

## Chapter 7

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### IDENTIFICATION OF THE CRITICAL REGION IN FURNITURE PRODUCTION

**Abstract:** This paper presents an analysis of the critical region in furniture production. The analysis includes quantification of incompatibility, and analysis of the causes of this incompatibility with the Ishikawa diagram. An analysis of Parto-Lorenc was used in order to quantify identified incompatibilities within assumed research period. In order to determine risk associated with the occurrence of a given type of incompatibilities and its importance for the next stage of the manufacturing process as well as for external customer FMEA method was used.

**Key words:** quality, furniture, Pareto-Lorenz, FMEA

#### 7.1. The quality of furniture

An important problem that should be solved while designing some new furniture understands the concept “perceived quality”. From experience it is obvious, that perceived quality for the selected product (in our case - furniture) not always is identical with the technical quality. It, how we perceive the quality of a product, especially after it is purchased, depends on many outside factors (ULEWICZ R. 2013.). Keep in mind that functional properties of furniture, including their safety of use and durability, depend directly on quality of workmanship. It is the quality of used materials; way of connecting structure elements, stability and way of finishing are the main determinants of whether a given piece of furniture is sturdy and safe. Properly designed piece of furniture

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should be characterized by technical structure so formed that recognizes the priority of characteristics and needs of man. The quality of furniture depends primarily on the type and quality of used materials. The best construction material is wood (both solid and laminated) and rattan. In case of composite wood products (such as e.g. particle board) very important is the level of hygiene (related to the emission of so-called free formaldehyde), however, today the majority of boards meet the highest hygiene requirements. In case of upholstered furniture attention should be paid to the quality of filling materials: springs, foams, coconut mats and coating materials (upholstery): fabrics and leather.

The quality of furniture is also influenced by quality of used make fabrication: adhesive joints (glue connections), shape-adhesive connections (dowelled joints, mortise-and-tenon joints and mini-doverail joints) and liaison connections (nailed joints, screw joints and tap screw). Only special laboratory tests may certify whether a given piece of furniture in this regard is adequately strength, and hence safe. In well-constructed skeletal furniture (chairs, stools, chairs and tables), we should not perceive visible breaks and clearances between individual elements of the frame: joins, legs, case, plate elements of the seat, backrest and worktop of the table. All the elements, even those cropped at an angle, should be ideally adjusted. In the chest furniture first of all attention should be paid to the perfect geometry of the plate elements (e.g. doors, drawers fronts, rear and side walls).

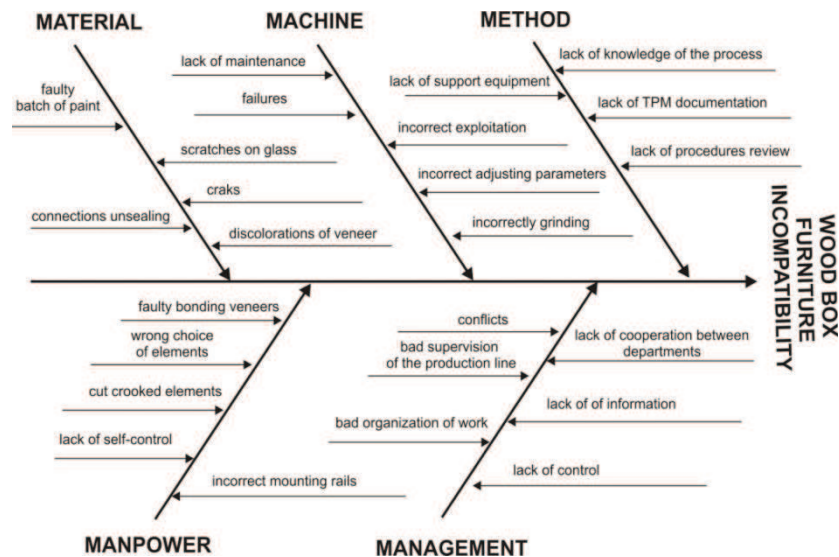
Quality of furniture is furthermore associated with safety and safety with stability. In general, it can be said that a piece of furniture will be stable as long (will not turn over), until its centre of gravity will not come out beyond the base of the structure.

Noteworthy is also the way of finishing furniture. Materials of furniture of high quality often are veneered with natural veneer (manufactured in the process of peripheral machine cutting of wood). Parts made of solid wood or laminated are varnished with the so-called ecological water-based varnishes deprived of unpleasant odors. In case of upholstered furniture, well tightened upholstery should show no folding

and symmetrically arranged elements (such as armrests, head rests, cushions, and seats) should be equally formed and sewn the same.

## **7.2. Identification the causes of box furniture incompatibility with the use Ishikawa diagram**

An important element in ensuring quality of produced furniture is to define critical areas. In case of furniture production in the first stage of the analysis we can use Isikawa diagram in 5M system (Machine, Manpower, Management, Method, and Material) ( BORKOWSKI S.2013). The purpose of use of the diagram is to obtain feedback from production employees on incompatibilities occurring during the manufacturing process, assembly process as well as forwarding (RADHARAMANAN R. et al. 1996). After completed interview carried out among employees and brainstorming based on obtained data there was created Ishikawa diagram for the causes of occurring incompatibilities for box furniture (Fig. 7.1).



*Fig. 7.1. Ishikawa diagram wood box furniture incompatibility.*

*Source: own study .*

### 7.3. Quantification of incompatibility wood furniture

Pareto-Lorenz diagram is a graphic way that shows both a relative and absolute distribution of types of incompatibility, problems or their causes. This diagram is a tool that allows you to show factors influencing the studied phenomenon in an orderly way (BORKOWSKI S., ULEWICZ R. 2008, LESTYÁNSZKA ŠKŮRKOVÁ K. et al. 2013). By using this type of chart can provide data on the column chart emphasizing the elements that have the greatest impact on the problem. Pareto-Lorenz diagram will help identify problems that may impact strongest on the occurrence of incompatibility during the production of wood furniture. At the time of the audit conducted Pareto-Lorenz diagram provides an overview of the structure of existing incompatibility. Diagram also helps the person who

carries out an audit to identify unclassified incompatibility (STASIAK-BETLEJEWSKA R., et al. 2013).

Production system in analysed company is a flexible synchronized process. Availability of produced assortment exceeds an average of 300 blocks, which makes it necessary to conduct analyses (based mostly on statistical methods and the calculation of production capacity of the plant) and correcting production. Employees are obliged to record the product pieces made during operation. The results are analysed at the end of each month, saved in the database and verified with previous using statistical methods. Any incompatibilities are recorded on the „OBSERVATIONS CARDS „ (Fig. 7.2).

Table 7.1 presents the identified incompatibilities and their percentages occurring during the wood furniture manufacturing process within the prescribed time interval.

<b>OBSERVATIONS CARD</b>			
Date: .....		No of audit: .....	No of card: .....
Author of observation:.....		KZ :.....	
<b>DESCRIPTION OF INCOMPATIBILITY / OBSERVATION (*)</b>			
..... Signature of author of observation		..... KZ signature	
<b>CAUSE OF INCOMPATIBILITY</b>			
..... Signature of author of observation		..... KZ signature	
<b>CORRECTIVE ACTIONS</b>			
..... date and NK signature		..... date and KZ signature	
<b>PLANNED CORRECTIVE ACTION/ PREVENTIVE (*)</b>			
Planned realization date	PLANNED BY	EXECUTION APPROVED BY	Confirmed the effectiveness of executed actions (**)
.....	.....	.....	.....
* Please delete as appropriate			
** assessment of effectiveness; place on the reverse of the form			

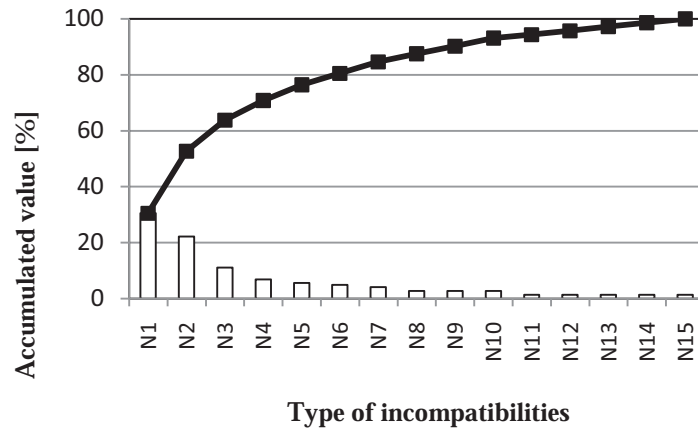
**Fig. 7.2. Observations card.**

Source: own study.

*Table 7.1. Quantification of incompatibility wood furniture*

<b>Symbol</b>	<b>Incompatibilities</b>	<b>Percentage value [%]</b>	<b>Accumulated value [%]</b>
N <sub>1</sub>	Shortages in assembly elements	30,6	30,6
N <sub>2</sub>	Improper selection of veneers	22,2	52,8
N <sub>3</sub>	Bad cut	11,1	63,9
N <sub>4</sub>	Differences in colours (wrong choice of stains for veneers)	6,9	70,8
N <sub>5</sub>	Wrong management decisions	5,6	76,4
N <sub>6</sub>	Glue punctures	5,0	80,6
N <sub>7</sub>	Assembly errors leading to destruction of element	4,2	84,7
N <sub>8</sub>	Insufficient amount of glue	2,8	87,5
N <sub>9</sub>	Technology errors when	2,8	90,3
N <sub>10</sub>	Errors when packaging (bad description of the content)	2,8	93,1
N <sub>11</sub>	Wrong formatting	1,4	94,4
N <sub>12</sub>	Wrong drilling	1,4	95,8
N <sub>13</sub>	Execution of dressing of wood with moisture content exceeding permissible norm	1,4	97,2
N <sub>14</sub>	Faults in delivery	1,4	98,6
N <sub>15</sub>	Errors when cutting boards	1,4	100,0

*Source: own study.*



*Fig. 7.2. Pareto-Lorenz diagram.*

*Source: own study*

#### **7.4. Assessment of risk and effects of incompatibilities**

In order to determine risk and effects of incompatibilities FMEA method was used. Its purpose is to determine the area of occurrence of incompatibilities (the critical region) as well as its likelihood of its occurrence (influence of technology, quality of materials, qualifications of staff, forms of management), as well as opportunities to detect given type of incompatibilities at the manufacturing stage (evaluation of the quality control system) (SELEJDAK J., SLÁDEK A., 2013). The advantages of the FMEA can include: increase of the effectiveness of efforts to improvement of quality, improvement of quality of product/process, better adaptation to customer requirements, achievement of the functionality of the process, improvement of the efficiency and safety of the process, increase in productivity and reduction of production costs, reduction of incompatibilities cost (reduction of the number of defects and complaints), defining risk (significant in the context of product liability). Table 7.2 presents the FMEA sheet for defined incompatibilities from table 7.1.



**Table 7.2. FMEA sheet for wood furniture**

Incompatibility	Potential Effects of Failure	Potential Causes of Failure	Process Control	S E V	O C C	D E T	R P N	Recommended Action	Responsible/ Completion Data	Action Taken	Action Results			
											S E V	O C C	D E T	R P N
Shortages in assembly components	It is necessary to make a duplicate of elements	Mistake of employee, destruction of elements, lack of quantitative control	Quantitative controlling throughout the process.	9	1	3	27	Preparation of a list of items of the manufactured product	1 month	Training of staff, appointment of supervising persons	5	1	2	10
Improper selection of veneers	It is necessary to make a duplicate of elements	Mistake of employee	Visual inspection (carried out by the employee)	7	1	2	14	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, appointment of supervising persons	4	1	2	8
Bad cut	Different colour, necessary re-sanding	Mistake of employee, wrong choice of grinding belt roughness	Controlling carried out by at least two employees	7	3	3	54	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, appointment of supervising persons	5	3	2	30
Differences in colours (wrong choice of stains for veneers)	Different colour, necessary re-sanding	Mistake of employee, bad choice of stains to tint veneer	Visual inspection (carried out by the employee)	8	3	2	48	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	5	3	1	15
Wrong management decisions	Material losses, loss of working time	Starting the production orders without confirmed order, inefficient management of human resources	Introduction of the reporting procedures	4	1	4	16	Training for management staff	1 month	Training for management staff	2	1	2	4
Glue break-down	Complaints, unsightly appearance	Applying too large amount of glue	Request to purchase tools for control and removal of excess amount of glue, visual inspection (carried out by the employee)	7	4	4	112	Issue an order for the use of tools	1 month	Training of staff, use of purchased tools	5	4	2	40
Assembly errors leading to the destruction of the element	It is necessary to make a duplicate of elements	Wrong assembly method haste routine, use of improper tools	Visual inspection carried out by the employee	7	2	4	56	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	5	2	3	30
Insufficient amount of glue	Complaint, correcting elements	Applying too small amount of glue	Request to purchase tools for control and removal of excess amount of glue,	7	4	4	112	Using appropriate tools	1 month	Using purchased tools	5	4	2	40
Technological errors when designing	Complaint	Lack of carrying out load research	Bearing strength research	4	5	2	40	Consideration of load research in the design phase	1 month	Training of staff	2	5	2	20

Source: own study

Continues Table 7.2. FMEA sheet for wood furniture

Incompatibility	Potential Effects of Failure	Potential Causes of Failure	Process Control	S E V	O C C	D E T	R P N	Recommended Action	Responsible/ Completion Data	Action Taken	Action Results			
											S E V	O C C	D E T	R P N
Errors when packaging (bad description of the contents)	Complaint,	Routine, haste	Visual inspection carried out by the employee	8	7	4	224	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	5	7	3	105
Wrong formatting	It is necessary to make a duplicate of elements	Lack of control of machine settings	Checking and adjusting machine settings, measurement control of elements (carried out by the employee)	5	1	4	20	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	4	1	3	12
Wrong drilling	It is necessary to make a duplicate of elements	Lack of control of machine settings	Checking and adjusting machine settings, measurement control of elements (carried out by the employee)	6	1	4	24	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	4	1	3	12
Performance of sizing of wood with moisture content exceeding permissible norm	Complaint, drying out of the sizing, cracks	Lack of humidity control, routine	Control of humidity measurement (carried out by the employee)	8	6	5	240	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	4	6	4	96
Delivery errors	It is necessary to provide appropriate product	Mistake of employee	Increased control when loading	6	9	5	270	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	3	9	3	81
Errors when cutting boards	To make a duplicate of elements	Mistake of employee	Checking machine settings and adjusting, measurement control of elements (carried out by the employee)	6	1	4	24	Training of staff, drawing attention to staff mistakes	1 month	Training of staff, staff meetings with management	3	1	3	9

Source: own study

## **7.5. Conclusion**

Customer requirements and strong competition requires from manufacturers of furniture production of good-quality of furniture while maintaining adequate production costs. Reducing costs associated with occurring incompatibilities and costs of their management is an important factor affecting the price of the final product. Based on selected quality assurance tools: Ishikawa diagram, Pareto-Lorenz diagram there was carried out identification of critical areas, which after the analysis proved to be human resources (lack of experience, carelessness), and material and exactly transport and storage conditions that affect the level of humidity of wooden elements. This is also confirmed by results obtained by FMEA, which showed that the greatest risk of incompatibilities occurrence is directly related to human error. In conclusion, we can clearly state that in analysed company critical area is human resources. It is necessary to implement appropriate corrective and preventive actions.

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