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### Modern Tools for Sustainable Development of Territories. Special Topic: Project Management in the Regions of Russia

#### QUALITY MANAGEMENT IN PRECAST CONCRETE INDUSTRY: PROBLEMS AND PERSPECTIVES

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#### *Abstract*

The point of implementing of current approaches to the quality management systems in various spheres enterprises is one of the crucial issues in an innovative economics. Specialization profiles and training directions of higher education institutions have been opened, where they provide capacity training on business processes management and reengineering for improving the quality level as criteria of competitiveness of local products in the international market. The authors considered the possibility to adaption of the concept and its practical implementation at the construction industry enterprises - factories which produce reinforced concrete products and structures. The key factor of applying different quality management tools in this industry is that the products are designed exclusively for the local market neither exporting the ready products nor importing the raw materials for their production. Thus, there is no legislative need of its certification according to ISO 9001 or GOST R ISO 9001. It is completely voluntary and performs just in the case of managerial commitment introducing just image policy. At the same time, product quality issues are strategic in nature and can be the reason of economic, environmental and other problems.

As a result of conducted study the program of activities due to quality product management at the enterprise with gradual volunteer certification after evaluation of economic effect of intermediate results of the project was developed.

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**Keywords:** Precast industry products, quality management, quality management approaches, quality management systems.



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## **1. Introduction**

In case of mass-produced products the question of introducing a quality management system often carries a share of slowness, as it can globally lead to overproduction crises because of high quality products. But the construction products and precast industry products quality is another matter. In terms of importance, an indicator of the quality of such products can be compared, with items, tools and equipment of medical industry. As the using of low-quality materials, structures during the construction stages can lead to irreversible negative consequences that are dangerous for people's life.

## **2. Problem Statement**

In the context of strategy of development of regional precast enterprise top management set a task to make an additional project of reducing defect level during manufacture of precast concrete products. The quality problem is not a crucial issue in the enterprise; it has a positive image on regional market, reach experience to tender, but modern trends requires loss reduction for reversible defects elimination. Furthermore the top management set a task to reduce losses of forced price reduction during the distribution of permissible defected products. Initially it was decided to review all possible tools which can be used for abovementioned issues in the industry framework. The second stage considered the possibility of using of the tools had to be analyzed for the subject of availability of sufficient resources for implementation and expected results.

The lack of strict State regulation according to the precast industry in this particular case has negative consequences. During the high season small unscrupulous manufacturers enter the regional market and violate GOST requirements due to reduce costs and, consequently, prices for their production. Visual inspection of concrete products can not identify defects. It is impossible to determine the quality of concrete, the metal rods quantity and inner grid form without special equipment.

Violation of precast concrete manufacturing technology may lie in the non-compliance of metal weight, and using of mixtures of sand, gravel and an adhesive plasticizer. These methods allow reducing the cost of the finished product as much as 2 times. Such enterprises feel free to submit a bid of customers, including organizations specializing in road paving, power sales companies, providing color copies of conclusions about the quality from the laboratories of large manufacturers, and exposing significantly lower prices. This phenomenon has become widespread, and requires restrictive measures to prevent development of such “handicraft” industries, at least at the regional level. The decisions can be mandatory requirements for the work period of enterprise, testing laboratories, brand, etc.

One of the solutions can be compulsory certification in case of taking part in massive tenders. In case of these requirements certification authorities will have some troubles.

## **3. Research Questions**

Per the term of reference issues demanded study and work were drawn: 1) study of local and foreign quality management tools; 2) evaluation of the experience of their application in the industry; 3) Evaluation of factors which support and impede their using during the project program development.

#### 4. Purpose of the Study

The results of implementing experience approaches were reflected in the works of (Alexander, Anthony, & Rodgers, 2017; Alkunsol, Sharabati, AlSalhi, & El-Tamimi, 2016, Deamonita, Pujiyanto, & Rosyidi, 2017; Nemati, Dave, Sias, & Perkins, 2019; Keşek, Bogacz, & Mirza, 2019; Mousavi Isfahani, Tourani, & Seyedin, 2017; Yadav, Mathiyazhagan, & Kumar, 2017; Salam, 2008; Sigrid Nordby, 2017; Messinger, Rogers, & Hawker, 2019) analysis of which highlights one common essential point: the success of the implementation of any approaches depends on strict compliance with the conditions, the assessment of the existence and implementation of which is not subject to formalization, it is subjective, meanwhile underperformance or non-performance of these conditions are inherently flawed as a quality management system project:

- 1) it should be initiated by top - management of a company;
- 2) the top management involvement during all stages of the project must be real, but not formal;
- 3) the project implementation requires high-quality pre-project preparation of the motivation system and personnel training which ensures “staff involvement” condition.

Compulsory fulfillment of the first condition relates to the fact that all system mistakes and the results of all processes in the company can be noted at the top-management level. The implementation of a quality management system contributes to the strategic objective while strategic planning in accordance with GOST R 52806-2007 (inter-state standards – GOST) is a responsibility of top-management.

The features of some approaches of quality management in terms of their using efficiency in precast concrete products factories will be considered.

For that purpose we will identify the features of production and products of these enterprises from the point of view of quality management approaches.

According to data of professional representatives, construction waste contains 26% of concrete and concrete products. Not all the waste is a manufacturing defect, but, nevertheless, is its component. As any other production the defect, during the production of concrete products, can be preventable and irreparable.

Preventable defects are for instance superficial cracks and chips which do not cause quality, as well as the quality of their installation and operation. Furthermore such kinds of defects may occur as a result of transportation. Such defects are eliminated with cement-sand solution and different repair mixtures. The most critical is a manufacture’s defect, which is revealed as a result of laboratories tests at precast industry and eliminated during its production that economically increases its costs.

Irreparable defects are profound cracks, reinforcement structure changes, decreasing of protective layer which cause a deformation and destruction of the structure. This kind of defect generates the largest income losses, products require disposal which imposes costs.

The cost of concrete products equipment is about Euro 240-370 thousand , that is, about 300 thousand dollars. Such kind of investment is not available for all precast industries which activity is a subject of seasonality and is not a high-marginal branch. The issue of recoument of such sets can be solved by considering recycling as an additional type of business, but this approach is also relevant mainly for large enterprises and requires additional calculations of the effectiveness of investment costs.

The recycling of irreparable defected products through organizations that provide such type of service is also entail additional costs. So, the cost of such a service (without delivery cost) in Novosibirsk city is about 5 dollars per a ton. The advantages of recycling are obvious: savings on the purchase of raw materials for the new products manufacture, the source of secondary crushed stone, elimination of demolition waste. But due to the lack of strict unified state requirements for waste disposal, many companies prefer non-ecological ways to get rid of defects: taking the defected products to the waste dumps or storing them on its territory.

The certification of precast industry's products has not currently introduced at the State level as it local market oriented either the export of the product or the import of raw materials for its manufacture. Therefore the certificate of quality management system requirements of ISO 9001 is more one of the marketing tools, image campaign, rather than compliance with the legal requirements.

To ensure reinforced concrete products comply with quality GOST requirements they implement raw materials receipt, control a production process, implement manufactured product quality control using non-destructive and destructive testing technology in special laboratories. The above mentioned tests and control are conducted in accordance with GOST requirements, technical conditions and intra-industry and internal quality regulations.

Precast products are composite construction material which consists of steel reinforcement and concrete of different brands regarding the strength and density. Concrete blocks, trays, hoops, slabs and space dividing and supporting partitions are widely used during the construction. Precast concrete products are the frame of structure which ensures durability and reliability. These products can be divided into two kinds: prefabricated (individual precast structures which are produced at the factory and installed on the building site) and precast-monolithic (separate parts to which monolithic structure joined on the building site).

Precast concrete products are not subject to obligatory certification. But manufacturers often process voluntary conformity certificates of quality and reliability of production which can be get in specialized accredited organization. The certificate confirms the fact that all products have been passed appropriate tests and corresponded characteristics stated in technical documentation: technical specification (TS) or inter-state standards (GOST).

After laboratory tests, applicant get an opportunity to highlight priorities of the products for potential customers. For the moment conformity certificate is a competitive advantage among precast concrete manufacturers which directly impact the increasing of distribution of production volume. What is more, manufacturer which got a conformity certificate can take part in tenders on governmental and commercial platforms.

Formally the existence of conformity certificate considerably increases the level of confidence to the products of enterprise in comparison with competitors. Customers always prefer organizations production of which was tested by Certificate authority's experts. Volunteer certificate is a basis of successful business in construction sphere and in the sphere of distribution of precast concrete products but certification process due to work and money input. The conformity certificate due to one GOST or one TS is 125 dollars per year and about 200 dollars per 3 years. Besides tests reports are paid separately, its cost is significantly more expensive now and it is 400-3500 dollars.

As certification is not compulsory so, not all manufacturers agree to follow such procedure to save time and money. As mentioned above there is not a compulsory state supervision in this area now.

The main aim of reforming the national accreditation system, legislation on requirements for regulating is improved product quality on the market and increased confidence to the documents confirming production safety.

It is possible to find falsification in the supermarkets among the products which requires mandatory certification. Non-existent test laboratories continue to issue adulterate records and unscrupulous certification authorities publish documents of conformity and register the declarations as a consequence of such records.

Such facts undermine confidence of either certification authority or certification procedure. It is difficult to work in such situation for those who are conscientious market makers. To make things better it may be necessary to strengthen criminal and administrative responsibility from supervisory bodies in such cases.

There are some issues in the working process of certification authorities and test laboratories which require solution. One of them is incorrect technical documentation. Some applicants and manufacturers attach products documents which are do not comply with appropriate requirements that leads to the certification rejection. In case of negative test results some applicants try to return their money back and threaten litigation trying to press the experts to be given positive results.

Another one issue is incorrect requirements for tenders and procurement due to manufacturers or vendors about the presence of certificate or declaration for the products that are not subject to mandatory conformity assessment. In such case applicants need to contest the tender but they demand registration of documents from accredited person instead. Such approach leads to frustration among manufacturers and as a result implies further violation in formalities and sometimes negation the need of certification and neglect of it.

One of the key factors of the success of “Six Sigma” program is a step-by-step approach or a roadmap with defining steps, measure, analyze, improving, and monitoring.

Determination stage is identifying and issue fixing and describing of its critical qualitative description which are the most important for customers.

At the stage of measuring the clearly marked output characteristics of the products quality are determined as well as criteria of maximum permissible error of quality after that collection of preliminary evaluation of current quality and productivity of the process is provided.

The next stage of the analysis is identifying of defects causes or mistakes (Xs or input variables) with the subsequent development of measures to reduce and / or eliminate them at the improvement stage. After that measurements are taken to achieve the statistical result of defect - 99.99966 %. In case the indicator is not reached a return to the analysis stage is required.

The control stage implies a current and planned quality control to maintain the results and timely measures to prevent deterioration in the quality due to other reasons.

The “Six Sigma” methodology in the quality management system is not appropriate to single out in an independent direction as it is used as a part of Lean technology in the quality management system at foreign industrial enterprises. Its using is appropriate only in case of full automation of the production

process at the enterprise and high level of CRM , as well as improving product quality becomes the main strategy for the planned period. In addition, the application of this concept is justified in the framework of the system implementation of all elements of lean tools in the enterprise because this project requires the mandatory full automation of all processes.

The most economical way of waste cost reduction is implementation of proven approaches or product quality management systems at the enterprise the analysis of which is given in Purpose of the Study.

## 5. Research Methods

Methods of analysis and generalization of information, methods of observation, project approach were used in the work.

## 6. Findings

Let’s consider the projects results in the industry for the implementation of quality management systems. The implementation of lean technology at the factories has received the greatest popularity among industrial enterprises recent years. Table 01 shows the results of some projects at the construction enterprises as well as their features and the possibilities of using of quality management systems tools to reduce losses are also presented.

**Table 01.** The results and using of Lean technologies in the construction industry

Company	Products produced by the company	Results of implementation “6 Sigma”/ Lean technology
Group of Companies "Izh sintez - Decoration Materials"	Construction and outfitting materials	Reducing the cost of eliminating the mistakes of performers by 36%
Kursk Factory of construction structures	Sandwich panels for walls and roofs, fencing and fireproof structures	<ul style="list-style-type: none"> <li>• streamline the staffing structure by 12 %;</li> <li>• cost reduction of the manufacture and storage of non-popular products by 17%</li> </ul>
Saransk Facing Brick Factory	Ceramic facing brick, standard brick	<ul style="list-style-type: none"> <li>• reduction of defect by 58%;</li> <li>• working time optimization;</li> <li>• increasing of working capacity</li> </ul>
Precast Concrete Products Industry №13 Iskitim Novosibirsk region	Hollow slabs	Reduction of costs for waste and storage of defected products by 18.4%
Combine building materials №10 city of Rostov-on-Don	Reinforced concrete products, reinforcing mesh and frames	Reductions with costs by 23% by reducing the costs of disposal and storage of defected products
Voronezh combine of building materials	Reinforced concrete products	<ul style="list-style-type: none"> <li>• increasing of production capacity;</li> <li>• streamline the staffing structure;</li> <li>• simplification of organizational structure</li> </ul>

Setting the task of improving the quality management of products, every forward-looking manager, who aims at increasing of enhancing quality management, knows that all the activities of an enterprise are divided into operations and processes that add value and do not add value to a client.

There are always losses in the manufacturing process. There are following types of losses and the causes of their occurrence for the construction materials (reinforced concrete products) in Table 02.

**Table 02.** Types of losses and their causes during manufacture of concrete products

Loss type	Process type	Causes
Loss due to overproduction	value added	The need of formation of stocks due to the season
Loss of time due to waiting for the end of the process	value added	Depends on production technology
Transport losses	auxiliary process	Material fragility
Losses due to additional steps to correct the deficiency (elimination of defects)	value added	Violation of the technology, quality inconsistency of raw materials
Losses due to extra inventory	auxiliary process	It depends on lack of calendar orders, need of non-contributory stocks before and during the season
Losses due to defected products	value added	Violation of the technology, quality inconsistency of raw materials, low qualification of personnel involved in the production process
Losses due to storing and disposal of defected products	auxiliary process	All the reasons of irreversible defects
Losses due to unnecessary relocation of workers during the manufacture	value added	Lack of technological maps or errors, lack of business processes monitoring, low qualification of employees

Table 03 presents potential use of elements of approaches and quality management systems.

**Table 03.** Potential tools of quality management systems for losses elimination at precast concrete industry

Input Loss type	Possible solutions (QMS tools)	Expected effect	Feasibility of using
Loss due to overproduction	Checklists	The application is received "just in time" with the help of checklists and each department is informed about its business processes	The using is appropriate and allows to combine different profile units in one system, the CRM system is possible to be used
Losses due to additional steps to correct the deficiency (elimination of defects)	Ishikawa Chart	The reason is revealed with the help of a graphical image shaped like a fish skeleton	This type of analysis presents a possibility to visualize the processes which have the highest % of remediable defects and allows to reengineer the process
Losses due to extra inventory	JIT system	Reducing the cost of products storage "produce what is exactly needed, just in time"	Individually for each kind of manufacture. Suitable with only permanent customer base.
Losses due to defected products	Control cards of V. Shukhart	Identifying of defective products proportion, the number of defected products and the number of defects through the sample	Automatic registration of defects allows to identify the most inefficient process
Losses due to unnecessary relocation of workers during the manufacture	5S	Every employee knows where their working tools are.	A simple system to be implemented, fast adaptability, suitable for any enterprise.

## 7. Conclusion

As a result of conducted study it was made a decision to develop the program of activities due to quality product management at the enterprise. The program includes 2 stages: the first stage which lasts till the end of 2019 lean tools will be implemented, the second stage the start of which is 2020 implies to initiate gradual volunteer certification after evaluation of economical effect of intermediate results of the

project. The implementation of “6 Sigma” concept is provided at the first stage which will require extra labour force - 2 undergraduate students from technical university and industry Construction University.

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