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Organization Risk Management of the Machine-building Complex

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Abstract

In this article, an overview of earlier published research about the problems connected with the analysis and risk management at the enterprise is carried out. Risks of the organization of machine-building complex with the subsequent map development of risks and the offer of strategy for their prevention are implemented, evaluated, and analyzed. Thus, this work carried out the complex analysis of the problems connected with identification, assessment, analysis, and risk management in the organization of a machine-building complex; the tree of efficiency of the principle and the analysis of the synthesis of the Total Quality Management (TQM) and Quality Management System (QMS) was constructed, the leaf of potential risks of the organization of a machine-building complex at a stage of PLC taking into account confidence figure of emergence and level of danger is created. The card of risks is constructed, the analysis is carried out it and the strategies of management are offered.

Disciplinary: Quality control, Manufacturing Management.

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1 Introduction

Risk management» is a young discipline which deep studying began about 40 years ago. Despite it, risk analysis covers a wide range of industries: medicine, mechanical engineering, food,

metallurgical and chemical industry, transport, social and legal sectors, sectors of security and defense, and others.

Application of risk management system for the organization of a machine-building complex is a current problem on which effective work the result of the activity of all enterprise depends.

2 Literature Review

Problems of the analysis and risk management are provided in the scientific research of Azhmukhamedov (2015), Popova (2017), Oshurkova (2015), and Mishura (2020). About and in a number of the ISO 31000:2018, ISO/IEC 27005:2011, COSO ERM standards, etc. Scientific research in the field of risk analysis of the enterprises of the machine-building complex is stated in works as Vorontsova (2019), Deberdiyeva (2020), and Islamova (2018).

The purpose of this article is the overview of the published research about the problems connected with the analysis and risk management; representation of applied experiment on the analysis and risk management at the enterprise of the machine-building complex to improve understanding of concerned parties (researchers and practicians). For achievement of the effective objective in the article, risks of the organization of the machine-building complex with the subsequent map development of risks are identified, evaluated, and analyzed.

To understand a root of a problem it is necessary to try to give an accurate and short definition of the concept of «risk». To answer difficult unambiguously the question «What Is Risk? ». As a rule, the risk is associated with the approach of any adverse events which lead to this or that choice. Therefore, the task of risk management is to develop a strategy, which will lead to the smallest losses.

Each famous scientific figure dealing with problems of methodology of risk management offers risk identification. Therefore, the risk is defined as the probability of loss by the organization of a part of the resources, by short receptions of income, or the emergence of additional expenses because of productive and financial activities. Therefore, the risk belongs to a possibility of the approach of any unfavorable event, a possibility of failure, a possibility of danger.

The following determination of risk is accompanied by the concept «risk situation». A situation, in a broad sense, is called the set of various circumstances and conditions creating a certain situation for this or that type of activity. The situation can promote or interfere with the implementation of this action.

Let us consider the following conditions proceeding from which determination of risk is formed:

- When at the disposal of the subject choosing from several alternatives there are objective probabilities of obtaining the expected result. These are the probabilities independent directly of this organization: rate of inflation, competition, etc.

- When probabilities of the approach of the expected result can be received only based on a value judgment, i.e., the subject deals with subjective probabilities. Subjective probabilities directly characterize this organization: potential production, job management, etc.

- When the subject during the choice and realization of an alternative has both objectives, and subjective probabilities.

Thus, the risk is the operation performed in the conditions of the choice (in a choice situation in hope for a happy outcome) when in case of failure there is an opportunity (danger degree) to fall into the worst state, then before the choice (than in case of not commission of this action).

At the implementation of activity of the enterprise organizations, many decisions often should be made in the conditions of uncertainty when it is necessary to choose the direction of actions from several possible options, which result of realization it is difficult to predict.

3 Organization Risk Management of the Machine-build Complex

According to ISO 9000:2015, the risk is the influence of uncertainty, which is expressed in a deviation from the expected result. Each such uncertainty can render both positive and negative influences. The positive influence arising from risk can create an opportunity for the improvement of quality.

Risk-management (risk management) and quality management system (QMS) – two parts of a single whole; their integration promotes the creation of the general system of management of the organization.

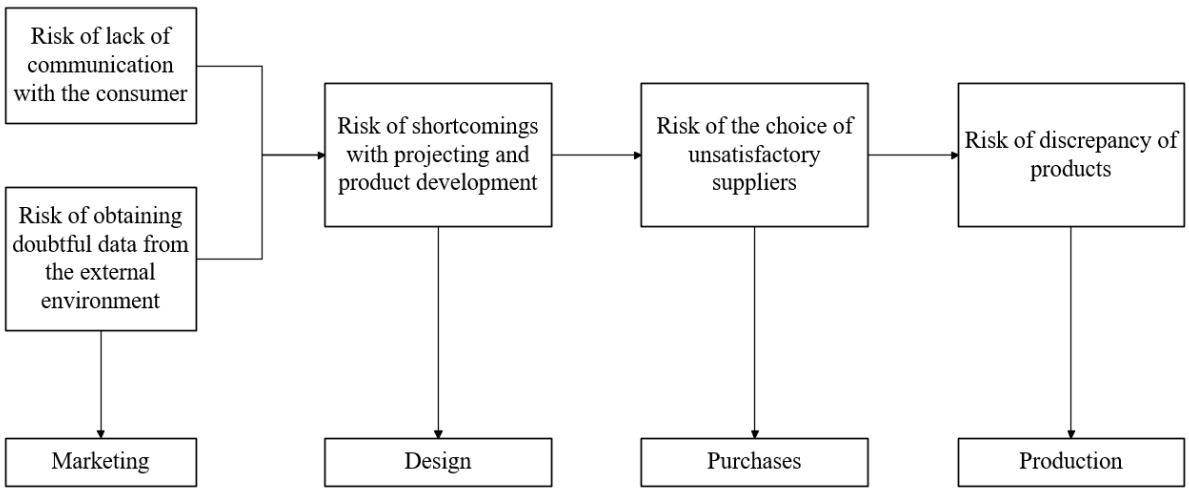

Figure 1: Influence of risks in QMS of the organization of a machine-building complex at certain stages PLC.

An innovative feature of ISO 9001:2015 is the refusal from usual to the Russian companies of the warning actions and transition to risk - the focused model to decision making which works in synergy with the process approach, the including cycle PDCA that allows the organizations to integrate the QMS with requirements of other standards of the systems of management. Applying the process approach to risk management, the enterprise defines basic processes of activity and in these processes makes identification of risks. The approach consists of an allocation of all

processes of the enterprise in which, there are risky situations. All-important risks can influence the achievement of the goals of the enterprise and the accomplishment of tasks negatively. In Figure 1, the influence of risks in QMS of the organization of a machine-building complex at certain stages of the product life cycle (further – PLC) is shown.

Concerning the quality, usually consider a group of production risks: increase in product cost; technological hazards; risk of failure to follow production program; the risks connected with product quality. However, quality management is not limited to accounting only of production risks and demands accomplishment of the cycle risk management including the following stages:

- Identification of risks.
- Analysis and measurement of risks.
- Risk management.
- Monitoring of risks.

The risk-focused model to decision making allows the organization to define internal and external factors, which can lead to deviation from the planned results of processes of QMS, minimize negative consequences, and maximize the arising opportunities. Therefore, in the organization, the document – Provision on identification and risk management must be developed.

Development and deployment in activities of the enterprise of Provision for identification and risk management will allow operating, to control production risks at all stages of management. Also, will allow determining the level of influence of the reason of risk on the activity of the enterprise, assess the current level of risks, and offer actions for optimization. All significant risks must be subject to identification, assessment, and documenting for the achievement of the goals of the enterprise and accomplishment of tasks. Making risks assessment, the enterprise has the opportunity to reveal events, which adversely influence its activity, to reveal consequences, the probability of emergence of events, to define the reasons, which can reduce adverse effects or lower risk situations.

Valuation methods of risks are used for different purposes – some methods allow identifying only risk, using others, it is possible to estimate risk qualitatively, and some methods are capable to give a quantitative assessment. Therefore, often never use only one method; in the present, effectively they work in total. Moreover, it is necessary to be able to pick up them so that the excess work, which is taking away time, but not bringing the expected effect was not carried out.

Many methodologies of risk analysis have been developed and applied by researchers as the instrument of decision support by providing descriptions of risks.

In this article, we classified risk analysis methodology by the following criteria:

1. **Qualitative analysis of risks** – the most often used methodology for assessment of uncertainty in many industries. The methodology of the qualitative analysis of risks is based on the deductive method, which includes subjective judgments of the group of experts as input

information. It is considered that it is the fastest and simple method among risk analysis methodologies as he demands small use of mathematical and computing skills or does not demand them at all. The example of the use of the quality standard of risks is provided in work;

2. **Quantitative analysis of risks** – a systematic approach to the identification and quantitative assessment of potential probabilities with the use of mathematical and computing models.

3. **Semi-quantitative risk analysis** represents a hybrid of qualitative and quantitative methodologies of risk analysis. It relates to the fact that both qualitative and quantitative methods of risk analysis have restrictions therefore to compensate for restrictions of each method, subjective data of experts unite with quantitative risk analysis. This method approaches when objective data on refusal are inaccessible or insufficient. The preliminary analysis of dangers, a type of refusals, the analysis of consequences and criticalities, danger and working capacity, Bayesian networks are typical examples of methods of semi-quantitative risk analysis.

Let us analyze the main production risks of the organization of the machine-building complex.

Let us construct a tree of efficiency of the principle of the analysis and synthesis of the TQM and QMS systems for the creation of registers of risk, which is represented in Figure 2.

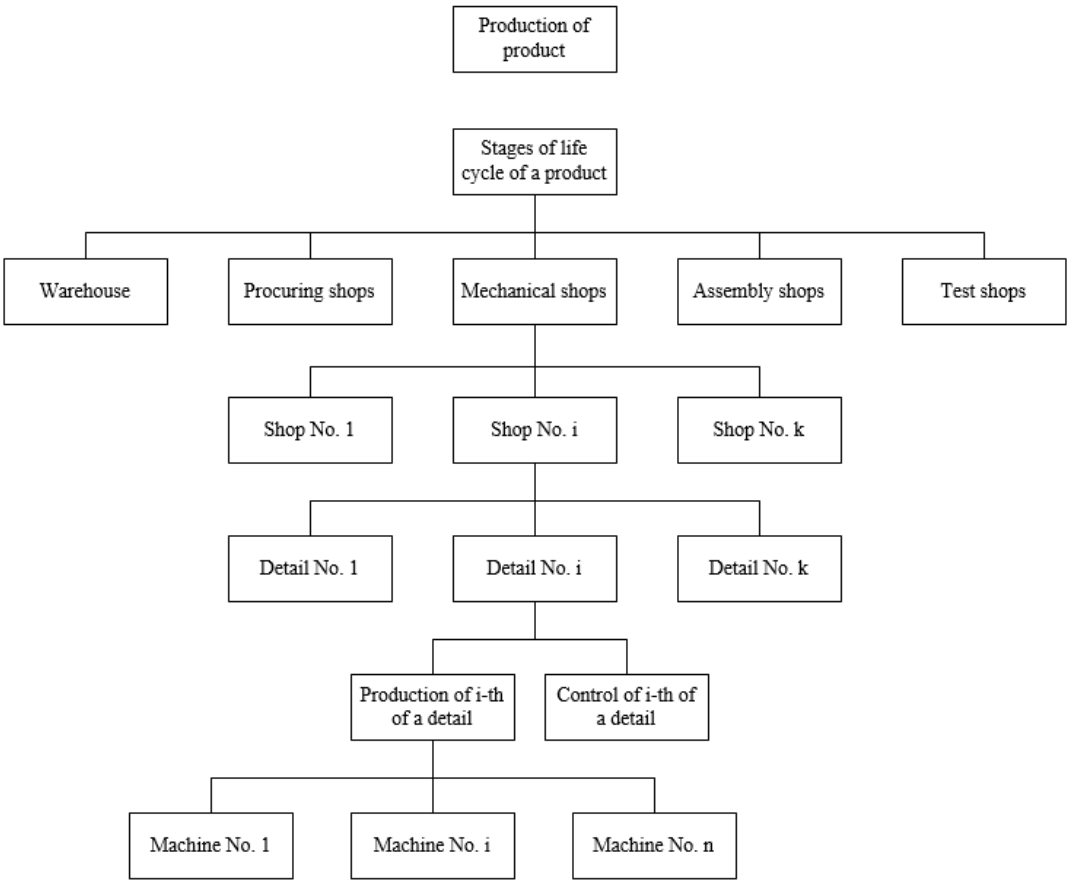

Figure 2: A tree of efficiency of the principle and the analysis of the synthesis of the TQM and QMS systems for the creation of registers of risk.

The creation of a tree of efficiency is caused by the fact that everyone responsible for the stage of lifecycle could understand accurately the management purposes in the field of quality. For example, the management designates that the marriage level for finished products should not exceed 0.03 (3%). Therefore, raw materials pass the way from a warehouse to the procurement shop where it is transformed to procurement, there passes the stage of machining, assembly, and final tests. On each of the stages, the level of marriage, which in the general result will not exceed 0.03 (3%), is established.

To the implementation of requirements of fundamental standards at the enterprise has developed the Work program on the introduction of an analysis technique and risks assessment in relation to specifics of the activity.

After the purposes in the area of quality were sounded and accepted under control, the process of identification of potential risks (responsible departments, the engineer, members of the top management) through brainstorming began to be implemented by a project team. The leaf of potential risks with comments of the head of a project team on their possible elimination is so created. As a result, the revealed risks are included in «The magazine of registration of risks».

Further, it is necessary to estimate potential risks on the degree of probability of their emergence and level of danger. Considering that judgments of experts have verbal character, for transition to numerical estimates it is expedient to use Harrington's scale:

Danger level – low (1) ➔ 0;

Danger level – below average (2) ➔ 0.29;

Danger level – average (3) ➔ 0.51;

Danger level – above average (4) ➔ 0.72;

Danger level – high (5) ➔ 1.

The integral size relation from the function of «the current risk» to the area of «the ground of possible values of risk» allows determining the rated size of the current risk in number:

$$R^{cur} = \frac{[\int_{\tilde{U}}^{1} P^{cur}(\tilde{U}) d\tilde{U}]}{1-\tilde{U}} \quad (1).$$

If $R^{ac} < R^{cur} < R^{D}$, then the risk level is subjectively unacceptable for the responsible person. If $R^{D} < R$cur, then the risk level is unacceptable for the organization.

The difference between sizes of acceptable and current rated risks characterizes the dimensionless absolute value of the degree of danger of a situation in number:

$$\Delta^{abs} = R^{cur} - R^{ac} \quad (2),$$

where Δ^{abs} – metric characteristic of the absolute value of the degree of danger of a situation.

Thus, at $\Delta^{abs} \leqslant R^{ac} - R^{D}$ the risk level is subjectively unacceptable for the responsible person.

Table 1: List of potential risks of the organization's machine-building complex.

№	Risk	Probability emergence	Level dangers	Consequence of risk
RAW MATERIALS PURCHASE				
1	Deficiency of means	1	4	Production stop
2	Violation of delivery dates	4	2	Failure of the production schedule
3	Deficiency of quality raw materials	2	3	The decline in quality of finished goods
4	Performer mistake	2	2	Additional costs and failure of production graphics
ENTRANCE CONTROL				
5	Improper control method	1	3	Doubtful results, wrong management decisions
6	The truncated selection volume	2	2	Doubtful results
7	Low qualification of the performer	1	3	Wrong management decisions
8	Performer mistake	2	4	False assessment of the quality of raw materials
9	Inaccuracies of the equipment	2	4	Doubtful results
STORAGE AND WAREHOUSING OF RAW MATERIALS				
10	Incomplete marking	1	2	Impossibility of identification of products
11	Discrepancy of picking	1	3	Violation of completeness
12	The broken packing	2	1	Safety of products
13	Inadmissible conditions storages	3	2	The decline in quality and emergence of defects
14	Increase in a period of storage	3	2	Additional costs and decline in quality
PRODUCTION				
15	Violation of technological accuracy of the equipment	2	4	The decline in quality of finished goods and emergence of defects
16	Malfunction of the equipment	1	5	Unplanned stop of production
17	The imperfection of the technological process	2	3	Increase in time for the production of products, increase in prime cost at the production of products
18	The discrepancy of materials and semi-finished products to requirements of technical documentation	2	5	Production of inappropriate products
19	Lack of control devices, measurements and tests and/or non-compliance with an order of their operation, repair, and service to the established requirements	2	4	Production of inappropriate products
20	Non-compliance with labor safety, production hygiene, and other requirements of technology and other documentation on production organization	2	3	The emergence of dangerous and emergencies which can entail harm and danger to the health of personnel of the enterprise
ACCEPTANCE CONTROL				
21	The discrepancy of geometrical, physical and chemical, and functional parameters of finished goods	2	5	Production of inappropriate products, increase costs of production of products, failure of the production schedule, violation of the purposes in the area of quality
22	Outer and internal defects of finished goods	2	4	Production of inappropriate products, increase costs of production of products, additional time and finance costs on completion of products (and/or coordination with the customer)
23	Lack of a brand and/or marking	3	4	Impossibility to establish identification, guilty of a case inappropriate products
24	Lack of the accompanying documentation on finished goods (labels, labels, quality certificates, technology passports, accompanying cards), their availability, and correctness of filling	3	2	Violation of completeness

The relation of values of absolute degree of danger and acceptable risk defines the relative degree of danger of a situation:

$$\Delta^{rel} = \frac{\Delta^{abs}}{R^{ac}} \quad (3).$$

The sheet of potential risks of the organization of a machine-building complex at a stage of PLC taking into account the degree of probability of emergence of risks and level of danger is presented in Table 1. Based on the data obtained from Table 1, we will construct the card of risks of the organization of a machine-building complex (Table 2).

Table 2: Card of risks of the organization of a machine-building complex.

		DANGER LEVEL				
		Low	Below average	Average	Above average	High
EMERGENCE PROBABILITY	Low			10	5 7 11	11
	Below average	12	4 6	3 17 20	8 9 15 19 22	18 21
	Average		13 14 24		23	
	Above average		2			
	High					

Having analyzed the card of risks, it is possible to notice that the most probable risk the risk of violation of delivery dates of products from the supplier is considered that can cause the failure of the production schedule which, in turn, as dominoes will be subject to threat and other aspects of work of production.

The risks revealed at a stage of acceptance control when Quality Department decides on whether the products are suitable are considered as the most dangerous risks or defined in marriage. In case the finished goods are defined as inappropriate, there is a risk of their identification. It is necessary to answer questions: «in whose change the product is made?», «who made a product?», «on what installation marriage was established?», «by whom it is passed to further processing?» and «how to prevent further discrepancy of this sort?». Answers to these questions are impossible, not marked products that involve the corresponding risk.

4 Conclusion

There are several strategies for the management of this sort of risk. For the strategy of aggravation (expansion), the risk is managed and controlled in the organization, at the same time influence of external factors is avoided. The owner of the process establishes fixed control of the contractor, in case of further (systematic) violation from the contractor the owner of the process makes management decision on replacement of the contractor (transfer to another shop to perform other functions), either its training or, as a last resort, reduction (risks 18 and 23);

For the strategy of avoiding, the activity of the organization is directed to avoiding risk. That is, the responsible owner of the process makes management decisions concerning the reasons established discrepancies – it can be the error of technology process, the mistake at stages of PLC, the error of the technique of accomplishment of measurements (risk 21).

Thus, the authors carried out the complex analysis of the problems connected with identification, assessment, analysis, and risk management in the organization of a machine-building complex; the tree of efficiency of the principle and the analysis of the synthesis of the TQM and QMS systems was constructed, the leaf of potential risks of the organization of a

machine-building complex at a stage of PLC taking into account confidence figure of emergence and level of danger is created. The card of risks is constructed, the analysis is carried out it and the strategy of management are offered.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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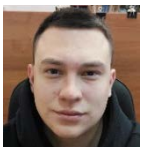

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