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QUALITY EVALUATION IN PRODUCTION OF WOODEN ELEMENTS

Abstract: In the chapter concepts of quality and production were presented. The production-service plant, which is engaged in production frame slats of about 300 designs and colours, of high quality, for frame plants, glass and art galleries, was characterized. These slats are made of wood and ecologically sound materials. The production process of the frame slat depicted technologically was presented. With the use of the Pareto-Lorenz diagram, a hierarchy of nonconformities occurring during the manufacturing process of wooden frame was made. It was indicated that the most frequent nonconformities of the wooden frame are: elements soiled with glue, dirty slat and different colours of individual parts of the frame.

Key words: quality, production, frame slat, the manufacturing process depicted technologically, nonconformity, Pareto-Lorenz diagram

1. The concept of quality and production

The concept of quality is derived from the ancient times. The first time Plato used this term, recognizing the quality of specific things as "a certain degree of perfection".

In contrast, Aristotle understood the quality as "the distinction of being" enabling along with nine other categories (time, place, quantity, substance, relationship, location, disposition, operation, exposure to operations and quality) division of all the concepts in the logical groups (FRĄŚ J., 2000, PRUSSAK W., 2006).

In the literature many different definitions of quality can be found. The reasons of the differences are individual differentiators of products and services quality and the criteria for its evaluation. In general, the quality is associated with meeting the requirements. In practice the quality is defined as the sum of the features and characteristics of a product or service that make it possible to meet specific or hidden customer needs.

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Standard PN-EN ISO 9000:2006 (Quality Management System - Fundamentals and vocabulary) defines quality as "the degree to which a set of inherent characteristics fulfils requirements". On the other hand the European Organization for Quality (EQQ), determines the quality of the product as a component of three factors:

a) type quality - compliance design of the product to be manufactured to the requirements and expectations of the customer – pre-production sphere,
b) performance (production) quality - the degree of compliance of the manufactured product with the adopted model - production sphere,
c) exploitation quality – the degree of compliance of service in respect of the product with the requirements of the project - post-production sphere.

The main features which determine the quality of the product are following:

- efficiency of the product (degree of satisfaction of the needs in the term of use, performance, accuracy and operation economy of the device),
- durability (application period during which the product maintains its properties),
- operational reliability (probability that the product will be able to operate under specified conditions within a specified time).

If these features intensify, the quality level of products increases. The manufacturer must choose such its level that in the best way meets the needs of customers. Because verification of the quality of products occurs on the market where products with inadequate quality simply cannot find buyers (DĘBSKI S., 1994).

In the most general terms, the production is a social process designed to produce certain material goods to satisfy social needs. This task is implemented in production systems, which are grouped in a suitable means of labour resources (machinery, equipment, tools, etc.) and labour force (employees), by which the subjects of work in the form of input materials are converted into products.

In the production people produce material goods, which are then subjected to distribution and consumption. The organization of production aims to associate the most effective human labour with the material factors

of the production process, the most effective deployment of the means of production and linking them with work processes in space and time to ensure maximum efficiency and optimal economic performance. A characteristic feature common to all types of production, is the way in which the materials move or flow in production. The production should be considered as the flow of materials in a complex system of flow streams merging and splitting, depending on the complexity of the product, type, and organization of production.

2. Presentation of the subject and object of research

The production-service plant located in the province of Silesia was analysed. Initially it worked as a general carpentry manufacturer, but its offer included also frame slats, mainly for the local glass-making companies and dealing with luminary of paintings.

Development of the company led open new branches dealing with luminary of paintings and the introduction of new offers such as own picture framing, mirrors, antiframes etc. Plant also sent a number of offers to art schools in the country - the production of frame for canvas pictures, passe-partout.

The production-service plant is engaged in production frame slats of about 300 designs and colours, of high quality, for frame plants, glass and art galleries. These slats are made of wood and ecologically sound materials.

The degree of technological advancement also allows to produce each type of slats:

- stained (coated with wood impregnant, which penetrates into the wood structure and permanently stained the surface, keeping the visible pattern of the grain),
- varnished (used varnish gives a shiny and smooth surface to slats while maintaining their natural texture such as wood grain),
- ornaments (various motifs and decorative motifs teams).

The plant is a supplier of raw materials for other factories producing frames and photo-frames, as well as producers of occasional, communion paintings or pictures etc.

The products consist of many finishing materials. There are many type of slats for which other type of material is needed. The slats are made of of pine wood and exotic wood type ayous and samba.

3. Manufacturing process of the research object depicted technologically

The structure of the production process depicted technologically is defined as a system of stages and technological operations together with material, energy and information connections, indispensable for manufacturing a final product. In this version it is possible to distinguish stages, processes and operations carried out in the whole plant or production unit (DURLIK I., 1998).

Manufacturing process of the frame slat depicted technologically was presented in Figure 1.

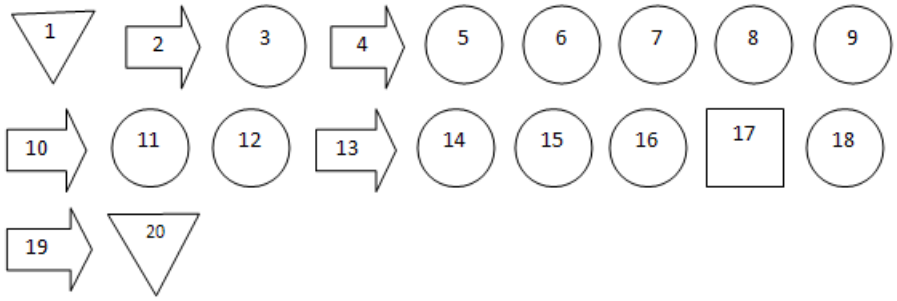

Fig. 1. Scheme of the manufacturing process of the frame slat depicted technologically.

Source: own study

Charakteristics of the individual steps of the production process (BORKOWSKI S., ULEWICZ R. 2008, DURLIK I.1998, BURCHART-KOROL D., FURMAN J. 2007):

1. Taking materials from the warehouse. In the warehouse there are stored materials (lumber) that are waiting for transport to the dryer. The material is segregated and stacked. Stacks of lumber are put on the composition of

separately according to: the type of wood or generic groups, the degree of processing, thickness, classes or groups of quality, destination, length groups.
2. Transportation to the dryer. Transport is done by special trucks and forklifts.
3. Drying of wood. It is carried out by a panel of devices for drying wood using heat and electricity. Wood drying process begins by wetting the wood and warm-up and ends with a cooling and air conditioning.
4. Transport of wood to the production hall. Transport is done by special trucks and forklifts.
5. Cutting wood to appropriate dimensions. Cutting is done by machines installed respective band saws, carbide tipped, and ordinary brakes.
6. Cutting out knots. Knots are cut with special drill bits.
7. Bonding of wood. Bonding is carried out on a hydraulic press.
8. Milling the boards. It results from the recommendations technology (e.g. rounding of the edges of elements in preparation for painting) or decorative (e.g. giving special look to the edges). There are used down-spindle shaper, to the edge and modular shaper.
9. Cutting boards to the appropriate size. Boards are cut to the appropriate size, depending on what will be used for.
10. Transport of slats to a pneumatic press. Transport is done using special hand trolleys.
11. Gluing of slats on the pneumatic press. Pneumatic press is used for gluing the wood pieces by a predetermined pressure, and applied design solutions allow bonding elements to have proper thickness and width.
12. Beading of slats to the appropriate shapes. There are used down-spindle shaper, to the edge and modular shaper.
13. Transport of slats to the second production hall. Transport is done using special hand trolleys.
14. Application an ornament to slats. Number of techniques which result in a countless number of combinations allows for unique decorative effects (including own stylistic).
15. Cleaning of slats. It takes place in order to remove impurities, inequality, etc.

16. Varnishing of slats. This is done by hand using pneumatic spray gun to paint (painting), properly prepared solutions.
17. Quality Control. The control employee checks elements mainly visually for compliance with the technological process. Products not compatible with the specifications are rejected or passed to improve.
18. Packaging and labelling. This is done according to the type of slats, species, ornament, etc., in appropriate packaging materials (films, fillers polystyrene, cardboard boxes) and labelled by properties
19. Transportation to finished products warehouse. This transport is done using special hand trolleys.
20. Acceptance of the finished product to the warehouse - after the acceptance of the finished product to the warehouse, it is carefully described and stored in a properly designated place (shelf). In the warehouse it goes to the customer.

4. Hierarchy of nonconformities with use of Pareto-Lorenz diagram

Pareto-Lorenz diagram (BORKOWSKI S. 2004., BORKOWSKI S. 2012., HAMROL A. 2008, INGALDI M., ROSAK-SZYROCKA J., JAGUSIAK-KOCIK M. 2012, JAGUSIAK M., ULEWICZ R., ŚWIDER A. 2009, KONSTANCIAK M., JAGUSIAK-KOCIK M. 2012) is the next used quality management tool. It belongs to traditional tool and is based on the regularity that typically 20-30% of the causes decided by about 70-80% of the effects. This tool assumes that the general causes of the phenomenon does not occur with equal frequency, or not have the same meaning. It allows for identification and prioritization of the most important causes, events causing an effect and to identify action which should improve the level of processes and the quality of products and services.

On the basis of research, in analysed production-service plant, during one quarter the most common nonconformities of the wooden frame generated during the manufacturing process were identified and summarized.

There were following nonconformities:

- N_1 – elements soiled with glue,
- N_2 – unevenly applied ornament on the slat,

- N_3 – uneven sticking of decorative tape,
- N_4 – different colours of individual parts of frame,
- N_5 – damaged ends of frame,
- N_6 – scratches,
- N_7 – poorly glued slat,
- N_8 – too much imposed kaolin on slat,
- N_9 – different sizes of individual elements of frame,
- N_{10} –dirty slat.

The listed nonconformities of the wooden frame and their frequency in the research period are shown in Table 1

Table 1. Hierarchy of the nonconformities of the wooden frame In the research period

Denotation of the causes	Name of the causes	The frequency of nonconformity occurrence [pcs]
N_1	elements soiled with glue	54
N_2	unevenly applied ornament on the slat	17
N_3	uneven sticking of decorative tape	10
N_4	different colours of individual parts of frame	31
N_5	damaged ends of frame	15
N_6	scratches	27
N_7	poorly glued slat	21
N_8	too much imposed kaolin on slat	6
N_9	different sizes of individual elements of frame	4
N_{10}	dirty slat	40

Source: own study

The nonconformities occurring in the research period were ranked according to their frequency. Their percentage fractions and cumulated fractions were presented in Table 2.

Table 2. The ranking of nonconformities of the wooden frame according to their frequency

Denotation of the causes	Name of the causes	Percentage fraction	Cumulated fraction
N_1	elements soiled with glue	24.00	24.00
N_{10}	dirty slat	17.78	41.78
N_4	different colours of individual parts of frame	13.78	55.56
N_6	scratches	12.00	67.56
N_7	poorly glued slat	9.33	76.89
N_2	unevenly applied ornament on the slat	7.56	84.44
N_5	damaged ends of frame	6.67	91.11
N_3	uneven sticking of decorative tape	4.44	95.56
N_8	too much imposed kaolin on slat	2.67	98.22
N_9	different sizes of individual elements of frame	1.78	100.00

Source: own study

On the basis of the data presented in Table 2 Pareto-Lorenz diagram was created and presented in Figure 2.

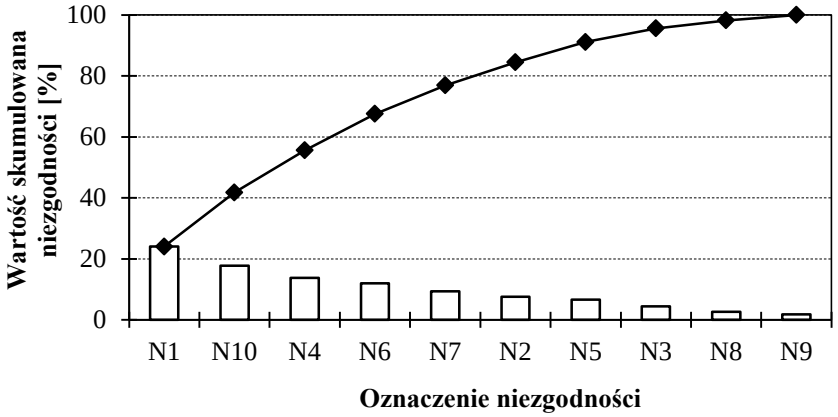

Fig. 2. Pareto-Lorenz diagram for the analysis of the nonconformities of the wooden frame.

Source: own study

From Table 2 and diagram presented in Figure 1 it results that 30% of all causes of nonconformities are responsible for 55.56% of all nonconforming products. Furthermore, it can be concluded that for 55.56% of nonconformities in the wooden frames are responsible 3 causes: N_1 (elements soiled with glue), N_{10} (dirty slat) and N_4 (different colours of individual parts of frame). The remaining 7% of causes are responsible for 44.44% of nonconforming products.

5. Summary

The Pareto-Lorenz diagram was used to rank the nonconformities in the manufacturing process of the wooden frame, from the most important to least important. Most nonconformities of this product were in form of elements soiled with glue, dirty slat and different colours of individual parts of the frame.

To eliminate or minimize the impact of these nonconformities on the process, more stringent control measures should be introduced and significance of the quality should be improved in order to eliminate or reduce the occurrence of nonconforming product.

After reduction or elimination of 2 most frequent nonconformities, the production process of wooden frames will improve, and the possibility of nonconforming products will be significantly reduced. This will allow the plant to increase the quality of its products, which in turn may result in the possibility of acquiring more customers, reducing the cost of repairs of defective frames, as well as increase in its profits.

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