Middle-East Journal of Scientific Research 16 (5): 714-720, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.16.05.12218

Methods of Controlling the Production of Civilian Goods at the Enterprises of Military-Industrial Machinery Complex

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Abstract: In modern Russian economy military-industrial enterprises, because of their specific tasks, are known as high-precision production in scientifically advanced technical sphere, which allows production of competitive goods. Production of civilian goods plays a particularly important role in ensuring the defense industry. In this regard the new requirements of organization, maintenance and management tools are needed. One of these tools is controlling. Controlling system of an enterprise is developed at the operational and strategic management level and should be aimed at achieving the strategic goals of the company and identifying its bottlenecks. The need to improve the tools of production controlling of civilian goods, as well as incoming information analysis, the necessity for correct timely decision-making stress the relevance of this work.

Key words: Controlling % Civil production % Controlling tools % Defense enterprises

INTRODUCTION

At present stage of their development defense industry enterprises are the core components of the main innovation potential of Russian economy and industry [1], but the competitive nature of the state defense order distribution, the federal underfunding, the rise of energy prices, materials, transportation, etc., force enterprises to look for ways out of this difficult situation. Production of civilian products is one way to maintain stability and lay the groundwork for further development.

The reform of the Russian defense industry began in the first half of the 1990s, when there was a sharp decline of state defense order and the scale of production could not ensure the profitability of business [2].

At the same time there is a break in existing technological relations of enterprises, as a result, the production of civilian products actively began to develop and conversion of business processes involved substitution of a purely military production for civilian products [3]. This approach in practice has been proved ineffective. The defense enterprises are forced to find a niche in the market for manufactured civil production distribution and commercialization of its production technology.

Products produced by civil defense enterprises have the following specific features: the innovative character, for in its production scientific and technical potential of the company is employed; the dual nature of the application that produces the need to improve the tools of controlling production and a high risk level of products launch on the market [3].

According to the statistics of Russian Industry and Trade Ministry the structure of domestic defense companies output in 2012 is as follows: about 50 % of its production goes to the domestic military spending, about 22 % of production is exported and more than 33 % is occupied by civilian products [4]. According to the Ministry of Socio-Economic Development of the Russian Federation plan, the share of civilian products manufactured by defense companies in 2015 should amount to 64%. The researchers note that defense companies are now producing more than 2 /3s of the innovative products in the country [2].

The analysis of the current state and trends of the defense industry led to the conclusion of a material value of civilian products [5] to ensure the stable operation of companies in the current market conditions and the need to develop tools of controlling its production [6, 7].

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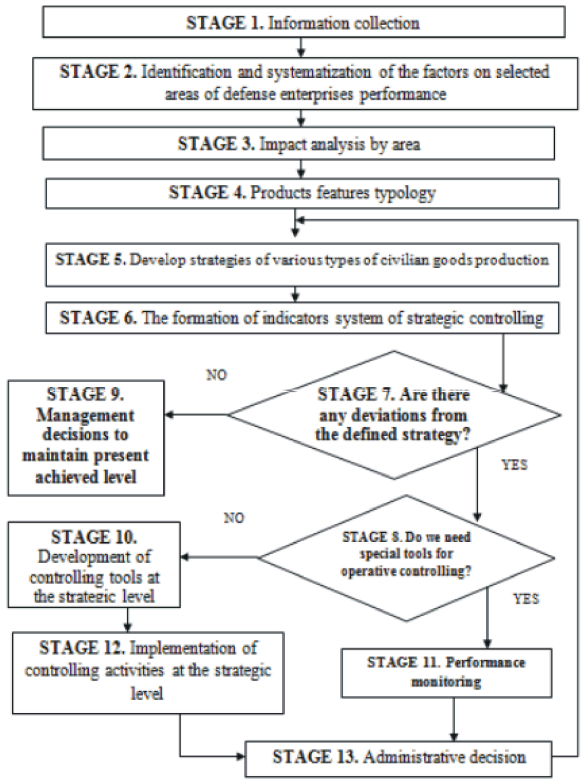

Fig. 1: Stages of civilian products production control

The current study developed a method of controlling the production of civilian goods by defense industry, which includes the following stages: identifying and ordering of the factors in the spheres of defense companies, analysis of the influence of identified factors, typology of civilian products, the development of manufacturing strategies for different types of civilian products, development of tools for controlling at strategic level, operation performance monitoring, administration decision-making management. The proposed method of controlling the production of civilian goods is shown in Figure 1.

The first stage is devoted to the collection and systematization of information about civilian products manufactured at the defense enterprise.

The second step is to categorize and identify factors [8], affecting the efficiency of the machine-building enterprises of defense industry, producing products for civilian use.

As a result of systematization one can conclude that one and the same factor in various spheres influences differently on the result of [9] civil purposes goods production. Thus, there is a need to highlight performance areas of defense enterprises, which require the use of controlling tools.

One of the main competitive advantages of the defense industry is its innovative manufacturing sector [3]. By tradition planning and production control at defense enterprises have always been very precisely and within a strictly regulated framework. Controlling tools are widely used in this activity field. However, the conditions for the defense enterprises have changed, they are forced to operate in a market environment, so currently it is particularly important to organize and imply controlling in production supporting areas, such as: marketing, science and technology sphere, finance, logistics and human resources.

It should be noted that different types of products in various fields will have a different impact on the efficiency of the strategic and operational level. For example, the factor "the existence of alternative markets", has no effect on the efficiency of the enterprise in existing markets, as it is external, the information about it is stochastic in nature and, therefore, it may be subject for management only at the strategic level. The same factor for the newly created civil products sold in new markets is essential for the development of strategies and strategic controlling tools respectively. In this case, the factor cannot be regulated by the enterprise and the stochastic nature of the information requires the selection of appropriate controlling methods for uncertainty accounting.

The result of systematic factors affecting the production of civilian goods at the machine-building defense industry enterprises is presented in Table 1.

It should be noted that the isolated factors influencing the effectiveness of the defense industry engineering enterprises producing civilian goods are probabilistic and uncertain, indicating the need for controlling the use of planning tools and control of production of civilian goods. Systematization of the factors in the development sphere takes into account civilian products marketing features and justifies the introduction and development of new tools for controlling at the strategic and operational management levels for different types of products.

At the third stage we analyze the influence factors according to activity area. The need for controlling system due to the activation of innovation activities of enterprises and the influence of external and internal factors such as violation of the structural links, the existence of two activity areas at defense enterprise (military and civilian production), the main product innovation, innovations diffusion to the production of civilian goods, the use of dual-purpose, etc. The influence of these factors on the effectiveness of the defense industry enterprises is ambiguous, as they are different in

Table 1: Characteristics of factors affecting the efficiency of the machine-building defense industry enterprises, producing civilian goods

Activity area	Factors	The source of influence	Regulation	Informa-tion character	Administration level
1	2	3	4	5	6
Production	The level of specific industries, the share of technology and equipment	IF	R	D	OL, SL
	Depreciation of fixed assets	IF	R	D	OL, SL
	Production type	EF	R	D	OL, SL
Marketing	The existence of alternative markets	EF	UR	S	SL
	Market volume	EF	UR	S	SL
	The level of competitiveness in the markets	EF	UR	S	SL
	Markets growth rate	EF	UR	S	SL
Science and techno-logy	Costs of research development	IF	R	S	OL, SL
	The timing of research development	IF	R	S	OL, SL
Finance	Commercial sources of funding	EF	R	S	SL
	The liquidity of collateral for loans and features of registration of a pledge	IF	UR	D	SL
Logistics	Volume increase reserves and expanding of the supply range of existing suppliers	EF	R	D	SL
	Suppliers reliability	EF	UR	S	SL
	Excessive stocks in warehouses	IF	R	D	OL
	Availability of alternative suppliers	EF	R	D	SL
	Availability of substitutes on the market	EF	UR	S	SL
Human Resources	Staff age structure	IF	R	D	OL, SL
	Competence level of staff	IF	R	D	OL, SL
	Labor market (necessary training target expertise in top universities of Russian Federation)	EF	UR	S	OL, SL
	The organization of specialists training and upgrading	IF	R	D	OL, SL

The source of influence: IF –internal factor, EF – external factor;
Regulation: R –regulated, UR – unregulated;
Information character: D – deterministic, S – stochastic;
Administration level: OL – operational level, SL – strategic level.

Table 2: Typology of civil products, their characteristics and the need for controlling tools in various activity spheres of the enterprise, depending on the types of products

			The need to develop controlling tools				
Typology feature	Civil product type	Civil product description	Marketing	Science and technology	Finan-ce	Logistics	Human Resources
1	2	3	4	5	6	7	8
The use of civilian products	The dual-purpose product	Does not require changes in production technology, therefore, the cost of its production is reduced.	NN	NN	NN	EN	NN
	A civil purpose product	Equipment, raw materials, science development, personnel adaption to the requirements of the market	NN	NN	NN	EN	NN
Innovative-ness	A conventional product	Conventional production technology, the product is in demand in the market	NN	NN	NN	EN	NN
	A modified product	Implies a change in the production technology using the same equipment. Requires a different approach in building manufacturing operations and collection of deliverables details. A lot of effort is not required, as the technology base remains unchanged	EN	EN	NN	EN	EN
	A completely new product	Involves the use of innovations in the field of scientific, technical, logistical and human resources potentials of the enterprise	EN	EN	EN	EN	EN
The possibility to diversify	An existing product sold in the existing market	A competitive product is manufactured and sold, the product is targeted at the occupied segment of the market	EN	NN	NN	EN	NN
	A new product sold in the existing market	A new civil product is developed and produced, the product is targeted at the occupied segment of the market	En	EN	EN	EN	EN
	A new product, sold in a new market	A new civil product is developed and produced, the product is targeted at a new segment of the market	EN	EN	EN	EN	EN

NN – no need to develop controlling tools;
EN –an existing need to develop controlling tools.

their structure and not homogeneous. In this regard they need to be analyzed according to the following criteria: activity area (production, marketing, science and technology, finance, logistics, human resources), a source of influence (internal, external factor), regulation (regulated and unregulated); nature of the information (deterministic, stochastic); level of management (strategic, operational).

At the fourth stage of civilian products typology you must decide which types of civilian products need controlling instruments. The state administration has defined the following civilian goods directions of development areas for defense enterprises: equipment for the fuel and energy complexes, sophisticated medical equipment, equipment for the processing industries, technical communications, optical instruments, etc. These types of products can be both civil and dual-purposes, they have different opportunities to diversify, also they may be implemented in different market segments, have different degree of innovativeness. In connection with this we proposed the typology of civil goods, according to the following criteria: the use of civilian products, innovation and the ability to diversify (Table 2).

According to the proposed typology, we described nine types of civilian products, gave their brief description and the need to develop tools for controlling different areas of the enterprise, depending on the products types.

For example, a dual-purpose product is characterized by that it requires no changes in the technology of production, so that the cost of its production is reduced, the need for controlling tools exists only in the sphere of logistics, there are enough already existing tools for planning and control in other fields of activity.

Noteworthy is an existing product targeted at markets. The need for development of controlling tools for this product exists in the following areas: marketing, science and technology, logistics and human resources. The financial sector does not require any controlling tools, as they already exist at the enterprise (break-even chart, budgeting, etc.). For a new product, targeted at a new market, there is a high need to develop controlling tools for all the selected areas of the enterprise.

At the fifth stage we analyze the development of manufacturing strategies based on the types of products for civilian use. To maintain progress and further increase of competitive advantage a defense enterprise needs to monitor the developments taking place in real time, as well as to take the necessary administrative decisions related to the characteristics of civilian products, features of suppliers and buyers, price, sales volume, etc.

To this end we introduce the sixth stage of forming a system of strategic controlling indicators, which can be used as a basis for a balanced indicators set [10, 11]. Civilian goods production controlling should be implemented according to the following basic result indicators identified in selected areas of the defense enterprises:

- Production area: wear rate of fixed assets, production volume of civilian goods, the coefficient of special equipment utilization;
- Marketing: market share, market situation rate of change, natural environment analysis quality;
- Science and technology: the ability of an enterprise to upgrade, the amount of science development costs, the time for to-market launch;
- Financial: income, the loan amount, the interest rate on the loan, the amount of outstanding shares (bonds), the term of the placement of shares (bonds);
- Logistics: the stability of suppliers economic performance, the price of supplied materials and equipment;
- Labor: employee satisfaction, staff loyalty, staff motivation, the stability of the staff.

At the seventh stage it is necessary to find out whether there are deviations from the defined strategy and, if the answer is ‘no’, then the process moves to the ninth stage and management decisions are made by the state of conservation. If the answer is ‘yes’, then one should take a decision on the development of operational controlling tools and go to the eighth stage of the procedure. If operational controlling tools development is not required one should go to the tenth stage and continue to pursue the company controlling at the strategic level and move on to step twelve. According to the results of controlling important management decisions should be taken at the thirteenth stage, which may affect the development of the strategy and lead to its correction.

If the development of operational controlling instruments is needed, you need to go on stage eleven to monitor operations. Monitoring is carried out in selected economic sectors of defense enterprises. A more detailed phase of monitoring will be discussed below.

Testing of the proposed instrument is made by the example of controlling the production of civilian goods of innovative type at *****Krasnoyarsk Machine-Building Plant". Defense companies are entering the sphere of market relations, in this regard, there is a need to respond rapidly to market changes, which makes monitoring an

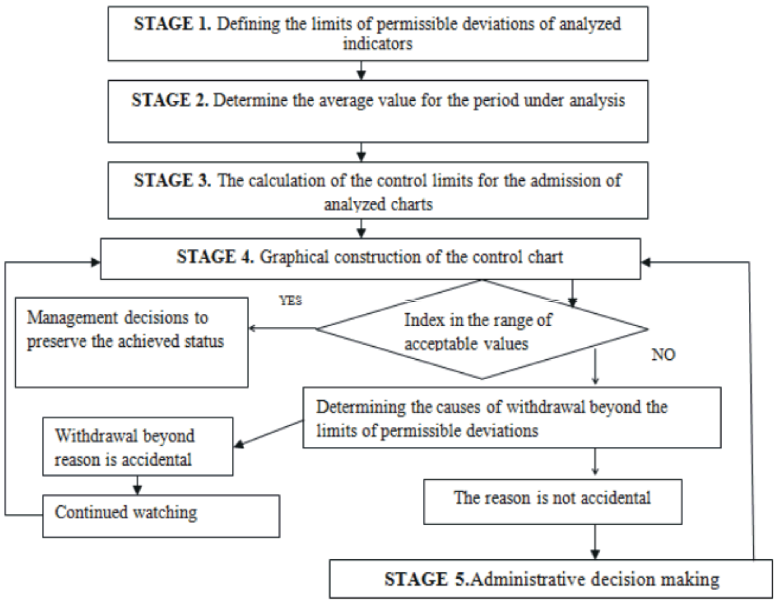

Fig. 2: The monitoring methodology, which includes the construction of check charts as a tool for effective controlling

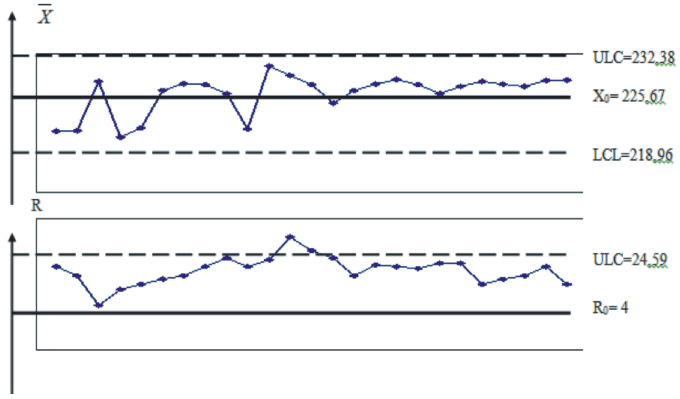

Fig. 3: Chart of average and range monitoring provision of reserve requirements

important part of controlling techniques. In this regard, the eleventh stage – the procedure "Monitoring the operational activities" – must be considered in greater detail.

The beginning of the monitoring operations for the defense enterprise is to assess the results and the conclusion - the analysis of the causes of deviations of actual results from planned ones.

This stage makes it possible to establish the evaluation criteria in the form of the control limits that ensures decision-making.

To monitor the production of civilian products at the operational management level we suggest the use of statistical process control, namely, control charts [12].

The monitoring task will consist in the fact that on the basis of the periodic (i.e., in dynamics) control sample values of monitored indicators one should evaluate and adjust the stability. Studies should be carried out at five stages (Figure 2).

At the first stage we define the limits of permissible deviations for quantitative indicators (indicators expressed in physical or monetary units) and alternative indicators (indicators, securing the presence or absence of controlled characteristics in each unit of the considered subgroup), depending on the nature of the controlled information.

The second step is to determine the average values for the analyzed period.

In the third stage we carry out the calculation of control charts in tabular form. Table 3 shows the formula for calculating the control limits in the construction $0 - R$ - chart. The coefficients for the respective cards are given and taken from the Russian State Union Standard of Russian Federation 50779.42 – 99 [12].

Table 3: Formula of admission control limits for cards 0 – *R*

No	Formula	Formula explanation
1	$ULC = x_0 + AF_0$	UCL – the upper limit of the control chart X_0 – centre line A – the coefficient to calculate the control limit F_0 - the standard process deviation
2	$LCL = x_0 - AF_0$	LCL – the lower limit of the control chart
3	$\overline{R} = \frac{\sum R}{k}$	$\overline{R}$ - centre line R – scale sampling k – the number of samples
4	$UCL = D_2 F_0$	D_2 – the coefficient to calculate the upper control limit
5	$LCL = D_1 F_0$	D_1 – the coefficient for calculating the lower control limit

Table 4: Control chart for controlling the operational security requirements reserve

Subgroup number	The average of subgroup 0	The range of the subgroupR	Subgroup number	The average of subgroup 0	The range of the subgroupR
1	220,14	4,5	15	224,52	4,0
2	220,15	4,0	16	225,19	4,6
3	225,50	2,3	17	225,70	4,5
4	219,50	3,2	18	225,16	4,4
5	220,45	3,5	19	224,19	4,7
6	224,52	3,8	20	224,98	4,7
7	225,28	4,0	21	225,52	3,5
8	225,16	4,5	22	225,19	3,8
9	224,18	5,0	23	224,96	4,0
10	220,35	4,5	24	225,62	4,5
11	227,15	4,9	25	225,67	3,5
12	226,12	6,2			
13	225,14	5,4			
14	223,16	5,0			

0 – chart

$ULC = x_0 + AF_0 = 225,67 + 1,342 * 5 = 232,38$ kg.

$LCL = x_0 - AF_0 = 225,67 - 1,342 * 5 = 218,96$ kg.

R – chart

$$\overline{R} = \frac{\sum R}{k} = \frac{101,3}{25} = 4$$

$UCL = D_2F_0 = 4,918 * 5 = 24,59$

$LCL = D_1 F_0 = 0 * 5 = 0$ (because n+7, so LCL is out)

In the fourth stage one should apply the graphical representation of the control chart (Figure 3).

At the fifth stage we come to the process of decision-making. The analysis of control charts reveals the nature of the deviations. Management decisions cannot be made according to the results of random deviations. In cases of withdrawal of the process beyond the control limits and when the process is not within statistical control one should make management decisions, based on the monitoring of the civilian goods production.

When constructing control charts for controlling the operational limits of permissible deviations are calculated. They were determined to monitor the availability of reserve requirements of steel sheet T = 4 – 20, which is used to produce a water boiler – 0,5 – 115 K (Table 4).

Calculations of the reserve security needs of Steel sheet T = 4–20, which is used to produce a water boiler – 0,5 – 115 K (X_0) 225,67 kg. per month. The standard deviation of the security reserve requirements (F_0) 5 kg. – is obtained on the basis of analogues production processes.

According to the result of analysis, it can be concluded that the process is not in statistical control at the required level. 0 - chart shows a sequence of points that lie below the center line, R-chart shows a sequence of 14 points lying above the center line. The reason for such a long sequence must be studied and fixed.

To sum up it should be mentioned, that the proposed controlling tools of civilian goods production of innovative type, produced at machine-building

enterprises in the defense industry will allow following the dynamics of changes of controlled parameters and adjusting management solutions with a single information space. This space provides a long-term basis for the full operation of the enterprise in a competitive environment.

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