continuation of scientific development, the beginning of which the authors presented in the previous room. Questions of simulation of electrical characteristics of marketing automation without separate technological purposes. As the object of study selected different types of low-voltage equipment. It is proved that the most important marketing characteristics of the products the electrical business Park is articles, which are currently in operation. Existing methodical approaches to the definition of industry Park electrical automation do not provide the required accuracy of calculations. They do not fully take into account the age structure of the main technological equipment for automation of work of which is intended for electrical automation. The technique of determining industry Park, products which do not have independent technological purposes, the use of indicators of the age structure of technological equipment. For example, different groups of low-voltage equipment of the basic steps of this methodology. Suggestions the authors suggest the partition of the whole technological equipment for the three age groups and conduct separate calculations for each of them. The final coefficients of the applicability of electrical automation at the unit of technological equipment are determined based on the specific weight of each age group in the total industry Park of technological equipment. All theoretical concepts are accompanied by detailed examples of calculations.

Keywords: park items, life, automation, marketing, the coefficients of applicability, processing equipment.
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Introduction. With the continuous introduction of new production capacity in all sectors of the economy, accompanied by the development of electrification, mechanization and automation of technological processes increases the demand for electrical products. Only in the last 25 years, the production of electrical products increased by almost half [1, 2]. Constantly improving the structure of manufactured electrical products, its technical and economic characteristics, increases quality, increases industry Park electrical automation (EA) [3].

The definition of industry Park ESA for any projected period is defined as the solution of two interrelated tasks: calculation of the prospect Park of the main technological equipment, automated operation which provide EA; determining the growth index of the level of mechanization and automation of the basic types of equipment, i.e. the change in the number of different types of EA per piece of equipment.

It is obvious that the need for EA for the maintenance needs is in direct proportion to the actual Park Electricals [3, 4]. Determination of its size in the future will be characterized and future needs in EA maintenance needs.

Intensive growth of the output branches of engineering is closely linked to the increased need for metal and other structural materials, which can not but affect the formation of the Park Metalworking equipment — metal-cutting machines, press-forging and foundry equipment.

Currently there is no single universally accepted methods of predicting industry Park of technological equipment. Our research suggests that for electrical automation equipment (contactors, motors, relays, fuses, switches, electromagnets, magnetic starters, transformers, etc.) such base calculations is virtually absent [2, 3]. Businesses and industries quantization Park EA is not conducted as to determine it by direct counting almost impossible. In this regard, the development of scientific and methodological foundations of determining of the Park electrical automation is an important and urgent task.

Problem statement. The existing scientific and methodological recommendations for determining equipment park in service, for certain types of industrial products have different methodological and regulatory framework.

However, these materials have not been paid due attention to consideration of the age composition of the main technological equipment in a particular industry. For equipment to a greater extent and used electrical automation. Our research suggests that Park of technological equipment of machine-building industries are very heterogeneous in its age structure [2, 3]. And therefore ignoring this situation leads to certain errors in the calculations of industry Park products, used for its configuration.

Analysis of recent researches and publications. Problems of modeling the marketing characteristics of market capacity for electrical automation was considered by such scientists as Kukhnyy L.S. [1], Aksenov A.P. [4], Kosenko A.V. [5], Illiashenko S.N. [6-8], Kosenko O.P. [9-10], Kobelev V.N. [11], Poberezhaya N.N. [12], Starostyna A.A. [13], Shypulyna Yu.S. [11], Tovazhnyanskyy V.L. [15], Yakovlev A.Y. [16, 17] etc.

The focus in these and other such works [18-20] given the definition of Park of the process equipment. The importance and relevance of this direction of scientific research is not in doubt, since the production of machine tools, foundry machines, presses, etc. is the most important and the primary task of engineering production. However, as the results of our research, the problems of assessing the Park's main technological equipment has been largely solved, and at present this is not so important. Much more urgent and more complicated is the problem of determining the equipment park, which has no independent technological purpose (bearings, motors, pumps, electrical products, computers, light fixtures, measuring instruments, etc.).

The purpose of this paper is the simulation of the characteristics of marketing automation. In particular, the definition of industry Park, electrical automation, has no independent technological purposes, taking into account the age structure of the main technological equipment. Object of research are machine-building enterprises of the Kharkiv industrial region.

Research findings. In the first part of this article sets out the methodology for determining branch Park electrical automation (EA), which has no independent technological purposes. To determine industry Park electrical automation proposed by studying their applicability (actual presence) in any one kind of technological equipment industry Park which is known in advance or can be set in a scientific and proven methods. In particular, while defining industry Park low-voltage equipment based on invited to take the main types of the main technological equipment, asynchronous motors with power up to 100 kW, the amount of generated or consumed in the sector of electricity, etc.

However, the use of this technique in practice is limited by the fact that in the industrial Park *j*-th type of process equipment can be represented by different years of release, whereby the calculation results are not accurate enough. Age structure of the park of technological equipment of machine-building enterprises of Ukraine, in our opinion, is not progressive. Most types of technological equipment operated outside not only moral but also physical life. And, over time, this provision is not only not improving, but has a pronounced tendency to deterioration (table 1).

Table 1 shows that currently in operation is quite a lot of similar types of process equipment for various model years. The results of our research allow to assert that the older technology equipment has a lower level

of automation in comparison with similar models later model years. For example, just 20-25 years ago in a classic electric circuit of the cutting machine contained two control buttons, one or two magnetic starter-fuses, which provides automated control and protection of one or two asynchronous motors. All automatics were attached to the ground screw of the machine and was on a mechanical basis. Over time electric circuit metal cutting equipment, there are additional motors that perform automatic part clamping, various other auxiliary operations. Modern metal-cutting machine installed in an average of 5-6 magnetic starters, as most relays, limit and contact switches, electromagnets, circuit breakers, pushbuttons and control stations.

Table 1 – **Dynamics of age structure of Park of technological equipment of machine-building enterprises** (developed by authors)

Life, years	The percentage of equipment in the industrial Park, %		
	cutting	forging	foundry
The age structure of process equipment in 1995			
Up to 10 years	32,7	35,0	27,0
10-20 years	27,5	26,3	31,8
More than 20 years	39,8	38,7	41,2
The age structure of process equipment in 2005			
Up to 10 years	27,8	31,8	25,1
10-20 years	29,4	27,9	32,8
More than 20 years	42,8	40,3	43,1
The age structure of process equipment in 2015			
Up to 10 years	24,7	35,0	19,9
10-20 years	30,7	26,3	34,7
More than 20 years	44,6	38,7	45,4

The value of automation, both immediate and in the long term will increase. It will manifest itself, first of all:

a) in expanding the scope of its application, in entering into those areas of production that are not yet amenable to cost-effective automation;

b) to increase the share of automated equipment in all sectors, in the development of automation of complex nature;

c) in the transition from more simple forms of automation to a higher, flexible forms, for equipment with numerical control, adaptive control systems that optimize production processes.

The development of automation in these areas would fundamentally change the nature of the proceedings.

Automation allows a single operator to make process control and monitoring instrumentation located on panel control. The job of the operator is much more complicated, since rapid decision-making associated with the direct operation operation the mode of operation requires constant psychological stress. Compliance with the technological mode when an automatic operation is much higher than in manual operation. In particular, the duration of rotation of the form, the beginning of rotation of the bucket, and other operations of the automated machine of centrifugal casting of cast iron tubes kept automation to a fraction of a second. There will be a strict sequence of operations.

Automation of any equipment entails an increase in the saturation of his EA. For example, in comparison with the centrifugal acting pipe-casting machine that has a functional push-button ignition and operation, for a similar machine with automated control requires 2 motor 11 and travel end switch, 15 relay, 3 relays, 1 command device, 1 universal switch. The total number of electrical products for the automated acting pipe-casting machine of the smallest size exceeds 100 units. Similar examples can be found on machine tools and forging equipment.

In table 2 shows generalized data on the dynamics of the coefficients of applicability for electrical automation in General, and their most typical representatives per one cutting machine. Determination of the coefficients of applicability was conducted by the method discussed in the first part of the article.

Table 2 – **Evolution of the rate of applicability of electrical automation on a single cutting machine** (developed by authors)

EA and their main groups	1995	2000	2005	2010	2015
The coefficients of applicability, units/machine:					
Magnetic starters	3,85	4,19	4,61	5,12	5,45
Circuit breakers	1,39	1,72	1,98	2,20	2,49
Electromagnets	0,86	0,78	0,83	0,72	0,88
Buttons	5,11	5,46	6,22	7,21	7,36
The ultimate and limit switches and switches	3,51	4,18	4,88	5,62	5,42
Control relay	3,64	3,87	4,09	4,49	5,08
Switches	2,18	2,73	3,02	3,49	4,11
The terminals	73	66	70	65	68
Connectors	0,76	0,92	1,23	1,55	1,73
Proximity switches	0,18	0,94	1,56	2,09	2,36
Fuse	6,42	5,81	7,50	7,30	8,01

Table 2 allows drawing a number of conclusions of importance for predicting the coefficients of the applicability of EA on Metalworking equipment. As expected, when analyzing the General growth trends of the level of automation equipment, the intensity of his EA increases every year, as evidenced by the dynamics of applicability as all of EA and of the individual species per unit of process equipment. In particular, during the period from 1995 to 2015. The number of low-voltage equipment installed on average, a metal cutting machine, has increased one and a half times.

The above material allows to conclude that the growth of automation equipment increases the intensity of his EA, i.e. change the ratios of applicability. In this regard, the analysis of the Electromechanical schemes of technological equipment of one year gives an incomplete view of the actual applicability of EA on its specific form. Therefore, to analyze the applicability of EA on the basis of the models should not one sample year, and for several. Offered this kind of analysis to carry out three years of production of technological equipment, taken in the middle of the actual term of its operation is defined to 10, 10-20 and more than 20 years. A sufficiently large gap in terms of operation is attributable to the substantial deterioration of Park of the process equipment at Ukrainian machine-building enterprises. The results of the analysis of applicability of electromagnetic actuators on different types of process equipment are listed in table 3.

Table 3 – **Coefficients of the applicability of electromagnetic actuators for the cutting machines of different years of release** (developed by authors)

The type of equipment and year of its release	Electromagnetic contactors rated current, A				
	10	25	40	63	100
Cutting					
1993	1,31	1,13	0,24	0,11	0,03
2002	1,56	1,34	0,30	0,08	0,03
2011	2,02	1,81	0,33	0,14	0,03
Forging					
1993	1,72	1,50	0,36	0,23	0,13
2002	2,15	1,24	0,29	0,28	0,15
2011	2,71	0,91	0,22	0,21	0,08
Foundry					
1993	0,92	0,94	0,07	0,02	0,01
2002	1,07	1,09	0,09	0,02	0,01
2011	1,14	1,31	0,14	0,03	0,015

The feasibility of this approach, in our view, especially noticeable when defining a Park EA for engineering industries with a large proportion of any age group equipment. Despite the complexity of the calculations, the accuracy of the final result in this case is increased.

Consequently, the coefficients of the applicability of EA on the main types of technological equipment can be calculated as follows:

$$K_{ij} = \sum_{t=1}^{h} K_{ij}^{t} \cdot \beta_{j}^{t}, \quad (1)$$

where K_{ij}^{t} – coefficient of applicability of the *i*-th type CA on the *j*-th type of process equipment in a given time interval *t* the actual period of service; β_{j}^{t} – the percentage of equipment with a given period *t* of his service in the park.

The values of the coefficients of applicability, is given in table 4, was calculated based on the dependence (1).

Table 4 – **Coefficients of the applicability of electromagnetic actuators for metal-cutting equipment, given its age structure** (developed by authors)

The type of equipment	The coefficients of applicability of electromagnetic actuators at rated current, A				
	10	25	40	63	100
Cutting	1,62	1,42	0,28	0,11	0,03
Forging	2,48	1,05	0,25	0,23	0,10
Foundry	1,01	1,08	0,09	0,02	0,11

To check the obtained coefficients the applicability (table. 4) regarding the possibility of their use in defining industry Park EA has investigated a number of engineering enterprises of the Kharkov industrial region. By direct counting on enterprises was determined by the actual Park ENA in different age groups of the main technological equipment of various kinds.

It should be noted that the method of direct calculation allows you to accurately set for each of the businesses actual existence of EA on all types of the main technological equipment. In determining Park ES by this method consider all the available manufacturing equipment, their specific characteristics, possible replacement or upgrading. Despite the greater accuracy of the final results, the method of direct calculation is rarely used in practice in connection with its significant complexity. In our opinion, to verify the qualitative characteristics of the proposed method is a method of direct calculation can be used to study a limited sample of EA.

The results of the study on electromagnetic actuator nominal current 10 A (I_{nom}= 10A) are listed in table 5.

Table 5 – **Coefficients of the applicability of the electromagnetic actuator (Inom= 10A) on technological equipment of individual enterprises** (developed by authors)

The type of equipment and year of its release	The industry				
	1	2	3	4	5
Cutting					
Up to 10 years	2,21	2,01	2,11	1,97	2,38
10-20 years	1,59	1,48	1,39	1,72	1,31
More than 20 years	1,32	1,26	1,38	1,18	1,28
Forging					
Up to 10 years	2,81	2,97	2,69	3,07	2,86
10-20 years	2,32	2,41	2,49	2,21	2,38
More than 20 years	1,69	1,84	1,79	1,87	1,61
Foundry					
Up to 10 years	1,23	1,30	1,14	-	1,19
10-20 years	1,11	1,07	0,92	-	0,88
More than 20 years	0,98	0,87	0,91	-	1,02

Using the apparatus of mathematical statistics [19, 20] have the opportunity to check the degree of reliability of the obtained coefficients of applicability of electromagnetic actuators (table 5) and their use in determining industry Park EA. The authors proved the validity of the distribution of these ratios for all age group equipment in the industry. Was determined the confidence intervals of the General population and proved that their border fits the estimated coefficient of applicability.

Conclusions. Analysis of the results conducted by the authors of the calculations leads to the conclusion that the estimated coefficients of the applicability of EA on metal-cutting, press-forging and foundry equipment according to the adopted age structure of this equipment allows to draw the following conclusion. With a probability of 95% they can be used in an industry, abandoning time-consuming method of immediate (direct) Park invoices for electrical automation. The results of the study, the authors tested on several machine-building enterprises of the Kharkov industrial region.

Prospects for further research related to the development of methods for the determination of EA Park industry to other industries. First and foremost, in our opinion, very promising for such studies are: energy industry, agriculture, metallurgy and chemical industry. In addition, an extremely interesting area is the modeling of size industry Park EA for medium and long term. The results of these studies can form the normative-systematic marketing research in determining market (or marketing) characteristics of the product, provide maintenance needs, planning of development indicators of production.

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Моделювання маркетингових характеристик місткості ринку електротехнічних засобів автоматизації

Стаття являє собою продовження наукових розробок, початок яких авторами представлено в попередньому номері. Розглянуто питання моделювання маркетингових характеристик електротехнічних засобів автоматизації, які не мають самостійного технологічного призначення. Існуючі методичні підходи до визначення галузевого парку електротехнічних засобів автоматизації не забезпечують необхідної точності розрахунків. Вони не повною мірою враховують вікову структуру основного технологічного обладнання, для забезпечення автоматизованої роботи якого і призначені електротехнічних засобів автоматизації. Розроблена методика визначення галузевого парку виробів, що не мають самостійного технологічного призначення, з використання показників вікової структури технологічного обладнання. Підсумкові коефіцієнти вживаності електротехнічних засобів автоматизації на одиницю технологічного устаткування визначаються з урахуванням питомої ваги кожної вікової групи в загальному галузевому парку технологічного обладнання. Всі теоретичні положення супроводжуються детальними прикладами розрахунків.

Ключові слова: парк виробів, термін служби, засоби автоматизації, маркетинг, коефіцієнти вживаності, технологічне обладнання.

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Моделирование маркетинговых характеристик емкости рынка электротехнических средств автоматизации

Статья представляет собой продолжение научных разработок, начало которых авторами представлено в предыдущем номере. Рассмотрены вопросы моделирования маркетинговых характеристик электротехнических средств автоматизации, не имеющих самостоятельного технологического назначения. Существующие методические подходы к определению отраслевого парка электротехнических средств автоматизации не обеспечивают необходимой точности расчетов. Они не в полной мере учитывают возрастную структуру основного технологического оборудования, для обеспечения автоматизированной работы которого и предназначены электротехнических средств автоматизации. Разработана методика определения отраслевого парка изделий, не имеющих самостоятельного технологического назначения, с использование показателей возрастной структуры технологического оборудования. Итоговые коэффициенты применяемости электротехнических средств автоматизации на единицу технологического оборудования определяются с учетом удельного веса каждой возрастной группы в общем отраслевом парке технологического оборудования. Все теоретические положения сопровождаются примерами расчетов.

Ключевые слова: парк изделий, срок службы, средства автоматизации, маркетинг, коэффициенты применяемости, технологическое оборудование.

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