16 ANALYSIS OF GARMENT MANUFACTURING DEFECTS IN X CLOTHING MANUFACTURING COMPANY

16.1 Purpose and scope of subject of research

Because of the competition from Chinese clothing manufacturers quality management and a change in strategies of Polish clothing manufacturing companies has become a must.

The garment industry in Europe was not in a very good condition until 2000, which seems to be related to the fact that this is a mature and very disperse sector, where the cost of workforce is over 60% of a product value in manufacturer [3].

The clothing companies which have survived until today are those which can boast about high-quality products. One of significant reasons for this is a higher standard of life of inhabitants of Europe, and consequently, higher demands. Customers are ready to pay much more for good-quality clothes.

In order to produce clothes of high quality interoperational control and final control are the necessary elements of the production process. Complexity and laboriousness of the manufacturing process result in the fact that the larger a batch of garments is the more often quality should be checked between operations. It allows to detect a maximum number of defects and to eliminate them.

In order to reduce a number of defects in the manufacturing process they should be regularly recorded and their structure and mutual relations should be analysed. In Polish realities such activities are just being initiated. It is necessary to change the current approach which is often limited to recording defects without their comprehensive analysis. It does not lead to detecting defects, and consequently, to significant reduction of their number.

The purpose for undertaking this subject was to identify causes of occurrence of garment manufacturing defects in series production and to find the relation between these defects and a human factor.

According to the above the following hypothesis has been formulated:

There is a direct relation between conditions of working environment, first of all such as: lighting of workstations, work monotony, and maksimum number of garment manufacturing defectes manufactured in X clothing manufacturing company examined.

16.2 Description of subject of research

In X clothing manufacturing company a pipelined technological process with synchronised work groups is in use. This is a system of work organisation which consists in maintaining a sequence and continuity of works and agreeing on the time of carrying out elements of garments by work groups in order to maintain the continuity of production [3].

Fig. 16.1 presents a flow chart of processes of garment manufacturing, which has been developed based on the map of processes in X clothing manufacturing company.

Garment manufacturing takes place in three production halls. In the first hall a cutting room is located, in the second and the third hall there are sewing rooms connected with each other with mechanic-suspended transport and goods lifts.

Manufacturing of different kinds of assortment takes place in the same halls but with division into manufacturing sections. The division of works in the halls is organised taking into account a degree of advancement of works on garments being manufactured: in the first hall the initial and medium-advanced operations are carried out, in the second and the third hall - final and finishing operations.

Because the production process for each group of garment assortment being manufactured is unified, the research covered only one selected group of assortment, i.e. jackets.

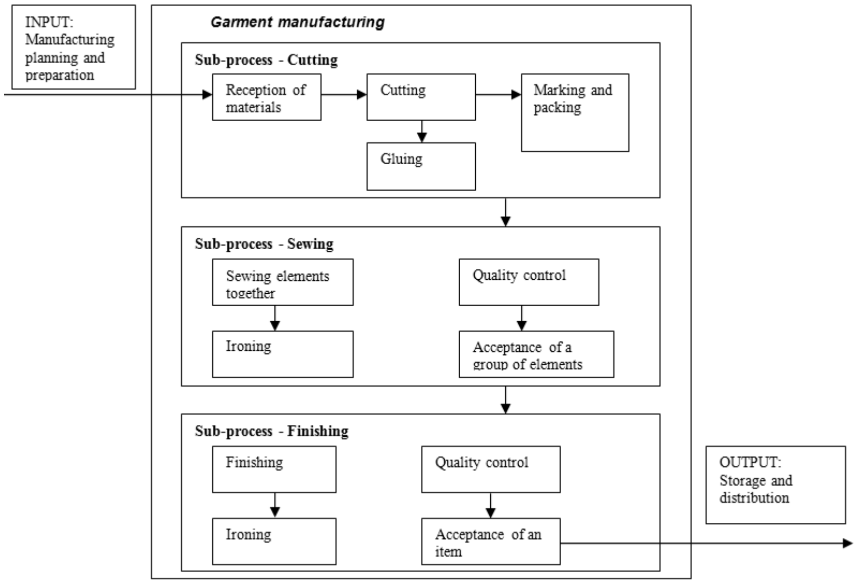

Fig. 16.1 Flow chart of basic processes of garment manufacturing [1, 8]

16.3 Methodology of research

Because of the amount and character of input data gathered and the specifics of the industry, the methodology of research applied consisted in combination of methods of quantitative and causal analyses in order to verify the hypothesis, to confirm or reject it.

The data was segregated and ordered as in a typical statistical research and then the analysis of the most important defects was carried out. The organisation of research covered four phases [4, 7]:

- Preparation of research - definition of the purpose of research, identification of the sample and features examined, determination if the examination is full or partial;
- Gathering statistical material, i.e. Genuine material consisting of 986 quality control sheets, and preparation for working on it;
- Working on the statistical material - processing the material gathered for the needs of the analysis, i.e. Summing up data in monthly summary tables and then calculating sw indicators;
- The analysis of the results using the Pareto - Lorenz analysis and the ishikawa diagram.

The research conducted was full and covered all defects related to jackets gathered in a whole calendar year during the last 5 years.

16.3.1 Presentation of input data

The input data gathered for the purpose of further analysis was the data from 986 genuine quality control sheets from the whole calendar year. Control documentation of X clothing manufacturing company covers data from four control points on "jackets" manufacturing line (tab. 16.1); in each of these points different types of typical defects were identified.

Tab. 16.1 Basic data from control points on the manufacturing line examined [8]

Data from control points on "Jackets" manufacturing line		
Control point	**Kind of control**	**Number of defects listed on defect sheet**
First control point	interoperational control	23
Second control point	interoperational control	27
Third control point	interoperational control	26
Final control	final control	28
	In total	**104**

Each quality control sheet provides information on a number of garment manufacturing defects (referred to as defects below) of a particular kind, a control point where they were detected (order no., name of outside company or identifier of domestic production), controller name, date, a number of jackets checked.

In order to distinguish individual defects and to identify defects and a place of their occurrence matrix denotations were used, e.g. 2/14, where:

- 2 - means a number of control point where a defect was identified;
- 14 - means a number of a specific defect listed under this number in a control sheet.

On the basis of the data gathered monthly tables of daily quantities of defects were prepared and then compiled into one auxiliary summary table for further analysis.

16.3.2 Ordering input data

Quantity of production was different in every month - both taking into account interoperational and final control. In order to avoid distortion of results quantities of items checked and accepted during final control were calculated at the end of the year into indicators taking into account a number of items checked in a given month, according to the following formula:

$$W = B_m/P_m \qquad (16.1)$$

where: W – a share of the defect in a given month,

B_m – a number of occurrences of the defect in a given month m,

P_m – a number of items checked in a given month m.

The calculations were carried out in the summary table using Office Excel functions. The calculated shares of a defect in a given month (W) were gathered in a separate auxiliary table and then summed up. The result of this operation was one number denoted as SW indicator, being a sum of shares of a defect in the whole period examined, i.e. 12 months.

$$S_W = \sum_{i=1}^{n} W_i \qquad (16.2)$$

where: S_W – a sum of the defect indicators for the period examined, i.e. 12 months,
W_i – a share of the defect in the monthly quantity of production,
n –12 months ,
i – a given month.

16.3.3 Segregation and comparative analysis of the defects listed

The Pareto-Lorenz analysis was used for segregation of the SW indicators. According to its rule stating that approx. 80% of effects are caused by 20% of factors it was assumed that only a small part of 104 defects was significant in the further analysis (tab. 16.1).

Then the identified defects were grouped according to their numbers into suitable activity-related groups. Groups of defects were denoted with capital letters A, B, C, D - each of the groups contains defects related to a specific kind of activity (tab. 16.2).

The defects were grouped taking into account kinds of activities related to a given operation, a worker's position when carrying out a given operation and a kind of control (final/interoperational control):

A. Final ironing – ironing complementary to machine ironing, ironing of linen, prints made by mesh,
B. Gluing - mesh coming unglued in the lower part of a sleeve,
C. Sewing - length of a jacket vent, unequal bottoms, sewing in sleeves, sewing linen to the lower part of a jacket,
D. Others.

The Ishikawa diagram, i.e. the cause and effect analysis of defects, containing possible human factors, it means causes related to conditions of the working environment, was developed. Then, according to the above diagram the valuation of the process of the most important defects was carried out and their most probable causes were identified.

Tab. 16.2 Grouping of garment manufacturing defects [8]

Group	**Defect No.**
A	4/20, 4/13,4/4
B	4/25
C	3/3, 3/18, 4/3, 4/2
D	4/28

These causes were grouped based on the rules of valuation of workstations contained in the Hungarian and Swedish method [5, 6].

The groups of defects being subject of research were estimated according to causes related to factors of the working environment of production workers. The results are presented on a radar diagram (fig. 16.3).

16.4 Interpretation of results of research

A number of defects detected in the period covered by research was 48,700 occurrences, whereas a number of checked items of garments was 266,192. This means that the share of defects was equal to 18.3% in the scale of the year. SW indicators were calculated into percentage shares and denoted with the symbol SW_% for the purposes of further analysis. The calculated percentage indicators (SW_%) were subject to the Pareto-Lorenz analysis and sorted in the decreasing order. Their cumulative percent was calculated using the following Office Excel functions [8]:

- COUNTIF($F$4:F4;F4)
- CONCATENATE($F4;”-„;$J4)
- LARGE($T$4:$T$107;$Z4)
- VLOOKUP($Z4;$T$4:$U$107;2;FALSE)

After analysing the results the following conclusions have been drawn:

- Out of 104 defects only 30 (29% of the total number of defects) are a cause of 80% of rejects;
- Approx. 50% of accumulated value of defects are the defects whose share is above 1% in the yearly quantity of production (according to S_W values) - this is why it was assumed that these defects were significant for the further analysis.

Nine out of thirty defects were taken into account in the further analysis. Ordered and grouped information about these defects is presented in tab. 16.3 and tab. 16.4.

Tab. 16.3 Data concerning the quantity and share of the most significant manufacturing defects [8]

	Months												
Defect No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total occurrences in the year**
4/20	887	1229	1534	839	177	488	429	325	435	564	1283	714	**8904**
4/13	751	776	597	371	198	484	379	249	403	632	409	300	**5549**
4/4	408	426	602	433	97	261	188	159	236	251	246	147	**3454**
4/28	396	276	343	362	142	317	46	50	92	265	144	110	**2543**
3/3	207	162	274	148	71	117	143	93	145	276	138	85	**1859**
3/18	253	368	346	245	22	6	1	0	9	21	12	4	**1287**
4/25	0	0	0	0	0	0	245	255	376	240	239	164	**1519**
4/3	89	95	48	84	87	134	172	114	188	159	56	37	**1263**
4/2	56	43	81	55	75	153	152	219	162	120	82	19	**1217**

Tab. 16.3 presents nine defects examined sorted in the decreasing order by a number of occurrences in production in the subsequent months. In the last column of tab. 16.3 there are total numbers of these defects in the year.

Tab. 16.4 presents nine kinds of defects examined sorted in the decreasing order by S_W indicator. Tab. 16.4 contains defect number, defect name, percentage indicator SW_%, cumulative indicator SW _ % and value of SW indicator for a given defect.

Tab. 16.4 Data concerning the quantity and share of the most significant manufacturing defects, with defect names listed [8]

Defect Name	Defect No.	SW_%, decreasing	cumulative SW_%	SW
Ironing complementary to machine ironing	4/20	0.16660	0.16660	0.7054
Ironing of linen	4/13	0.10368	0.27029	0.4390
Prints made by mesh	4/4	0.06417	0.33446	0.2717
Others	4/28	0.04824	0.38270	0.2042
Sewing in sleeves	3/3	0.04359	0.42628	0.1845
Sewing linen to the lower part of a jacket (others)	3/18	0.02999	0.45627	0.1270
Mesh coming unglued in the lower part of a sleeve	4/25	0.02858	0.48485	0.1210
Length of a jacket vent	4/3	0.02442	0.50927	0.1034
Unequal bottoms	4/2	0.02345	0.53272	0.0993

Most of these nine defects come from final control and only two from interoperational control (tab. 16.1). The first digit meaning a defect number informs about it. It can be concluded that these defects are interdependent because the defects have subsequent numbers.

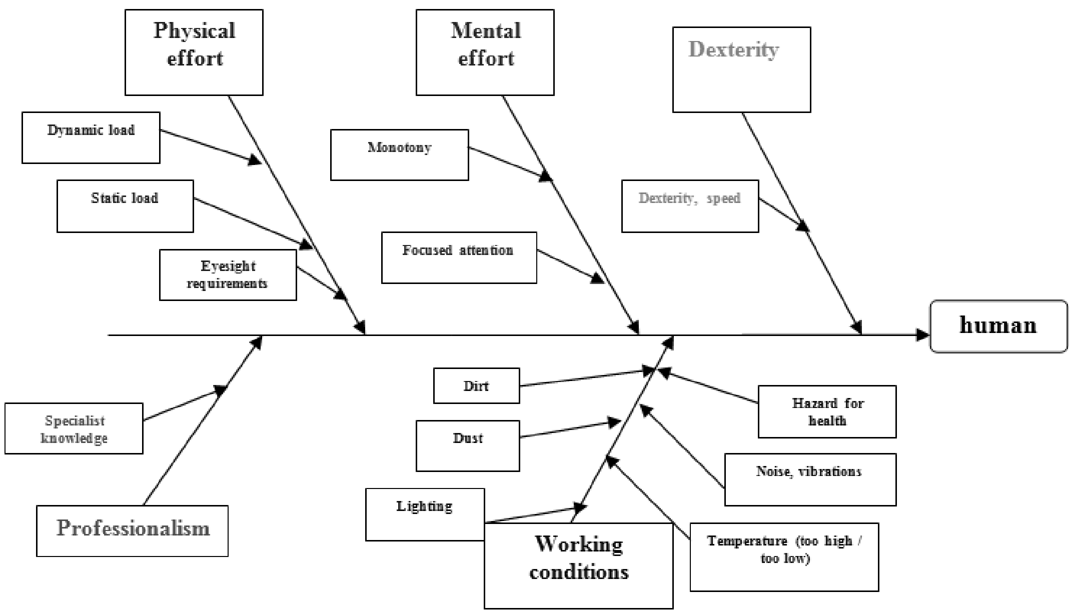

Fig. 16.2 A man as a cause of manufacturing defects – the Ishikawa diagram

Using the Ishikawa diagram (fig. 16.3) and the rules contained in the Swedish and Hungarian methods of valuation of workstations consisting in point valuation of factors related to working environment, it was concluded that the probable causes of these defects were the quality of working environment of production workers [5, 6].

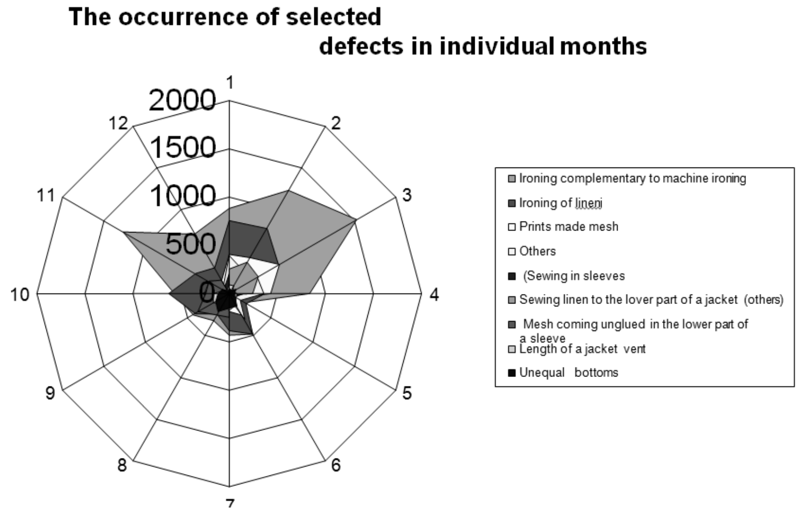

Fig. 16.3 The process of defects in individual months of the year examined, including a listing of defect names. [8]

Tab. 16.5 Point valuation of labour for individual groups of defects taking into account working environment [5, 6, 8]

	A	B	C	D	Average	Percent %
Dynamic load	10	8	10	10	9.5	0.12
Static load	0.6	0.6	0.3	0.9	0.6	0.01
Eyesight requirements	1.2	0.9	1.2	1.2	1.125	0.01
Dexterity, speed	7.2	4.8	7.2	7.2	6.6	0.08
Monotony	28.5	30	27	21	26.625	0.33
Focused attention	7.2	9	6.3	6.3	7.2	0.09
Specialist knowledge	7	10	5	10	8	0.10
Table 5 continued						
	A	**B**	**C**	**D**	**Average**	**%**
Hazard for health	3.6	3.6	4.5	4.5	4.05	0.05
Noise, vibrations	1.2	1.2	2	1.6	1.5	0.02
Temperature (too low/too high)	1.6	2	1.2	1.6	1.6	0.02
Dust	0.6	0.6	0.6	0.6	0.6	0.01
Lighting	12	11	12	12	11.75	0.15
Dirt	1.6	0.8	1.6	1.6	1.4	0.02

Tab. 16.5 contains point valuation of workstations taking into account kinds of loads production workers are exposed to in the working environment and groups of defects based on section 3.3, tab. 16.2.

Then, the process of defects and the relation between a number of defects and causes were analysed and the occurrence of 9 important defects in individual months of the year was presented in a radar diagram. It can be observed that the largest number of defects was detected in March and November.

16.5 Conclusions

After analysing the results of research in X clothing manufacturing company concerning the quantitative causal analysis of garment manufacturing defects in series production the following conclusions can be drawn:

The initially formulated hypothesis that there is a direct relation between conditions of working environment and maksimum number of garment manufacturing defects quality of garments manufactured in X clothing manufacturing company has been verified positively.

It was found that out of nine defects being analysed three defects have the highest share and the largest significance. They are:

- Defect no. 4/20 - ironing complementary to machine ironing
- Defect no. 4/13 - ironing of linen
- Defect no. 4/4 - prints made by mesh

All three defects belong to one group, they are defects of final ironing, and the main causes are:

- Work monotony,
- Insufficient lighting,
- Dynamic load,
- Specialist knowledge.

It was recognised that from among these factors insufficient lighting in winter months, i.e. in November and March (fig. 16.3), was the most important cause.

The research results have proved that there is a relation between a number of defects (assuming constant quantity of production) and a month of occurrence of these defects. This is related to the physiological aspect of work organisation and insufficiently lit working space, which requires immediate improvement of quality of lighting.

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