

## Chapter 12

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### THE QUALITY OF PRODUCTS APPLIED IN THE CONSTRUCTION OF SMALL ARCHITECTURE OBJECTS

**Abstract:** In the chapter was carried out a risk analysis of the production process in the factory, which manufactures products for small architecture. Using FMEA method identified the most important areas that affect the production of paving stones. Also carried out the synthesis of intangible factors affecting production in the audited company with a particular focus on visual inspection. It was examined determining the validity of the factors studies describing the 7 BOST Toyota's management principle. The statistical analysis was performed based on the results and correlation characteristics of company employees.

**Key words:** quality analysis, statistical methods, concrete pavement blocks

#### 12.1. Introduction

In order to meet the changing trends in architecture and fashion in the creation of public space, began to develop innovative gamut of products, both for equipment in outdoor areas, interiors of public buildings and private houses. A characteristic feature of these products is the architectural concrete and the surface that maintains its natural beauty, creates a timeless classic minimalist style and elegance.

The small architecture objects are finer, slight building structures that are not temporary building facilities. In the case of their construction apply greatly simplified procedure compared to buildings or structures.

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Object of small architecture, is sometimes colloquially misidentified with a temporary building structure. Building Law defines small architectural as a small construction objects, in particular:

- religious objects: chapels, wayside crosses, statues;
- statuary, fountains and other objects of garden architecture;
- objects of daily usage for recreation and to maintain order, such as sandboxes, swings, ladders and garbage cans.

According to the Act of Building Law, construction of small architectural objects does not require a building permit. If you are going to situate the object of small architecture on our private property, we are not obliged to notify the authority of architecture and construction administration.

The products manufactured for the purpose of small architecture is committed to a number of requirements for its quality. The most important can include: dimensional accuracy, surface aesthetics and long service life (BORKOWSKI S., KRYNKE M., INGALDI M. 2012).

## **12.2. The organization influence on environmental**

In the factory is carried out waste management, including segregation and re-use of such non-conforming product, which relies on selling them at a very attractive price. Buyers of this goods there is no shortage because reclassified paving stones is still an attractive product used on many surfaces, which are not required a perfect look.

Current technologies make the production of paving stones has many features that not only don't pose a threat to the natural environment, but also has a positive effect on his condition. One of the advantages of such a surface is permeability of water and air. Ready area does not pose a hot climate under the area, as does the asphalt or concrete, so that allows for the proper functioning of the ecosystem. This is particularly important in parks or gardens, where the roots spread out beneath the surface and extend walkways and streets. The company also manufactures many

concrete elements of structure which allows rainwater drainage to the ground.

An important advantage is the possibility of surface coating a few times with the same paving stones. There is no need at this consume a lot of electricity or use of thermal processes which emit a nuisance and a health hazard substances (as is the case with asphalt). In addition, there is a possibility to repair the installation, which is located under the surface, cubes can be removed, and after the repairs build over it again in the same territory. Everything can be done in a way that the breach will not be visible a built up area with paving stones.

In terms of environmental protection one of the most important features of paving stones technology is that it is produced in 100% of materials of mineral origin. These are mainly natural aggregates such as grit, sand, gravel, water and cement. After combine all the ingredients and the setting and hardening process that must be completed a get a take-back material characteristics of natural stone. Therefore, it is not severe for the environment.

### **12.3. The risk analysis of the production process by the FMEA method**

Analysis was carried out in company manufacturing products of paving stones and concrete, which is known to be the leading Polish manufacturers of paving stones. The company functioning in accordance with ISO 9001 quality standard and its products are subject to Building Law and system of declaration of conformity. Indications for risk analysis was to meet the requirements of ISO for the core business of the organization, in this case, the production of products for small architecture.

In the production process of paving stones company in the study identified 10 non-compliance. These include: fracture of the product, discoloration, poor consistency, equipment failure, the fragility of the product, abnormal shape, color washing, dents, cavities in the product

and inadequate production technology. These problems have a major impact on the quality of manufactured products, so the production process should be subject to corrective action.

To determine the effectiveness of corrective actions commonly used is FMEA method. Its objective is the systematic identification of each of the incompatibility that occur during the manufacturing process and to eliminate or reduce the effects of which can carry for each other (MAZUR M., ULEWICZ R. 2007).

Achieving that goal will be possible by determination of cause-effect relationships in the formation of each of the defects of the product. To their findings are used risk factors, namely: LPW occurrence, LPO detection and significance of the lack LPZ (KNOP K., SELEJDAK J. 2009). Table 12.1 shows the sheet from carried FMEA method which lists the risk priority number for each LPR defects occurring during the production of paving stones.

The FMEA results presented show that the company manufactures paving stones most common discrepancies in the production is washing a pigment and formed on the product discoloration. Hypothetically, it could be argued that it is they who are the most unfavorable and bring the greatest losses. However, the audit clearly shows that the fragility of the product in terms of occurrence, detection and the importance of non-conformity defect is causing the greatest losses and costs.

The occurrence this incompatibility can cause not only the loss of customers, but also expose to high financial costs of the company. In order to solve this problem of quality should be ensure better control of the devices responsible for of paving stones structure, or change the proportion of ingredients.

**Table 12.1. FMEA sheet for of paving stones**

Element and Function	Effects of defects, reduction of function	A potential defect	Causes, mechanisms of defect	Control methods	Rating			LPR	Preventive actions
					LPW	LPO	LPZ		
Color of cubes	No customer satisfaction,	Washout of pigment	Low quality of components		10	8	6	480	Supplies production of high quality raw materials
	poor appearance	Discoloration	Inappropriate proportions of pigment	The use of weights	10	2	6	120	Frequent review of the technical condition of the weights
Product characteristics	The product is not suitable for sale,  No customer satisfaction,  Bad reviews about manufacturer,  The costs of product returns	Fragility	Wrong proportions of ingredients	The use of weights	9	7	10	630	Frequent review of the technical condition of the weights
External appearance of the product		Break	Badly created logistics network	Visual inspection of the product	8	1	10	80	Better functioning transport system
Purpose of paving stones		Improper form	Damage the machine	Visual inspection of the product	7	1	9	63	Inspection of machinery and equipment
		Improper consistency	Inadequate proportions of components	The use of weights	6	8	8	384	Frequent review of the technical condition of the weights
External appearance of the product	Indentations	Incorrect storage	Visual inspection of the product	5	2	5	50	Better functioning system of transport and storage	
The whole usable	The product is not suitable for use	Improper production technology	lack of knowledge of employees	An insightful job interviews.	4	1	8	32	Courses for employees
		Equipment failure	Outdated equipment	Appliance overview	3	1	8	24	Maintenance of machinery

Source: own study

The manufacturer should most carefully consider this problem and to draw conclusions for the future. With this analysis of incompatibility, the company discovered a place that generates poor quality of their products

and can take specific corrective action (BORKOWSKI S., ULEWICZ R. 2008., HUBER Z. 2006).

#### 12.4. Summary of test results - assessing the validity of the factors describing the principle of 7 Toyota's management

Basic the stability of production process is essential for continuous production of the product with the highest quality standards. Control of its individual components and employee awareness of their significance is the key to optimizing the whole process (ULEWICZ R., KNOP K., DULBIŃSKI A. 2009). The results are based on surveys carried out among employees. Respondents in the E7 area of survey BOST provided answers to the following question (BORKOWSKI S. 2012a,b,c):

**What is the most important element in the visual inspection? In the box type 1, 2, 3, 4, 5, 6 (6 most important factor).**

CS	Cleanliness, order	UP	Participation in production places
EP	Flow	ME	Monitoring
TI	Information boards	GW	Graphical presentation of results

The results of the survey are presented in Table 12.2, which summarizes the validity of the ratings (on a scale 1 to 6) factors E7 area of survey BOST.

**Table 12.2. Ratings structure [%] of validity factors E7 area. Relates to company producing paving stones**

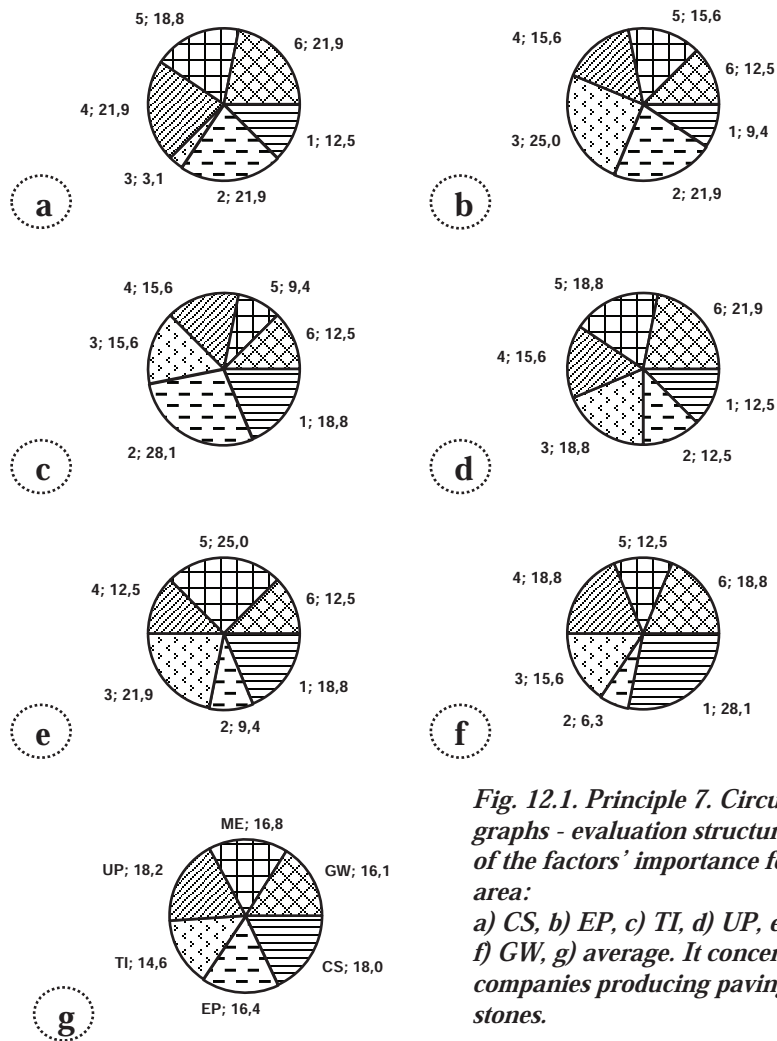
Evaluation	Indicating the factors'					
	CS	EP	TI	UP	ME	GW
<b>1</b>	12,5	9,4	18,8	12,5	18,8	28,1
<b>2</b>	21,9	21,9	28,1	12,5	9,4	6,3
<b>3</b>	3,1	25,0	15,6	18,8	21,9	15,6
<b>4</b>	21,9	15,6	15,6	15,6	12,5	18,8
<b>5</b>	18,8	15,6	9,4	18,8	25,0	12,5
<b>6</b>	21,9	12,5	12,5	21,9	12,5	18,8

Source: own study.

In interpreting the data in Table 12.2 is easy to realize that the employees for the most important factors in the company consider *cleanliness and order (CS)* and *participation in production (UP)*. These elements have been assessed as significant and very important (rating „5” and „6”) to give more than 40% of all votes. As the least important factor was assessed *graphical presentation of results (GW)*.

### **12.5. Ratings structure of factors validity describing the 7 management principle of Toyota**

Ratings structure of factors validity of visual inspection was illustrated in the form of pie charts presented in Figure 12.1. According to the company's employees the most important area of visual control in the manufacturing process of paving stones is *cleanliness and order (CS)* and *participation in production (UP)*. In contrast, the most the lowest ratings received *graphical presentation of results factor (GW)*. However, analyzing the average awarded ratings (Fig. 12.1g) as the least important was recognized by employees *information tables factor (TI)*. Tips received by BOST study are very important for the leadership, because they come from employees, who normally come into contact with the production process. These people have a very extensive knowledge of all components of production, therefore, this information may improve the process. The management after receiving any such results should direct all their goals to these elements.



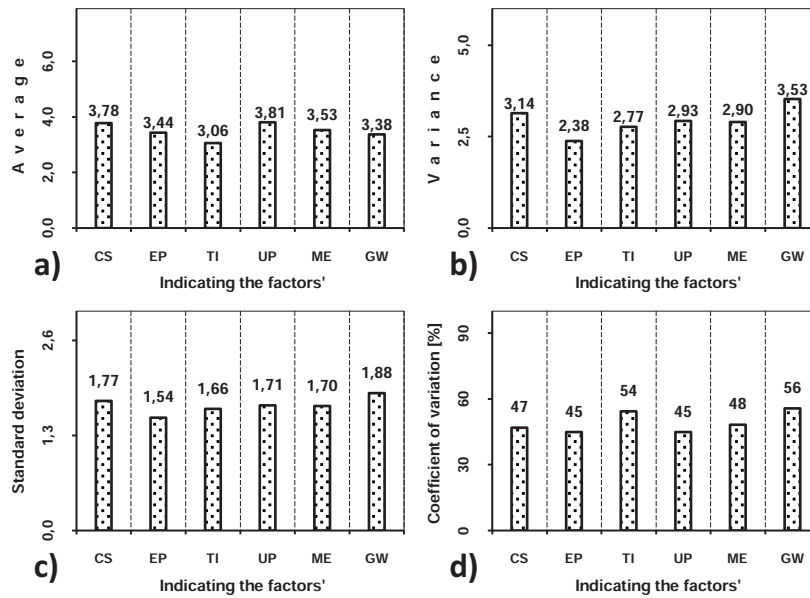
*Fig. 12.1. Principle 7. Circular graphs - evaluation structure of the factors' importance for E7 area:  
a) CS, b) EP, c) TI, d) UP, e) ME, f) GW, g) average. It concerns companies producing paving stones.*

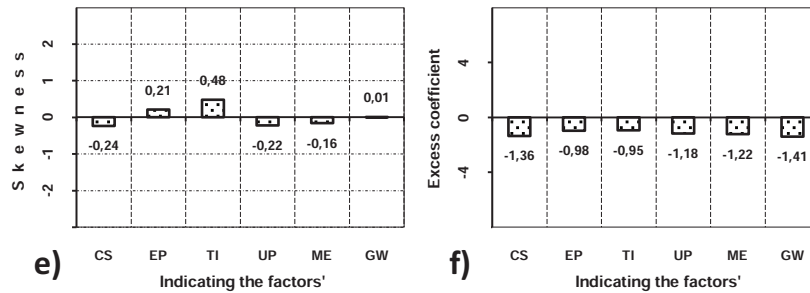
*Source: own study.*



## 12.6. Statistical analysis of results

Based on the data contained in Table 12.2, were compared of the following statistical indicators: average, variance, standard deviation, coefficient of variation, skewness and kurtosis for factors of E7 area of BOST research (CZEMPAS J. 2000, PUŁASKA-TURYNA B. 2008). Graphic interpretation of these indicators are shown in Figure 12.2.





**Fig.12.2. Principle 7. Comparison: a) average, b) standard deviation, c) variance, d) variation coefficient, e) skewness, f) kurtosis for E7 area factors. It concerns companies producing paving stones.**

Source: own study.

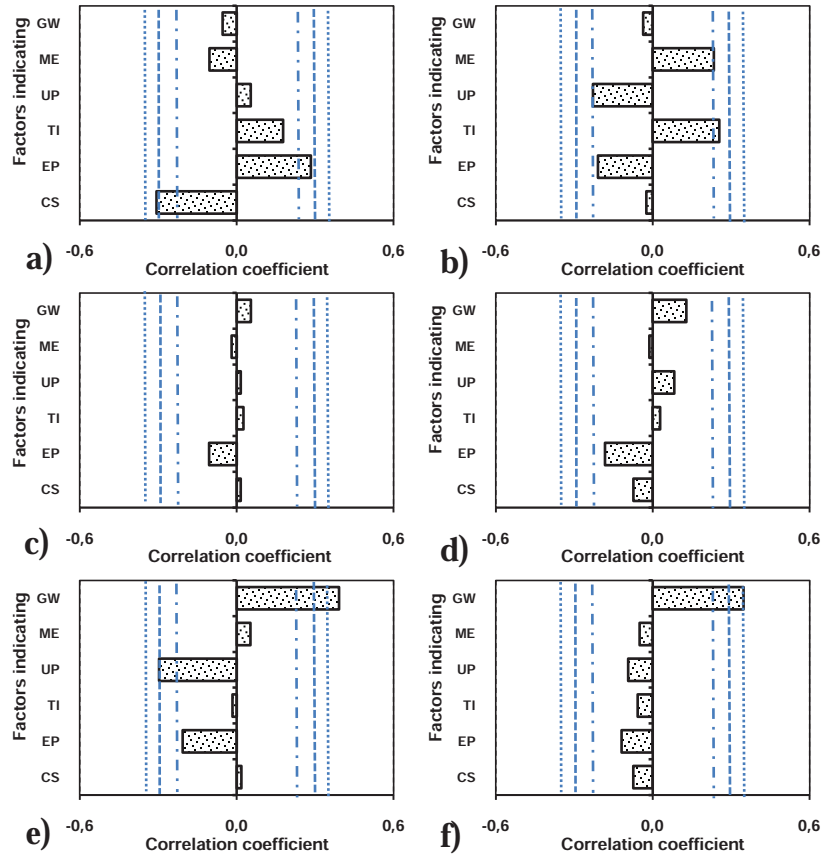
The highest average ratings received *participation in production factor (UP)* – 3.81. The lowest average presents *information tables factor (TI)* – 3.06. Analyzing the graph of variance (Fig. 12.2b), it can be concluded that the *flow factor (EP)* has the smallest scatter votes, so this factor accounted the most similar ratings. In contrast, *graphical presentation of results factor (GW)*, characterized by a larger deviation value which suggests a greater diversity of their assessments. This is confirmed by the coefficient of variation (Fig. 12.2d) showing which feature is the most diverse in terms of awarded votes. It turns out that *the graphical presentation of results factor (GW)* – 56% was often assigned very different note. In the case of *flow factors (EP)* and *participation in production (UP)*, variability was the smallest (45%).

## 12.7. Correlation dependence of the company's employees traits

The distribution of votes in the E7 area of BOST research (What is the most important element in the visual inspection?) is differentiated in many ways. It can be considered by gender, education, age, length of service, the number of employers and the mode of employees employment (BORKOWSKI S. 2012b). All these aspects have

an impact on employee responses. Each of the factors in this area, namely *cleanliness, order (CS)*, *flow (EP)*, *information tables (TI)*, *participation in production (UP)*, *monitoring (ME)*, *graphical presentation of results (GW)* is evaluated by employees of different experiment. Analysis of the results in this field is represented by the correlation graphs in Figure 12.3.

In the histogram, and the lines indicated in Figure 12.3a can be seen that employees gender affect assessment of two factors from the E7 area. Women lower rating *cleanliness and order factor (CS)* than men who have the factor of *flow (EP)* were evaluated higher than women. From the analysis of Figure 12.3 can also be noted that given the assessment was also influenced by features of the respondents such as: education, mobility and employment mode. Factors the *information tables (TI)* and *monitoring (ME)* were rated in proportion to the level of higher education employees, and factors of *flow (EP)* and *participation in production (UP)* were rated inverse proportion to the level of education of respondents (Figure 12.3b). Mobility of workers significantly influences *the graphical presentation of results factor (GW)*. This means that employees, for which the present work is another place of employment, evaluate this factor proportionally higher (strong correlation at the level of  $\alpha = 0.2$ ) (Fig. 12.3e). Also, the assessment of this factor significantly affects the mode of employment of staff. Employees who have been employed in the current company to work on the principle of the transfer and due to better financial conditions above evaluate this factor from employees who have been employed in normal mode (Fig. 12.3f).



*Fig. 12.3. Principle 7. Correlation graphs of evaluations in E7 area depending on the respondents features: a) gender, b) education, c) age, d) job seniority, e) mobility, f) mode of the employment.  $\alpha = 0,2$  (internal lines),  $\alpha = 0,1$  (central lines),  $\alpha = 0,05$  (external lines). It concerns companies producing paving stones.*

*Source: own study.*

## 12.8. Summary

The present study analyzed the incompatibility that occur during the manufacturing process of paving stones. For this purpose was used the FMEA method. From the presented analysis clearly shows that the fragility of the product in terms of occurrence, detection and significance of defects is an incompatibility causing the greatest losses and costs. Eliminating of this incompatibility or its reduction result in a significant increase in the number of correct products in total production, so it will affect the customer satisfaction. Therefore, in the first place should be the introduction of corrective actions that will allow the elimination of the causes of listed defects.

In further studies also considered the importance of visual inspection. Its importance spoke employees of the company in a survey. The results were statistically analyzed. It has been demonstrated large differences in assessing the validity of the factors by respondents in terms of average, variance, standard deflection, coefficient of variation, skewness and kurtosis. In the case of the coefficient of variation is characterized by the greatest diversity of *graphical presentation of results (GW)* and the lowest of *flow (EP)* and *participation in production (UP)*. Kurtosis which is a measure of concentration around the arithmetic average of the measured coefficient of excess, has for a set of ratings for all factors negative value. This means that the values of this features are less concentrated than in the normal distribution.

In analyses demonstrated that under the conditions of the company, in the opinion of the respondents/employees, the most important factor for visual control factor is *cleanliness and order (CS)* and *participation in production (UP)*. In this way, the top management of the company has obtained the information base for decision making in the area of improving the manufacturing process of paving stones.

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