Facultad de Ciencias Económicas y Empresariales
Universidad de Navarra

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The Impact of Absenteeism on the Quality of Assembly Line Production: Is the Value of Worker Expertise Decreasing?

Ricardo Mateo

Facultad de Ciencias Económicas y Empresariales
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ABSTRACT

Absenteeism among manual workers is, without doubt, one of the most significant factors to affect the functioning of assembly lines in developed markets. That high levels of absenteeism have negative repercussions on the quality and costs of operations is a widely held view. According to the scientific theory of work, workers who temporarily stand in for their absent colleagues affect production quality levels because of a lack of work specialization. However, as the technology of assembly lines has improved, the need for line operator specialization has gone into decline. In this article, we analyse the effects of absenteeism on four assembly lines over the course of one year. The analysis of two hundred working days reveals more than two hundred thousand instances of effects on the quality of products. In contrast to established thinking, the empirical evidence we present here confirms that absenteeism does not produce problems in the quality of operations even at the highest levels. This evidence can be explained by the fact that the value of specialisation among manual workers has been significantly reduced by the invention of more sophisticated and specialised machinery.

Key words: assembly lines, quality, absenteeism, performance.

Ricardo Mateo
Universidad de Navarra
Department of Business Administration
rmateo@unav.es

I. Introduction

In recent decades a large number of researchers working in areas such as strategy, organisational behaviour and human resources have been concerned with the better organisation of personnel in order to achieve a company's goals. The strategic question can be framed in the following terms: what structure should an organisation have in order to achieve its objectives? Multinational companies with transnational strategies are composed of a network of plants located in different places, each of which manufactures the same goods, in order to sell the company's products throughout the world. The characteristic strategic process of these companies is: Product Design, Production-Sales and Post-Sale Services. In many of these companies, production is carried out on assembly lines.

In mechanised production systems, such as assembly lines, the company defines the formal system of production in accordance with the scientific theory of work. This system clearly defines the manual, mechanical work to be carried out by the operator. At the same time, creative or participative work is considered to be of secondary importance because the worker's creative/participative contribution cannot be observed or measured in the same way as mechanical work. Work such as the detection, correction and prevention of defects, or efforts to continually improve production quality, therefore, is perceived by workers as having less value since it cannot be assessed or quantified. In light of this situation, companies find themselves compelled to establish quality control departments to monitor worker activities that fall outside the mechanised production process.

At the moment, the assignment of production quotas to different plants of the same company around the world is based on criteria such as cost, quality and product delivery time. Many multinationals have opened plants in highly populated countries, such as China, India and Brazil – countries which are also large markets with low salary economies. The establishment of production operations in these countries allows products to be sold at reasonable prices to consumers within these markets and, when the time is right, facilitates export to the rest of the world. The strength of the free commerce model in many parts of the world reopens the questions of how developed countries should deal with plant location and the distribution and development of assembly lines.

It is clear that the challenge consists in addressing the possibility of competition within the same multinational company, which produces the same products in different countries, and in some countries at a substantially lower salary cost. The concept of the mechanised production company, introduced by Frederick Taylor in his work on the scientific management of work (Taylor 1911), and further developed by Henry Fayol (Fayol 1984), rests on the assumption that work specialization and division of labour are the keys to productivity and quality standards on assembly lines. Thus, absenteeism poses a threat to assembly line production because it requires an immediate replacement of the worker. This replacement reduces the level of specialization in direct manual labour on the assembly line and threatens the quality of products made during the process. Companies that use mechanised forms of production respond to this reality by introducing a greater degree of technological sophistication, thus reducing the importance of specialization in manual work in the mechanical process of assembling products. Researchers from different disciplines, basing their studies on the scientific theory of work, have directly related problems in product quality to absenteeism, taking for granted that the latter compromises both production processes and product quality. This hypothesis may no longer hold true.

In this article we test the validity of this hypothesis by observing the effects of a rise in the level of absenteeism on product quality.

In different areas, such as the formation of workers (Inman et al 2004, Pinker et al 2000) and labour costs (Allen 1983), it is assumed that the replacement of expert workers by workers with less expertise results in lower product quality. Many theoretical, scientific models have been developed to respond to the question this situation poses. However, the truth of this hypothesis is not self-evident: other workers in the company, who work to improve the technology used by the company, may be able to compensate for a lack of expert workers.

From a strategic point of view, a multinational company with a transnational strategy must find economic reasons to justify the product decisions taken in different plants around the world. If the value of manual worker specialisation has decreased and the value of machinery specialisation has increased, the significance of innovations in assembly line production must be evaluated in order to revitalise the company's use of assembly lines for production in developed markets.

The decreasing value of specialised manual labour can be determined by measuring the impact that absenteeism has on the quality of work carried out on assembly lines.

II. Conceptual Framework

Assembly lines

Production on assembly lines involves the division of labour into parts, each of which adds value to the product as the assembly process develops towards its end. The constituent parts of the assembly process are: machinery, materials, technology and manual labour. Furthermore, the sequence of activities that make up the assembly process unfolds through a time cycle. This time cycle and the necessary balance of parts in the division of labour constitute a rigid model of production. Each worker must dedicate the same amount of time to the performance of his task in the case of each product, regardless of the level of training or specialisation that an individual worker may possess. Thus, when the assembly line is in operation and a worker is absent, the company must replace the absent worker. Forms of replacement can be described in the following way:

Random replacement occurs in unforeseen circumstances, normally as a response to illness or an accident. There are some situations where the need for replacement can be foreseen and planned in advance, such as holidays, trade union obligations or group meetings.

Urgent: The absent worker must be replaced, always and immediately, so that the assembly line process is not brought to a halt. It is difficult to plan for this situation adequately in advance.

Rigid: The replacement worker must do the same work in the same period of time as the absentee. Worker productivity should, in theory, be the same. Actual productivity will depend on the replacement worker's qualifications or training and his/her collaboration with other members of the work group. The worker chosen to replace the absentee will have to undertake the work in the time period available, but without the benefit of the same degree of specialised training as the absent worker.

Assembly line production is usually regulated by some form of internal organisation. Work groups on an assembly line are monitored by a supervisor whose task is to control operation and product quality. The work of each member of the group, and the cohesion of the group as a whole, is vital to the achievement of normal levels of quality when one of the workers on the line has been replaced.

Specialisation

According to the scientific theory of work, workers should receive specialised training in their part of the production process before they take their place on the assembly line. The specialisation of workers on an assembly line is valuable in two ways. Firstly, operation quality on the assembly line is improved; and secondly, specialised training foments innovation in all areas of work.

Operation quality on an assembly line is extremely important because any product defects must be rectified as soon as possible; if not, value is added to the defective products during subsequent stages of the production process, and the cost of the corrections that must later be made is greatly increased. The trained worker contributes to operation and product quality by carrying out his/her own task well and by alerting the company to possible deficiencies in the production process or to defects in the products themselves.

Company innovation and development depend on a number of factors. One of the most important of these is the contribution made by workers through their suggestions and by their participation in worker-groups established with the aim of improving the production process. Continual improvement in the production plant stems from the workers' ability to propose and implement changes to the product and the production process, and to adapt to those changes. This ability is strengthened by specialised training, when workers have in-depth knowledge of problem areas and the means to resolve them.

When a worker with specialised training is replaced by a non-expert worker, the probability that defects in the product will occur increases and the likelihood that such defects will be detected decreases. This description of the assembly line production process prompts the conclusion that absenteeism on the line will cause more defects in the process itself and in the end products. The decrease in specialisation caused by absenteeism must be compensated for by the work of the group as a whole, the commitment of the replacement worker, and the strength of the production process itself.

(Insert Figure 1 about here)

Developed Markets

Both trade union activity and the social protection of workers are strong in developed markets. In the case of illness or injury, therefore, workers may be absent from their posts without suffering any significant reduction in their salaries (the company's social security provisions make up any shortfall). Furthermore, trade union protection occasionally gives rise to situations in which the collaboration and commitment of workers diminish as a consequence of confrontations with company management. These situations may provoke higher levels of absenteeism and cause further conflict between management and workers.

Causes and consequences of absenteeism

The various causes of absenteeism have been widely studied by researchers in the fields of human resources and organisational behaviour. Demographic, social and labour variables have been identified as factors that may account for changing levels of absenteeism. In many of these studies, relationships between absenteeism and personal qualities such as age, sex, time in the company and time in the post have been shown (Spencer and Steers 1980). There is also some evidence that levels of absenteeism may be related to aspects of the work itself, such as group dynamics and attitude, the challenging nature of particular tasks, the value attributed to the work done, and workers' expectations.

However, studies of the consequences of absenteeism have focussed almost exclusively on labour factors, especially the origin and cost, both labour and social, of absenteeism.

Very little research has been carried out on the consequences of absenteeism in terms of product quality and the costs of internal reworking. Barmby, T et al (2000) examined the behavioural aspects of absenteeism in nine countries, emphasizing that absenteeism is more prevalent among women; that its prevalence increases with age; that there is a direct correlation between absenteeism and the quantity of work done, and that it is an economic fact that **the substitution rate of work and leisure time increases with work hours and gives leisure hours more value.** In another study, Barmby, T and Stephan, G. (2000) show that companies with higher numbers of employees tend to show higher indices of absenteeism. Their argument is centred on a theory of supply and demand. With respect to supply, they explain that the pay conditions in cases of absenteeism are better in larger companies and the relationship with employees is less personal. With regard to demand, they explain that larger companies can diversify the risk of absenteeism more easily than smaller companies because they have higher rates of absenteeism.

This argument was confirmed in the case of Germany in the period 1984-1990, when it was discovered that absenteeism among workers in companies that employed more than 2000 employees was more than double that found among workers in companies that employed less than 20 employees. In the case of staff employees, the size of the company was not considered to be relevant to the rate of absenteeism.

The rate of absenteeism in a company can be studied from a number of different perspectives. Illness and injury are not the only causes of absenteeism; family problems, dissatisfaction at work or personal habits may also be involved. The main difficulty for the company is that management cannot easily identify what the reasons for absenteeism are. The employees, in turn, have a vested interest in attributing their absence to health problems in order to qualify for the social security provisions supplied by the company to compensate for any drop in salary. Numerous studies have found evidence which relates very high levels of absenteeism to problems of motivation among employees, and motivation problems are more prevalent in companies that use mechanised production systems.

This article studies the impact of absenteeism on product quality. Our focus is on the problem caused by absenteeism, rather than on the cause(s) of absenteeism. The empirical evidence presented in this study, which was obtained from an analysis of several assembly line production processes, is intended to validate the model of production that the article proposes.

The central question addressed by this article is the following: is product quality adversely affected by worker absenteeism?

It is possible that this question be answered in the affirmative. In cases of absenteeism, given that the work group on the assembly line as a whole is less specialised, since not all the workers in the group have received the specific training deemed necessary for the performance of their task, product quality may be lower.

H0: The replacement of expert workers with less expert workers leads to an increase in the number of defects in products.

At the same time, however, it is possible that the specialised training of the absent worker might be compensated for by the interest and commitment of the replacement worker, cooperation among the group of workers on the assembly line, and a strong, sophisticated production process.

H1: The replacement of expert workers with less expert workers does not lead to an increase in the number of defects in products.

The methodology of research for this article is described in the following section.

III. Method

Participants

The participants in this study were four assembly lines that comprise a total of 4000 workers. The approximate number of workers in 2003 was 570, 700, 1200 and 489, on assembly lines 1, 2, 3 and 4 respectively. In all four workshops, workers work in the same post on the assembly line, without rotation. In each case, too, there is a team leader for every five groups of workers.

The four assembly lines make parts for the automobile industry. Workshops one and two specialise in technological processes. Workshops three and four specialise in the assembly of parts. All four workshops use the latest technology, are organised into assembly lines, and have not introduced changes to their production systems in the last few years. Likewise, all four workshops have a 100% quality control standard for their end products.

Outline of Research

The study consisted in an analysis of working days on the four assembly lines during 2003. A survey of the relevant literature in this area does not offer a clear guide as to what might be the best period in which to analyse the impact of absenteeism on quality.

However, a wide-ranging period of analysis would appear to be sufficient to determine the relationship between absenteeism and quality.

The variables used in this study are the following:

Q'ij (Quality ij): The number of defects reported on day i on assembly line j which cannot be immediately rectified. The defects were reported by quality control supervisors and by workers on the production lines.

A'ij (Level of absenteeism ij): This variable is defined as the percentage of workers who are absent from their posts on assembly line j on day i, in order to carry out their tasks on the assembly line. It has been assumed that all the workers had received the requisite training for their posts. Therefore, the level of training/qualification can be calculated as (1 – the level of absenteeism on assembly line j on day i).

Data Analysis

The data included in this study was collected on 200 working days in 2003.

Assembly Line 1: Sample of 200 observations.

Assembly Line 2: Sample of 200 observations.

Assembly Line 3: Sample of 200 observations.

Assembly Line 4: Sample of 200 observations.

A graphic analysis of the quality data was carried out in order to detect data that might distort the results of the study. The quality data was filtered according to the following criteria: the detection of serious quality defects on an assembly line that worked to rectify the problem.

The valid data and the filters applied are the following:

Assembly Line 1. Valid data: Cases 1 to 200. No filters.

Assembly Line 2. Valid data: Cases 43 to 200. Cases filtered, days 1 to 42

Assembly Line 3. Valid data: Cases 96 to 200. Cases filtered, days 1 to 95.

Assembly Line 4. Valid data: Cases 23 to 187. Cases filtered, days 1 to 23 and 188 to 200.

In the cases of those days when filters were applied, an analysis of the relationship between absenteeism and quality was carried out in order to establish what occurred in those time periods.

A preliminary statistical analysis of the absenteeism and quality variables was also carried out in relation to the valid samples.

Workshop 1: Sample of 200 observations.

Workshop 2: Sample of 157 observations.

Workshop 3: Sample of 105 observations.

Workshop 4: Sample of 165 observations.

Three tests were carried out to establish the validity of the null hypothesis:

1. An analysis of the normal levels of quality: Following the central theorem of the limit, if the quality levels on each assembly line were found to be normal, it is possible that no independent variable would be relevant to the quality results (the Kolmogorov-Smirnov-Lilliefors test); that is, no independent variable would be significant to the results. Thus, absenteeism, as one such variable, could not be considered to have a relevant impact on the level of quality. (At the same time, normal levels of quality do not necessarily indicate that absenteeism is not relevant or significant.)

2. An analysis of cases grouped together according to the absenteeism variable: the second form of analysis carried out involved the division of the observations of each workshop/assembly line into two samples. The first sample-group comprised the observations in which the level of absenteeism was higher than or equal to the average

level of absenteeism in the original sample. The second sample-group comprised the cases in which the level of absenteeism was below average. This analytic approach was intended to establish if the level of quality in both sample-groups belonged to the same population of samples, or if they constituted two distinct populations of samples with different average levels and different variations. (Independent samples T test)

3. Finally, we undertook an analysis of the correlation between absenteeism and quality to see if a linear relationship exists between them.

Model

Independent variable

Qij: Product quality on day i in workshop j.

Dependent variables

Aij: Worker absenteeism on day i in workshop j.

Qij = Q'ij/Constant (*)

Aij = A'ij/Constant (*)

Qij =A+

(*) Changes have been made to variables Q'ij and A'ij in order to preserve the confidentiality of the data.

Results

Table 9 presents the results of the analysis of the normal levels of variable Qij. These results show that the data collected from the workshops indicate that the hypothesis of normality cannot be rejected. This implies that no variable is sufficiently important or significant.

Tables 10,11,12 and 13 show the data and the normal levels of samples from each workshop, divided into two groups. The first group contains the data relating to Qij values where Aij is greater than or equal to the 2003 average; the second group, the data relating to Qij values where Aij is less than the 2003 average.

The results presented in this table prompt the same conclusion that the null hypothesis states: the two populations of samples are the same. This conclusion implies that the probability of the occurrence of defects follows a pattern independent of the levels of absenteeism in the groups of samples analysed.

Thus, the validity of hypothesis H1 can be confirmed, and hypothesis H0 rejected. The analysis carried out in this study validates the assumptions implicit in hypothesis H1: the specialised training of the absent worker can be compensated for by the interest and commitment of the replacement worker, cooperation among the group of workers on the assembly line, and a strong production process, all of which together allows normal levels of product quality to be maintained.

VI. Discussion

This study shows that worker absenteeism does not adversely affect product quality. Absenteeism is a form of personal and organisational behaviour which is poorly understood and requires further research. Until now it has been taken for granted that a negative relationship exists between absenteeism and quality. From a scientific point of view, it would be interesting to establish whether the absence of a relationship between absenteeism and quality is due to a decrease in the value of worker specialisation as a result of the introduction of more sophisticated production processes, or to a higher level of cooperation in the group of workers on the assembly line and the interest and commitment of the replacement worker in particular cases of absenteeism.

If the first explanation were to hold true, the implication would be that the value of worker specialisation has been transferred to the use of more sophisticated and specialised machinery.

The lack of a relationship between these variables may prompt changes in decisions concerning the training of new workers and the rotation of workers through posts on the production line. At the same time, however, the absence of a relationship between absenteeism and quality presents company management with a new challenge: to redefine the value of worker specialisation so that the specialised training of workers and the workers' career in the company have real meaning and value.

If the second explanation were to hold true, and workers could maintain the same levels of quality through higher levels of cooperation in the work group, then the next object of study would be to examine long-term forms of cooperation among workers that not only allow quality levels to be maintained, but also to be improved.

From the point of view of company management, and the structuring of their business, these two possible explanations suggest different organizational solutions. It is clear that rotation through work posts on the assembly line is something desired by workers. The lack of any evidence for a relationship between absenteeism and quality implies that strategies of worker rotation be revised and implemented. It is also clear that cooperation among the workers on a production line is a variable with considerable potential for the functioning of production plants, although it is as yet poorly understood. The fact that quality levels are maintained in more or less the same way in production facilities that show high indices of absenteeism as in facilities with absenteeism indices of only 2% should be highlighted. This fact implies that cooperation among workers can improve product quality levels and result in fewer defects.

The correlations between the analysis variables of this study and filtered data from the four assembly lines are presented in the tables of filtered data relating to each assembly line. In workshop two, a negative correlation can be seen. In workshop three, there is a positive correlation. On assembly line four, the relationship is insignificant. There is no filtered data in the case of assembly line one.

The following pages contain the graphs of absenteeism and quality for the four assembly lines and the tables of results from the tests that have been carried out.

(Insert Figure 2 about here)

(Insert Figure 3 about here)

(Insert Table 1)

(Insert Figure 4 about here)

(Insert Figure 5 about here)

(Insert Table 2)

(Insert Table 3)

(Insert Figure 6 about here)

(Insert Figure 7 about here)

(Insert Table 4)

(Insert Table 5)

(Insert Figure 8 about here)

(Insert Figure 9 about here)

(Insert Table 6)

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(Insert Table 8)

(Insert Table 9)

(Insert Table 10)

(Insert Table 11)

(Insert Table 12)

(Insert Table 13)

Conclusion

The analysis of the impact of absenteeism on assembly line production quality carried out in this study leads to the rejection of the commonly held view that absenteeism among manual labourers on assembly lines adversely affects product quality. No relationship between absenteeism and quality can be established even at high levels of absenteeism, up to and including 10% of the workforce.

Furthermore, there has been a decline in the value of specialised manual labour in mechanised production systems, and that the focus of work must now turn to more creative or participative activities, such as the detection, correction and prevention of defects and the continual improvement of the production process. This reorientation of the value of specialisation has serious implications for competition with assembly line production plants in China, India or Brazil. These countries, which use sophisticated technological systems and function on low labour costs, constitute a real threat to assembly line production plants based in developed markets. These latter must develop their competitive edge through innovation and improvements in their production systems and through collaboration with other plants in order to receive production quotas.

Finally, it is necessary that both management and workers in mechanised companies strive to develop a model of management which facilitates innovation and improvements in the production system and which will allow companies in developed markets to compete with companies in newer, developing markets that have the same structure, use sophisticated technological processes, and operate at lower salary costs. The idea that companies based in developing markets cannot make products to an equal standard of quality must be discarded. In light of the current situation, it is our view that a competitive edge will be established by those multinational companies who improve their production systems in ways that can later be transferred to other production plants in the same company, thus guaranteeing quality and innovation in a transnational context.

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Figure 1: The problem of absenteeism

Absenteeism ⇒ Less qualified persons within the chain

⇓ ⇓

The group does not collaborate

The group collaborates well

well with the replacement worker with the

replacement worker

and the process is not robust and the process

is robust.

⇓ ⇓

Greater probability of generating defects Equal probability of generating

defects

Lower probability of avoiding them Equal probability of

avoiding them.

⇓ ⇓

Multiplied by thousands of products Multiplied by thousands

of products

⇓ ⇓

More real defects Equal real defects

Greater internal reworking Equal internal reworking

Figure 2: Line Graph. Quality and absenteeism on Assembly Line 1 in 2003.

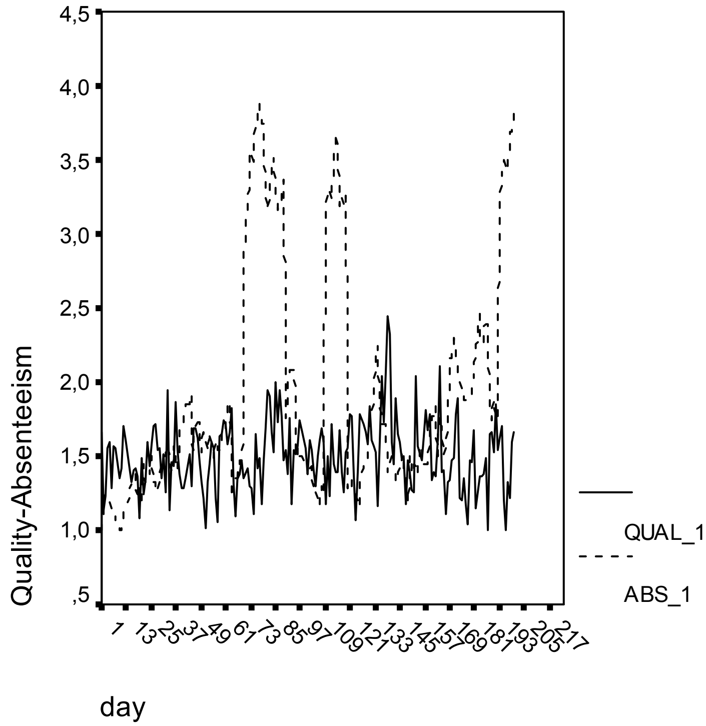

Figure 3. Dispersion diagram. Quality and absenteeism on Assembly Line 1.

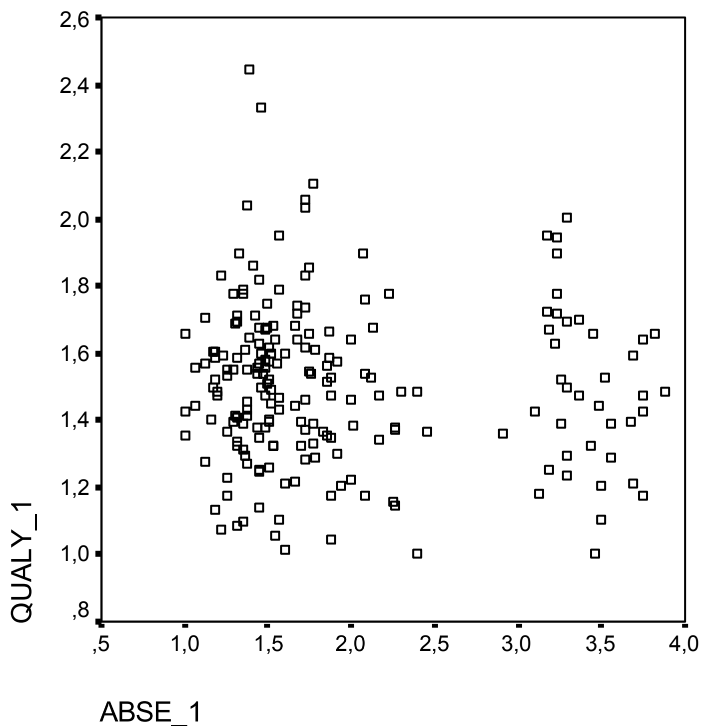

Figure 4: Line Graph. Quality and absenteeism on Assembly Line 2 in 2003.

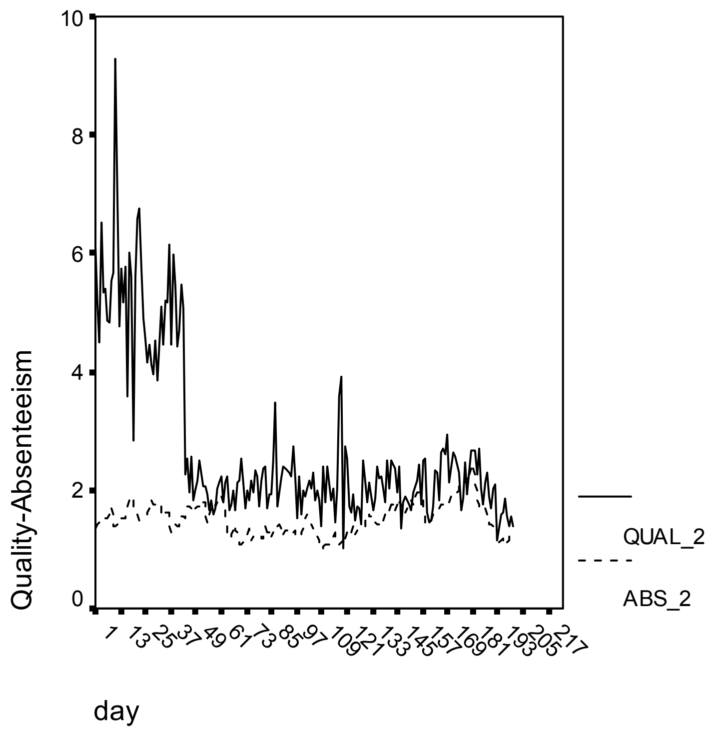

Figure 5. Dispersion diagram. Quality and absenteeism on Assembly Line 2.

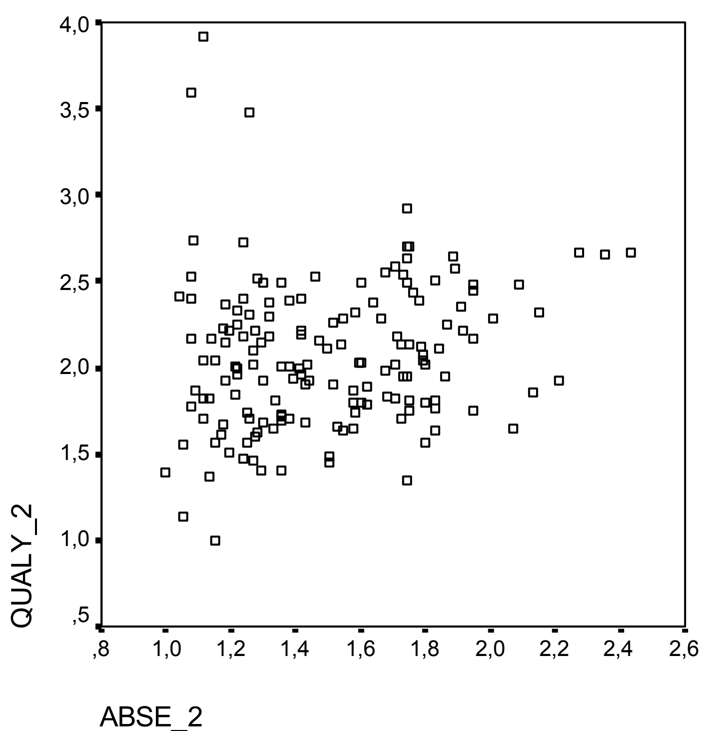

Figure 6: Line Graph. Quality and absenteeism on Assembly Line 3 in 2003.

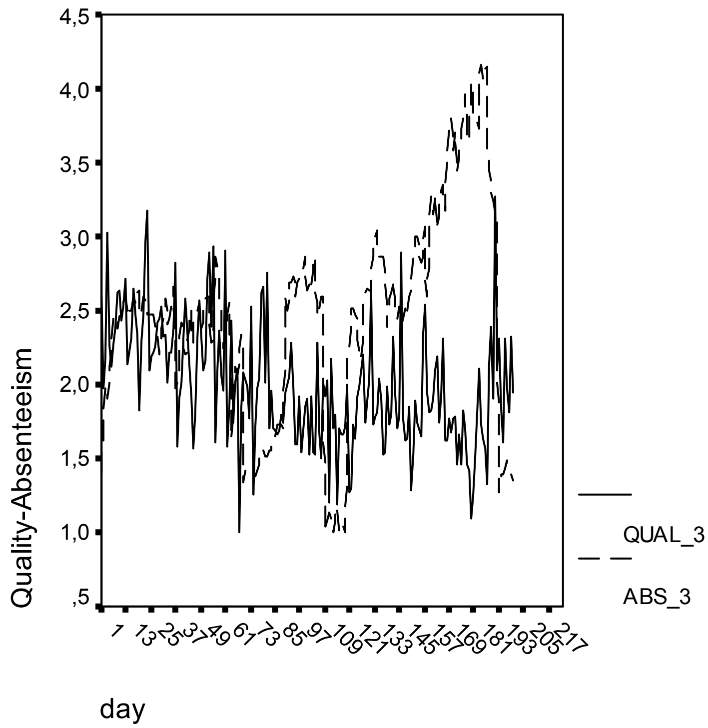

Figure 7. Dispersion diagram. Quality and absenteeism on Assembly Line 3.

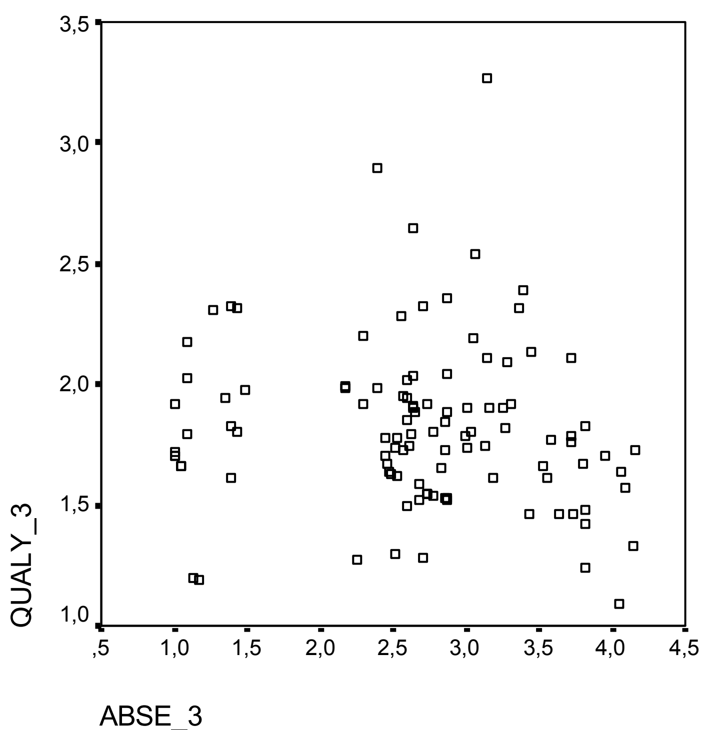

Figure 8: Line Graph. Quality and absenteeism on Assembly Line 4 in 2003.

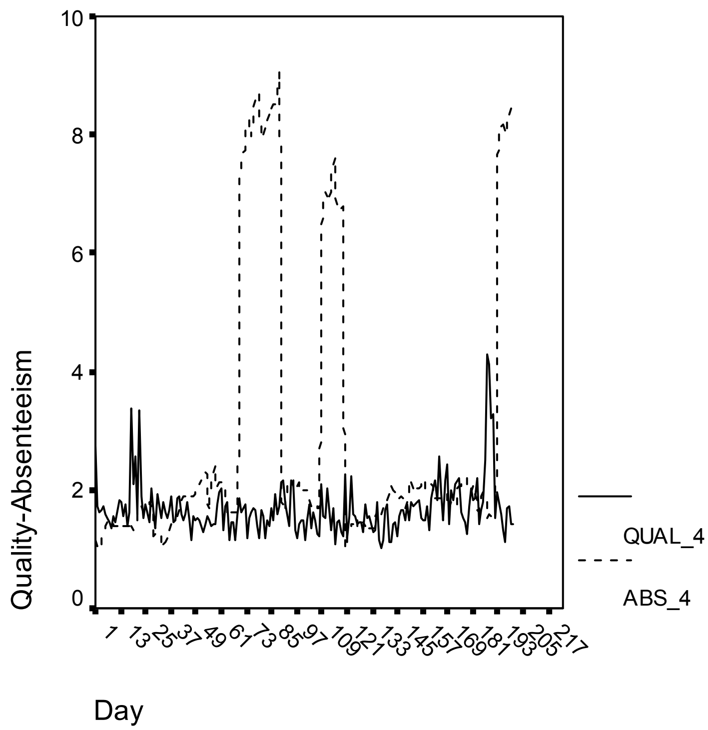

Figure 9. Dispersion diagram. Quality and absenteeism on Assembly Line 4.

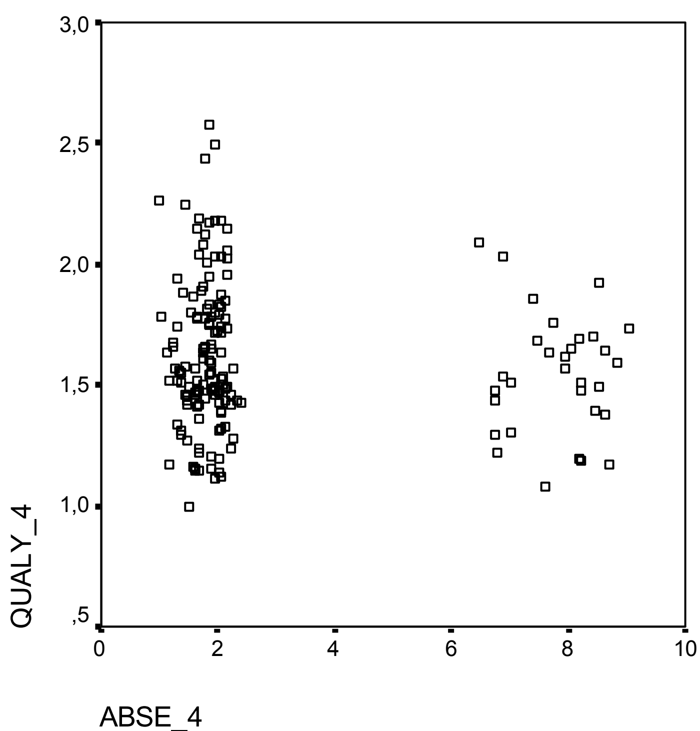

Table 2: Correlation of valid data assembly line 2

		QUALY_2	ABSE_2
QUALY_2	Correlation of Pearson	1	,167*
	Sig. (bilateral)	,	,037
	N	157	157
ABSE_2	Correlation of Pearson	,167*	1
	Sig. (bilateral)	,037	,
	N	157	157

*. Correlation is significant al level 0,05 (bilateral).

Table 3: Correlation of non valid data assembly line 2

		ABS_2	QUALIN_2
ABS_2	Correlation of Pearson	1	-.361*
	Sig. (bilateral)	,	,019
	N	200	42
QUALIN_2	Correlation of Pearson	-,361*	1
	Sig. (bilateral)	,019	,
	N	42	42

*. Correlation is significant al level 0,05 (bilateral).

Table 4: Correlation of valid data assembly line 3

		QUALY_3	ABSE_3
QUALY_3	Correlation of Pearson	1	-,114
	Sig. (bilateral)	,	,248
	N	105	105
ABSE_3	Correlation of Pearson	-,114	1
	Sig. (bilateral)	,248	,
	N	105	105

Table: 5 Correlation of non valid data assembly line 3

		ABS_3	QUALIN_3
ABS_3	Correlation of Pearson	1	,221*
	Sig. (bilateral)	,	,032
	N	200	94
QUALIN_3	Correlation of Pearson	,221*	1
	Sig. (bilateral)	,032	,
	N	94	94

*. Correlation is significant al level 0,05 (bilateral).

Table 6: Correlation of valid data assembly line 4

		QUALY_4	ABSE_4
QUALY_4	Correlation of Pearson	1	-,106
	Sig. (bilateral)	,	,176
	N	165	165
ABSE_4	Correlation of Pearson	-,106	1
	Sig. (bilateral)	,176	,
	N	165	165

Table 7: Correlation of non valid data assembly line 4

		QUALIN_4	ABS_4
QUALIN_4	Correlation of Pearson	1	,219
	Sig. (bilateral)	,	,328
	N	22	22
ABS_4	Correlation of Pearson	,219	1
	Sig. (bilateral)	,328	,
	N	22	200

Table 8: Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Stan.Dev.
QUALY_1	200	1,00	2,44	1,5049	,24068
ABSE_1	200	1,00	3,88	1,9318	,78894
QUALY_2	157	1,00	3,92	2,0678	,42977
ABSE_2	157	1,00	2,43	1,5000	,30898
QUALY_3	105	1,09	3,27	1,8220	,34554
ABSE_3	105	1,00	4,16	2,6791	,85034
QUALY_4	165	1,00	2,58	1,6087	,30081
ABSE_4	165	1,01	9,04	2,9221	2,39194

Table 9: Normality Test

Kolmogorov-Smirnov Test for one sample

		QUALY_1	QUALY_2	QUALY_3	QUALY_4
N		200	157	105	165
Normal parameters[a,b]	Mean	1,5049	2,0678	1,8220	1,6087
	Standard Dev.	,24068	,42977	,34554	,30081
Maximun Differences	Absolute	,041	,055	,105	,085
	Positive	,041	,055	,105	,085
	Negative	-,025	-,040	-,064	-,043
Z de Kolmogorov-Smirnov		,573	,694	1,077	1,097
Asymptotic Significance. (bilateral)		,898	,720	,197	,180

a. The distribution of the Test is the Normal.

b. Calculated from data.

Table 10: Two independent samples. Test of Assembly Line 1.

Group Statistics

	ABSE_1	N	Mean	St..Dev.	Stand.Error of the Mean
QUALY_1	>= 1,93	61	1,4721	,23997	,03072
	< 1,93	139	1,5193	,24044	,02039

Independent Samples T Test

		Levene Test for the equality of variances		T test for the equality of means						
									95% Confidence Intervals for differences	
		F	Sig.	t	gl	Sig. (bilateral)	Differences between means	Standard Error of the Difference	Lower	Upper
QUALY_1	Equal variances have been assumed	,224	,636	-1,279	198	,202	-,0472	,03691	-,11997	,02559
	Equal variances have not been assumed			-1,280	114,826	,203	-,0472	,03688	-,12024	,02585

Table 11: Two independent samples. Test of Assembly Line 2.

Group Statistics

	ABSE_2	N	Mean	Stand.Dev.	Stand.Error of the Mean
QUALY_2	>= 1,50	74	2,1117	,36364	,04227
	< 1,50	83	2,0286	,47997	,05268

Independent Samples T Test

		Levene Test for the equality of variances		T test for the equality of means						
									95% Confidence Intervals for differences	
		F	Sig.	t	gl	Sig. (bilateral)	Differences between means	Standard Error of the Difference	Lower	Upper
QUALY_2	Equal variances have been assumed	,822	,366	1,210	155	,228	,0830	,06861	-,05250	,21856
	Equal variances have not been assumed			1,229	151,183	,221	,0830	,06755	-,05043	,21649

Table 12: Two independent samples. Test of Assembly Line 3.

Group Statistics

	ABSE_3	N	Mean	Stand.Dev.	Stand.Error of the Mean
QUALY_3	>= 2,68	56	1,7885	,36242	,04843
	< 2,68	49	1,8602	,32465	,04638

Independent Samples T Test

		Levene Test for the equality of variances		T test for the equality of means						
									95% Confidence Intervals for differences	
		F	Sig.	t	gl	Sig. (bilateral)	Differences between means	Standard Error of the Difference	Lower	Upper
QUALY_3	Equal variances have been assumed	,285	,595	-1,061	103	,291	-,0717	,06755	-,20563	,06232
	Equal variances have not been assumed			-1,069	102,937	,288	-,0717	,06706	-,20464	,06134

Table 13: Two independent samples. Test of Assembly Line 4.

Group Statistics

	ABSE_3	N	Mean	Stand.Dev.	Stand.Error of the Mean
QUALY_3	>= 2,68	56	1,7885	,36242	,04843
	< 2,68	49	1,8602	,32465	,04638

Independent Samples T Test

		Levene Test for the equality of variances		T test for the equality of means						
							Differences between means	Standard Error of the Difference	95% Confidence Intervals for differences	
		F	Sig.	t	gl	Sig. (bilateral)			Lower	Upper
QUALY_4	Equal variances have been assumed	2,145	,145	-1,360	163	,176	-,0813	,05980	-,19938	,03677
	Equal variances have not been assumed			-1,560	53,908	,125	-,0813	,05212	-,18581	,02320