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Quality Tools: The Old New Means for an Efficient Supply Chain Implementation

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قائم بأعمال رئيس الأقسام التعليمي – كلية النقل الدولي واللوجستيات بالأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري

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المحاضر المنتدب بكلية النقل الدولي واللوجستيات بالأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري

Abstract

The aim of this research was to re-introduce a collection of an old well known quality tools to the divisions managers of one of the greatest steel companies in the Middle East, The tools selection was based upon a series of interviews conducted with three managers representing the middle management level in the steel company, upon which a training program for personals representing various divisions within the company on how to use the selected quality tools was achieved, also 150 questionnaire forms were disseminated over 150 employees representing three of supply chain main functions which are the procurement, logistics, and manufacturing functions to determine the impact of using the selecting quality tools on both employees' involvement and job satisfaction The companies' functions began to use these tools for solving problems that hinders the efficiency of supply chain processes, and the results were promising especially in terms of internal customers 'performance and cost reduction.

The research used several sample types throughout its methodology, primarily focusing on qualitative and quantitative data collection methods.

- Qualitative Sample:

Interviews: Structured interviews were conducted with three middle management managers (head of procurement, logistics, and manufacturing) to gather in-depth opinions and insights regarding quality management within the company.

- Quantitative Sample:

Questionnaires: A total of 150 questionnaire forms were disseminated to employees in EZZ Steal company across three supply chain functions (procurement, logistics, and manufacturing) to quantitatively assess the impact of the selected quality tools on employee involvement and job satisfaction.

- Mixed Methods:

The combination of qualitative interviews and quantitative questionnaires represents a mixed-methods approach, enhancing the robustness of the findings by providing both in-depth insights and measurable data.

- The research reached to:

– The validity of the used quality tools in eliminating a number of quality wastes were confirmed at the practical level with in the firm.
– The reports submitted by the company function refers more attention to quality issues.

- The research also recommends the following:

– There is a need for effective communication for the development of awareness, and commitment to quality in organizations 'environment.
– The evaluation of employee satisfaction should be conducted regularly. Such information can be used by the firm to further improve its employee satisfaction, because

increased employees' satisfaction will lead to a successful quality management implementation in the factory.

– Employees should be trained on using a collection of non-statistical tools (e.g. surveys, focus groups, failure mode effect analysis).

Key Words: Supply Chain Network Design (SCND), Quality Control, Quality Tools, PDCA cycle, Seven Quality Control Tools (7QC). Employees' Involvement. Job Satisfaction.

1. Introduction

Nowadays, many companies are heading to be more supply- chain oriented as to handle the increasing pressure of customer expectations in a rapidly changing competitive environment, and also the growing orientation towards of globalization. Although the concept of supply chain management has acquired a lot of attention in the last thirty years, yet it was not so for the concept of quality management. For a significant number of organizations quality was considered a secondary issue to be considered (Ye, Q., Law, R., Gu, B., & Chen, W., 2011). In the same context (Zhang et al., 2011), argued that a little attention has been given to quality initiatives in supply chains, he draws attention to a number of setbacks (e.g., product recalls) that indicates for a critical weakness in supply chains network. In contrast to firm level quality management, quality issues across supply chains have not been fully implemented. (Mellat-Parast, 2013) stated that more researches are needed to embrace the concepts of quality management through supply chains to move forward towards addressing quality issues within the firm supply chain network. (Vanichchinchai, A., & Igel, B., 2009) claimed that traditional QM tools should be applied to the company supply chain network in order to facilitate an effective team work through the organization while improving quality.

2- Literature Review

2.1 Supply Chain Network Design

The SCND is a network connecting different functions within organizations. It starts from the upper stream corresponding to suppliers and moves towards the lower stream corresponding to consumers (Kundu, A., Jain, V., Kumar, S., & Chandra, C.2015). The routes joining these functions together represent the supply chain processes that are conducted to ensure the efficient and effective delivery of products and/or services. The network activities are referring to the processes related to the flow of products and/or services from the suppliers of materials (raw material, semi-finished goods, finished goods, etc.) to the final consumer (Droge, C., Vickery, S. K., & Jacobs, M. A., 2012). Suppliers will provide the raw materials to be manufactured in the manufacturing facility. Then the output will be stored at distribution centers ready for delivery, upon customer's specific delivery requests.

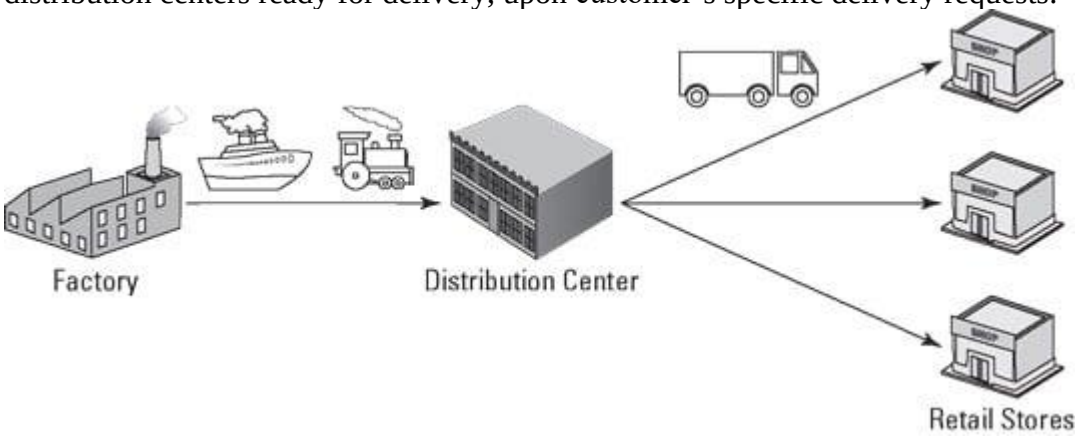

Figure 1: Supply Chain Network Design. (Chandra, C., & Kumar, S., 2000).

2.2 Main Functions of Supply Chain Network

- **Procurement:** This is the first function of a supply chain network, which mainly focuses on buying activities, delivery quests, and payment of suppliers.
- **Operations:** Simply involves planning and controlling of systems that create goods and/or provide services. The operation team engages in a wide spectrum of activities that includes but not limited to demand forecasting, capacity planning, design of products and service, scheduling, and location selection. So, operations function plays a critical role in supply chain management.
- **Logistics:** This function of supply chain management is responsible of all activities directly or indirectly related to the movement of materials into, via, and out of the organization, which includes but not limited to managing inventories, warehousing, and transportation.
- **Resource Management:** This phase is conducted by the resource management function team. It is concerned with the allocating resources efficiently at the right time in order to effectively reduce the production costs.
- **Information Workflow:** Information sharing and dissemination is what really keeps all functions of supply chain network on harmony. If the information and communication systems are not functioning properly, the entire supply chain would be out of order, and this situation may lead to mismanagement.

2.3 Quality Control

Quality control is a global management process used in running operations to prevent unfavorable changes and to maintain a state of stability. To maintain stability, the quality control process evaluates actual performance, compares actual performance to (standards) goals, and takes action on the differences between them. Quality control is one of the three basic management phases through which quality can be managed. The other two phases are quality planning and quality improvement, The Juran trilogy diagram the figure below shows the interrelation of these processes.

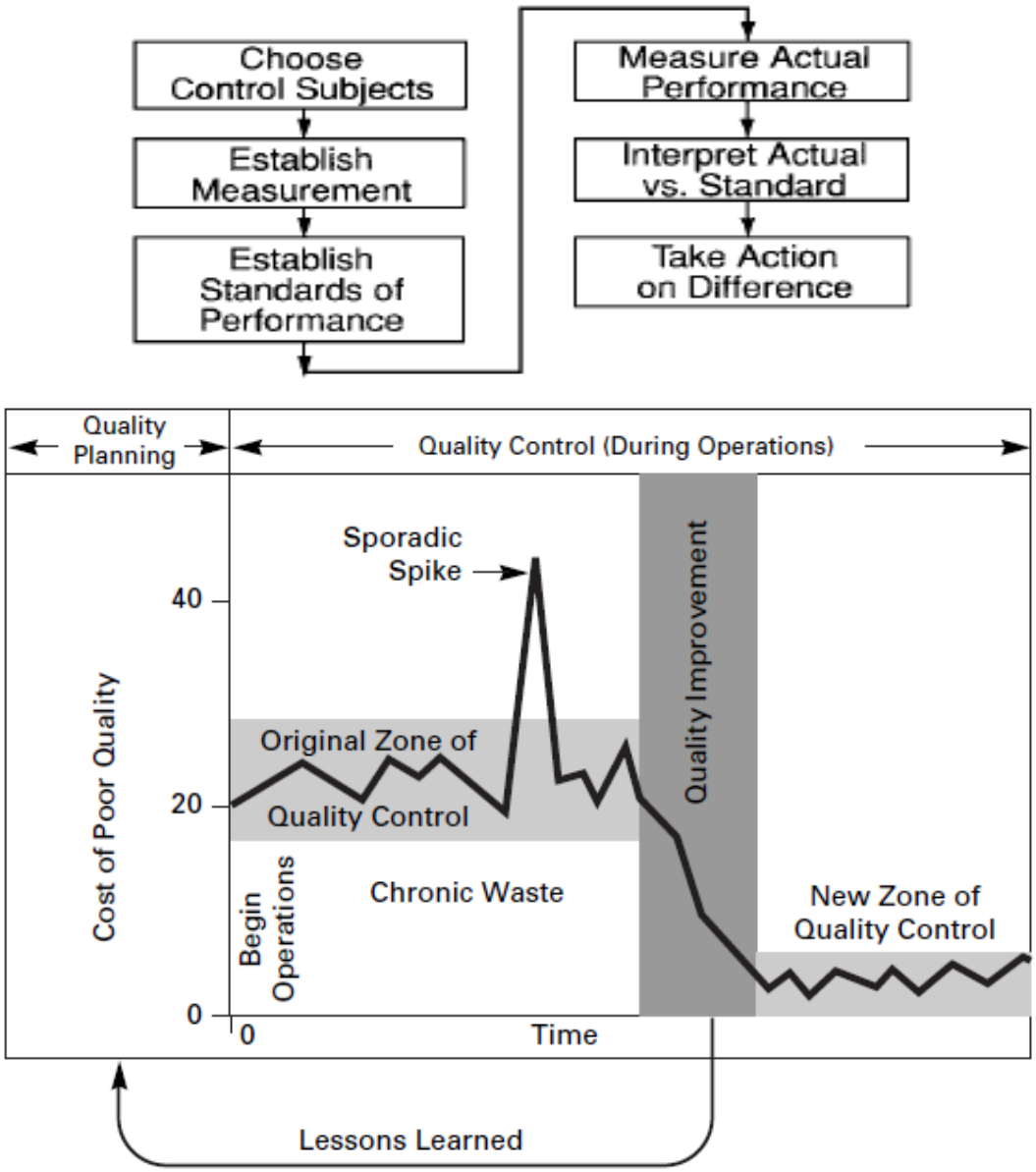

Figure 2: The Juran Trilogy diagram (Guran institute, Inc., Wilton, CT.)

The term "control of quality" emerged early in the twentieth century (Radford 1917, 1922). The concept was to expand the approach of developing quality, from defect detection, to what is called now be defect prevention. For a few decades, the word "control" had a wide meaning which included the concept of quality planning. Then came events which changed the meaning of "quality control." For a little bit. It began with the "statistical quality control" movement witch gave an impression that quality control consisted of just using statistical methods. While what was called the "reliability" movement claimed that quality control could be applied only to quality at the time of test but not during the product life time.

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Figure 3: The input- output diagram for the quality control process (Guran handbook 5th edition).

Quality control takes place by use of the feedback loop. A generic form of the feedback loop is shown in Figure below.

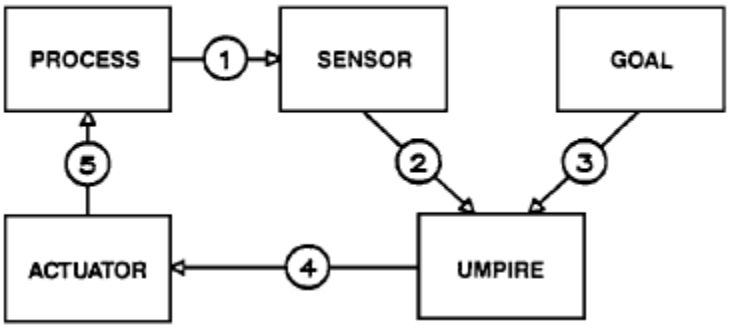


Figure 4: The generic feedback loop (Guran handbook 5th edition).

The methodologies of Quality Control are built around various concepts. Some of these concepts are very old; while others were developed recently. An essential activity within the feedback loop is data gathering and analyzing. The methods and tools used are often called quality tools. These tools have been always used in data collection and analysis, e.g. biology, government, economics, finance, management.

2.3 Quality Control in Supply Chains

Nowadays, quality control (QC) is not just a matter of preserving specifications, it's about developing a solid foundation upon which successful companies are founded. From consumer electronics to textiles, and from pharmaceuticals to automobiles, quality control is the spine that ensures that products conform with customer requirements. As globalization continues to change businesses, it becomes crucial for companies to understand what is meant by quality control and how QC principles could be applied effectively to enhance supply chain operations. The effective Implementation quality control practices in the supply chain offers a considerable business advantages such as improving product quality, cost reduction, enhancing customer satisfaction, and elevating efficiency. Quality control in supply chains is not a "set it and forget it" process. It requires continuous improvement, where feedback is an essential element for processes optimizing. This aligns with total quality approaches such as Lean and Six Sigma, which stress on the continuous processes of reducing wastes and improve quality. Quality control relies on a variety of tools and techniques to maintain high standards. Some of the most effective methods are stated in clause 2.4.

2.4 Quality Tools

For solving quality problems there are an assortment of quality tools, some developed by quality practitioners, and some was adapted from other practices. Comes on the top of the tools are the seven QC tools which are Pareto Diagram, Cause & Effect Diagram, Histogram, Control Charts, Scatter Diagrams, Check Sheets, flow chart, in addition to the PDCA cycle. All these tools are important tools used widely at both manufacturing/service fields to monitor the overall operation and continuous process improvement. These tools are used to

find out root causes and eliminate them, thus technical and even managerial processes can be improved.

2.4.1 Plan. Do. Check. Act. (PDCA Cycle)

A useful tool in the context of kaizen is the PDCA cycle. The PDCA/PDSA cycle is a continuous loop of planning, doing, checking (or studying), and acting. It provides a simple and effective approach for solving problems and managing change. The model is useful for testing improvement measures on a small scale before updating procedures and working practicing, the tool is proceeded as follows.

- Plan: Recognize an opportunity and plan a change.
- Do: Test the change. Carry out a small-scale study.
- Check: Review the test, analyze the results, and identify what you've learned.
- Act: Take action based on what you learned in the study step.

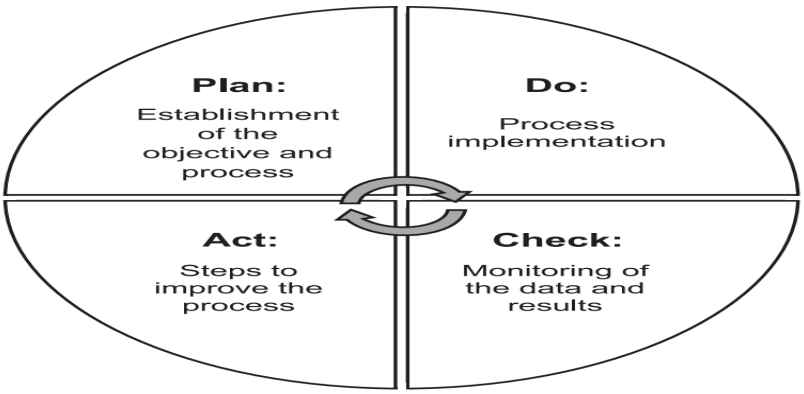


Figure 5: PDCA Cycle (Deming, 1986).

2.4.2 Cause and effect diagram

The cause and effect diagram, also known as the Ishikawa or fishbone diagram, is a tool which can be used to analyze facts with a view to identifying the cause of a defined effect. The problem, or the effect, is entered in the head of the fish; the bones represent the main influencing variables. The individual causes are entered inside the bones. The principle influencing variables frequently correspond to the 7M checklist (Man, Machine, Material, Method, Marginal conditions, Management, and Measurement), (Owen, M., 2013).

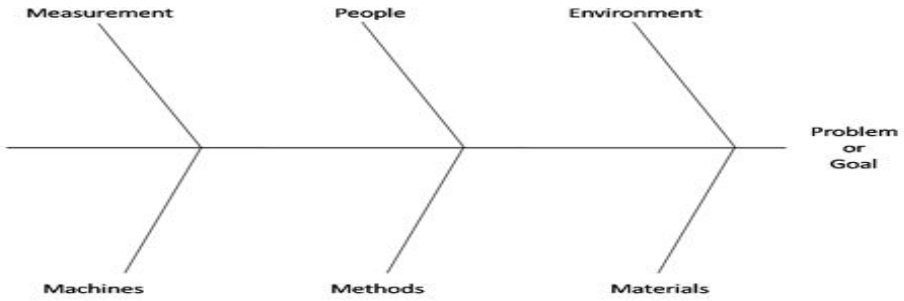
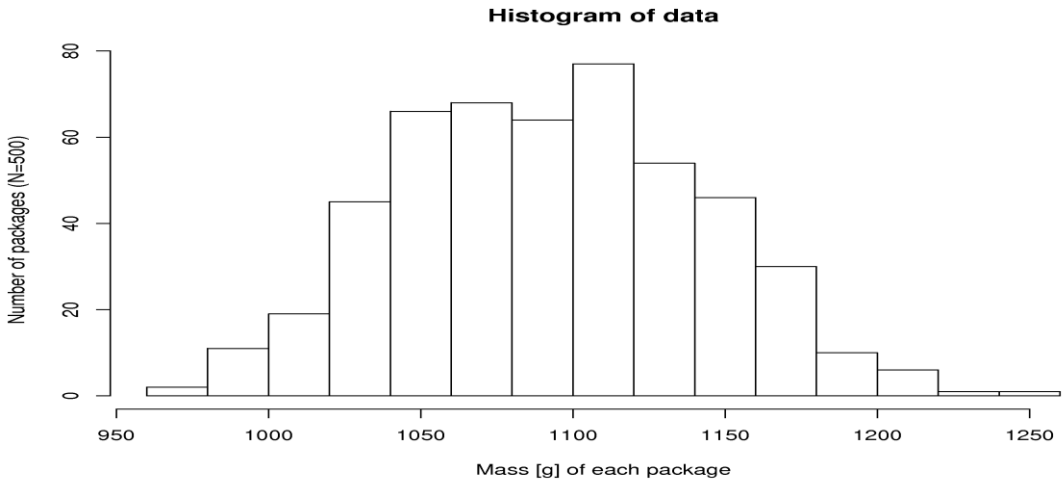


Figure 6: Cause & Effect Diagram (Owen, M., 2013).

2.4.3 Histogram

Histograms help to interpret the reasons for scatter by displaying the distribution of data values. The data values are divided into classes in accordance with statistical rules. These form the coordinates of the diagram. The number of data values per class is shown on the y-



axis. The average value and type of scatter are shown by the distribution curve (Owen, M., 2013).

Figure 7: Histogram (Owen, M., 2013).

2.4.4 Scatter Diagram

Scatter or correlation diagrams describe graphically whether there is a correlation between two variables (problem and influencing variable). Plotting factors in relation to one another in x-y diagram yields information as to the nature of the correlation between the factors. This is achieved by plotting a sufficient number of pairs of values, formed by altering the problem variable and determining the associated influencing variable, as measured points in the diagram. The nature of the correlation (strong or weak, positive or negative) is shown by the distribution of the points. This permits conclusions to be drawn as to potential cause (Lewis-Beck, C., & Lewis-Beck, M., 2015).

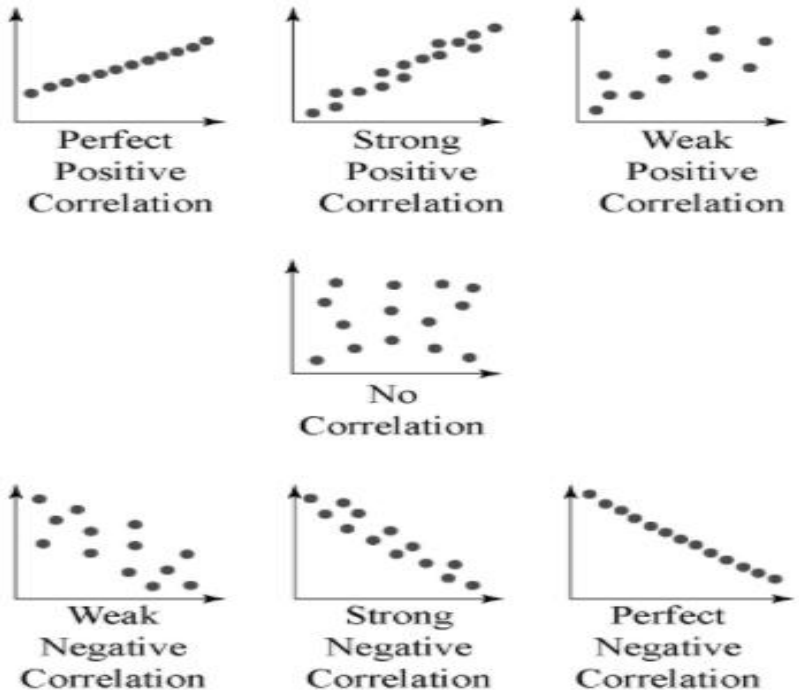


Figure 8: Scatter Diagram (Lewis-Beck, C., & Lewis-Beck, M., 2015).

2.4.5 Flow Chart

The term flow chart is a general term used to describe the common forms of presentation such as bar, line, pie and spider charts. Depending on the purpose of the analysis, one or other form of visualization is suitable for demonstrating correlations or flows Lewis-Beck, C., & Lewis-Beck, M., 2015).

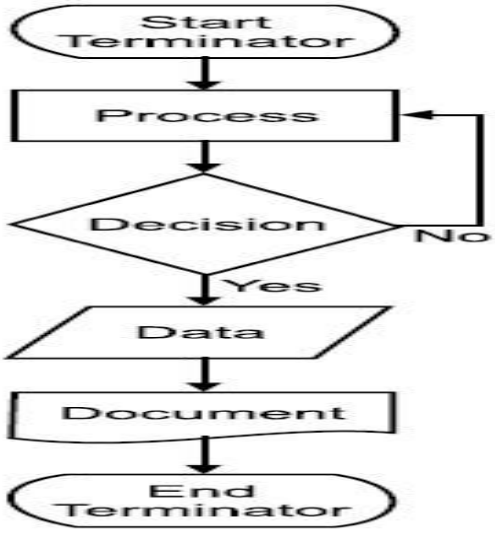
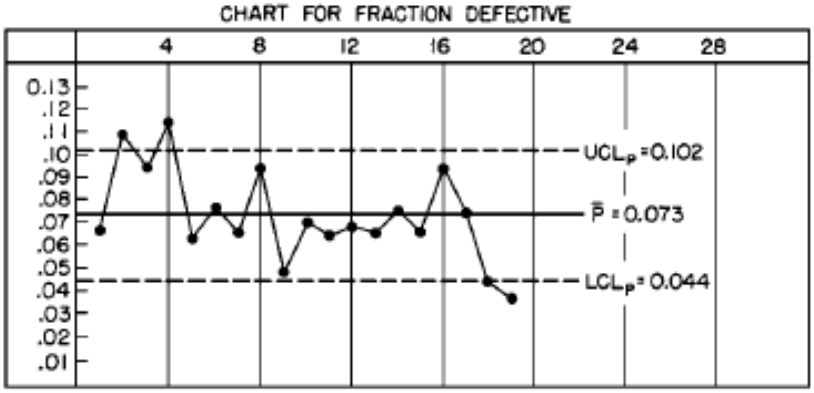


Figure 9: Flow Chart (Lewis-Beck, C., & Lewis-Beck, M., 2015).

2.4.6 Control Chart

Data collection is the starting point for improvement activities. Control or SPC charts are used to take samples at regular intervals and enter the measured valued or the statistical parameters (e.g. average value, scatter or spread) into the SPC chart. It may become necessary to intervene in the process, depending on the control limit specified and the characteristic progress of the data values (Owen, M., 2013).

Figure 10: Control Chart (Owen, M., 2013).



2.4.7 Check Sheet

The frequency of the occurrence of individual types of faults and the frequency with which data values occur at certain intervals in the range can be presented in the form of frequency distributions. Fault clusters at individual points can thus be recognized and the causes investigated (Fortune, J., & Utley, D. R., 2005).

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Daily Newspaper Ads	𝍸 ||	||||	𝍸	|||	𝍸	24
Weekly Newspaper Ads	|||		||	|	||	8
Website	|||	𝍸	𝍸 |	||||	||	20
Road Signage		||		|		3
Referral	|				|	2
Total	14	11	13	9	10	57

Figure 11: Check Sheet (Fortune, J., & Utley, D. R., 2005).

2.4.8 Pareto Chart

People are frequently faced by a number of problems or causes of faults that cannot be processed simultaneously. It makes sense to deal with the greatest, most important or most cost-intensive problem first. Pareto Analysis (also known as ABC Analysis or Lorenz Distribution) visualizes the rank order of the influencing variables of relevance to one particular issue. These are listed in order of the level of influence they exert and their numerical significance and cumulative percentage are shown accordingly. In the course of investigating a quality issue, it often emerges that only a few of the many causes identified are actually very important while many of the remainder are very insignificant (Wilkinson, L., 2006).

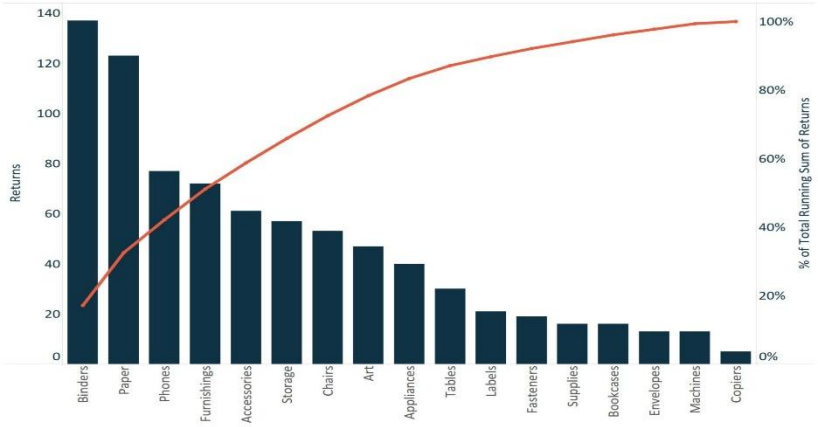


Figure 12: Pareto Chart (Fortune, J., & Utley, D. R., 2005).

The concept of quality management within supply chains has received increasing attention over the past few decades. Several studies highlight the critical role of quality tools in enhancing supply chain efficiency and effectiveness:

1. **Ye et al. (2011)** emphasized that many organizations often regard quality as a secondary issue, leading to a lack of effective quality management initiatives within supply chains. They argue that this oversight can result in significant setbacks, such as product recalls and inefficiencies.
2. **Zhang et al. (2011)** pointed out that quality initiatives are frequently underrepresented in supply chain strategies, leading to inadequate responses to quality issues. Their research indicates that traditional quality management (QM) tools must be adapted for supply chain contexts to foster improvement.
3. **Mellat-Parast (2013)** calls for further research into the integration of quality management concepts across supply chains, suggesting that existing frameworks are insufficient for addressing quality challenges within this domain.
4. **Vanichchinchai and Igel (2009)** propose that applying traditional QM tools within supply chain networks can facilitate teamwork and improve overall quality. They stress the need for a more systematic approach to quality management in supply chains.

Despite the contributions of existing literature, several gaps remain:

1. **Limited Empirical Studies**: While theoretical frameworks have been proposed, there is a scarcity of empirical studies that examine the practical application of quality tools within supply chains, particularly in specific industries such as steel manufacturing. Most existing research focuses on broader quality management principles rather than their implementation in real-world supply chain settings.
2. **Employee Involvement**: The literature lacks a comprehensive exploration of how employee involvement in quality management practices affects job satisfaction and organizational performance. Previous studies often overlook the mediating role of employee engagement when implementing quality tools.
3. **Industry-Specific Contexts**: Most research has been conducted in sectors like consumer goods or services, with little focus on heavy industries. This gap is particularly relevant in the context of steel manufacturing, where the dynamics of supply chains and quality management may differ significantly from other sectors.
4. **Integration of Qualitative and Quantitative Methods**: There is a need for studies that utilize mixed-methods approaches to capture both qualitative insights and quantitative data on the effectiveness of quality tools in supply chain management. This would provide a more holistic understanding of the challenges and successes experienced by organizations.

3. Research Methodology

3.1 Stage 1 (Interview stage):

A structured Interview were conducted with three of the middle level managers of the steel company (the head of the procurement department, the head of logistics department, and the head of manufacturing) in order to find answers for the following questions.

- **The first question was about the degree to which quality concepts, and principles are embedded in the firm's culture?**
  - Answer: The respondents in general stated that unfortunately there is a shortage in quality awareness through the firm.

• **The second question was about the quality problems that encounter the firm?**

➢ Answer: the respondents in general agreed that the firm is seeking efficiency, and this goal is abstracted by a great deal of wastes

• **The third question was about the quality tools and methods that are used by the firm to handle those quality problems?**

➢ Answer: the respondents in general saw that improvements around the firm are based on individuals' initiatives mainly and not on a scientific approach.

3.2 Stage 2 (Questionnaire stage):

➢ A 150 questionnaire forms as were disseminated over 150 of EZZ Steal company workforce where 50 of them are located in the procurement function, anther 40 are located in the logistics function, while the rest are located in the manufacturing function. The purpose of the questionnaires was to determine the nature of the relationship between the usage of the 7 quality control tools and job satisfaction using employees' involvement as a mediator.

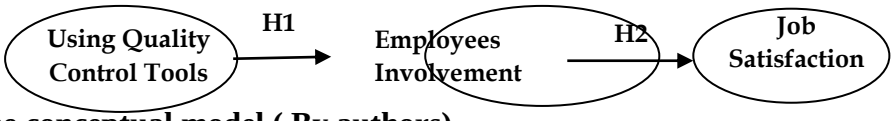


Figure 13: The conceptual model (By authors).

3.2.1 Employees Involvement:

Employee involvement is the process of allowing employees to declare their opinions on decisions that affect their work. This could be done through company meetings, training sessions, and so on. Employees will have a great deal of control over their work when they are encouraged to participate in decision-making. This means that employees aren't only involved in processing their daily activities. But they're and in an active manner involved in the management and decision-making of the organization.

3.2.2 The relation between Quality tools and Employees Involvement:

There is a strong relationship between both employee involvement and commitment and the success of continuous improvement (Coyle-Shapiro, 2002). Consequently, various articles interested in the field of production and operations management pointed to the positive impact of a true employee involvement and commitment in improvement programs, such as training on quality tools, and having a common improvement method. On continuous improvement (Ahmed, Loh, and Zairi, 1999). While (Anand et al., 2009) stated that organizations' often use systematic training initiatives at different organizational levels to train in a company-wide structured improvement method with corresponding quality tools and so develop a climate and infrastructure for continuous improvement. Therefore, the following hypotheses are formulated:

H1: The using of quality tools is positively related to employees' involvement.

3.2.3 Job Satisfaction:

Job satisfaction is defined as the level of comfort employees feel with their job. This concept surpasses beyond their daily tasks to include a satisfying relations with team members/managers, satisfying attitude towards organizational policies, and the impact of their job on their own personal lives and welfare.

3.2.3 The relation between employees' involvement and job satisfaction:

It is believed that there is a positive relationship between employees 'involvement, and employees satisfaction, the higher the employees' involvement in work activities the more they feel satisfied with their work because of the appreciation they receive. Past researches argued that when organizations encourage employees to involve in the decision-making process and to be able to express their own points of view, they will be encouraged to make

real actions in their work practices (Rees, Alfes, & Gatenby, 2013). Therefore, the following hypotheses are formulated:

H2: Employee involvement is positively related to job satisfaction.

3.2.4 Statistical Analysis for stage 2

The research instruments employed a 5-point Likert scale from strongly disagree (1) to strongly agree (5). Before testing the hypothesis, the validity and reliability of the research instrument were firstly tested. Factor analysis is used to test the validity of the instruments. Statement items will be dropped if they have a factor loading of less than 0.5. The reliability was measured with Cronbach's alpha. The research instruments in this study were previously developed and validated other research.

- Using quality tools was measured using the 7-point scale developed by Williams and Anderson (1991). The factor loadings for the items were between 0.55–0.81. Cronbach's alpha for this scale was 0.83. The sample item is " we uses the QC tools extensively."
- Employee involvement was measured using the psychometric dimensions developed by Glaser (1897). This scale consists of four items. The factor loadings for the items were between 0.68–0.81. Cronbach's alpha for this scale was 0.76. A sample item is "This organization values workers' ideas at all levels."
- Job satisfaction was measured using a 3-item scale developed by The Michigan Organizational Assessment Questionnaire and revalidated by Zhou and George (2001). The factor loadings were between 0.80–0.84. Cronbach's alpha for this scale was 0.75. A sample item is "Overall, I am satisfied with my job."
- Table below shows the descriptive statistics (mean and standard deviation) of the research variables.

Table 1: The mean and standard deviation of the research constructs (Before training)

Variables	Mean	S.D.
Using quality tools	2.75	0.44
Employees' involvement	3.01	0.51
Job Satisfaction	2.98	0.49

source: By authors

- A simple regression model was developed between employees involvement as dependent variable and using quality tools as independent variable, the results revealed that the model is significant through a (P value = 0.003) which is less than (0.05), and confirmed by (F calculated = 6.030) which is greater than (F tabulated = 3.952), so it is clear that customers' satisfaction has a positive impact on customers' loyalty, to confirm the previous result the coefficient of determination was calculated and its value was (r2= 76.25%) and this result confirms that using quality tools has a direct and strongly positive relationship with employees' involvement. For, so the first hypothesis is confirmed.
- Also, a simple regression model was developed between job satisfaction as dependent variable and employee involvement as independent variable, the results revealed that the model is significant through a (P value = 0.012) which is less than (0.05), and confirmed by (F calculated = 3.25) which is greater than (F tabulated = 1.313), so it is clear that gob satisfaction has a positive impact on service quality, to confirm the previous result the coefficient of determination was calculated and its value was (r2= 75.64%) and this result

confirms that employee involvement has a direct and strong relationship with job satisfaction. For, so the second hypothesis is confirmed.

- It is obviously clear that the Control Quality tools are not effectively used through the company which in return effects both employees' involvement and job satisfaction negatively.

3.3 Stage 3 (Training stage):

In order to increase the quality awareness of the workforce within the firm, in addition to enhance their ability in identifying and solving quality problems, a training program was activated, the purpose of this program was to train personals representing the company functions (total of 50 employees) on the following stated topics.

Table 2: The Training Program Milestone

Topic	No. of hours
1-Quality Awareness	7 hours
3-Internal job training	7 hours
3-Control Chart	14 hours
4-Cause and Effect Diagram	
5-Flow Diagram	
6-Scatter diagram	
7-Check Sheet	
8-Histogram	
9-Pareto Chart	
Total	28 hours

source: By authors

The first two programs will start at the same time; while the other one will start later Figure (14) displays the time dimension, while the major responsible departments involved in implementing this improvement plan are represented in milestones tables below.

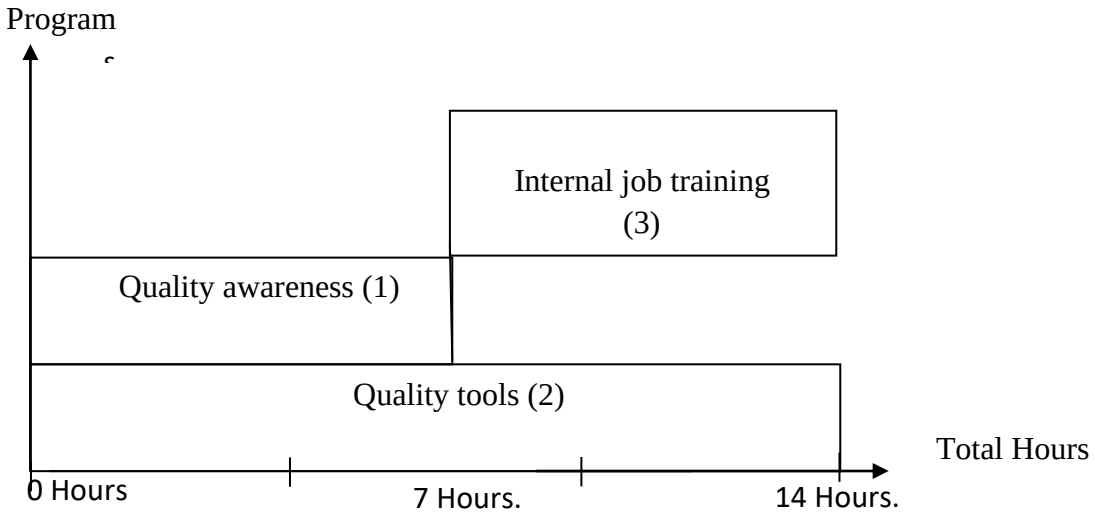


Figure 14: The TQM Training Programs.(By authors).

Employees' training (Program 1):
Quality awareness education should be carried on in order to improve employees' quality awareness and performance. It can be expected that employees' performance will be improved, and in return fewer quality problems will occur. It will be more effective to use practices and experiments to teach employees rather than only depend on theories. Finally, the effects of quality awareness education should be regularly monitored in order to continually improve the effectiveness of this practice.

Employees' training (Program 2):
A variety of internal job training courses should be conducted to improve employees' skills and morals. Skilled employees can be asked to give training lectures. Thus, training costs could be extremely reduced. External job training should go along hand by hand with internal job training. Before conducting internal job training, it is essential to understand employees' skill levels, so the training program can be effective and give back the desired impact.

Employees' training (Program 3):
Employees will be trained on how to efficiently and effectively use the selected of QC tools to achieve the company quality objectives. QC tools should be used extensively in detecting and solving service quality problems.

Table 3: Departments Responsibilities

Training Programs	Department
Program 1	Quality
Program 2	Quality
Program 3	HR

source: By authors.

3.4 Stage 4 (Implementation stage)

In this stage the selected quality tools were used to deal with a dozens of quality problems, each problem will be referred to as a case, but due to the research space limitation only three cases will be considered as follow.

3.4.1 Case 1:

The procurement function faced a quality problem using two quality tools, brainstorming to detect all the possible causes of the problem, the predicted causes was depicted on a fish and bone diagram for further investigation.

- **The problem**

There are some items called steel suppliers it contains of some elements such as steel sheets, stripes, angles N-channel and H-channel. The main problem is as following:

1. These items are requested for purchase very frequently.
2. These items are critical for production process so its lead time should be very short.

- **The causes of the problem**

1. **Money:** These items are low cost which may cause the frequent purchasing requests
2. **Methods**: Miscommunication between the requesters which lead to duplicate the purchase requests for the same items. The requesters may divide the purchase requests to be in small amount of money in order to overcome the hierarchy of approval authorities (smaller amount of money requested need fewer steps of authority approval)
3. **Manpower:** Lack of planning and knowledge for the manpower, so they cannot predict the requested quantities for a sufficient period of time.

4. **Material:** These items are semi-fabricated and customized according to the requests which may lead to the unavailability of these items in the suppliers' stores in some conditions.

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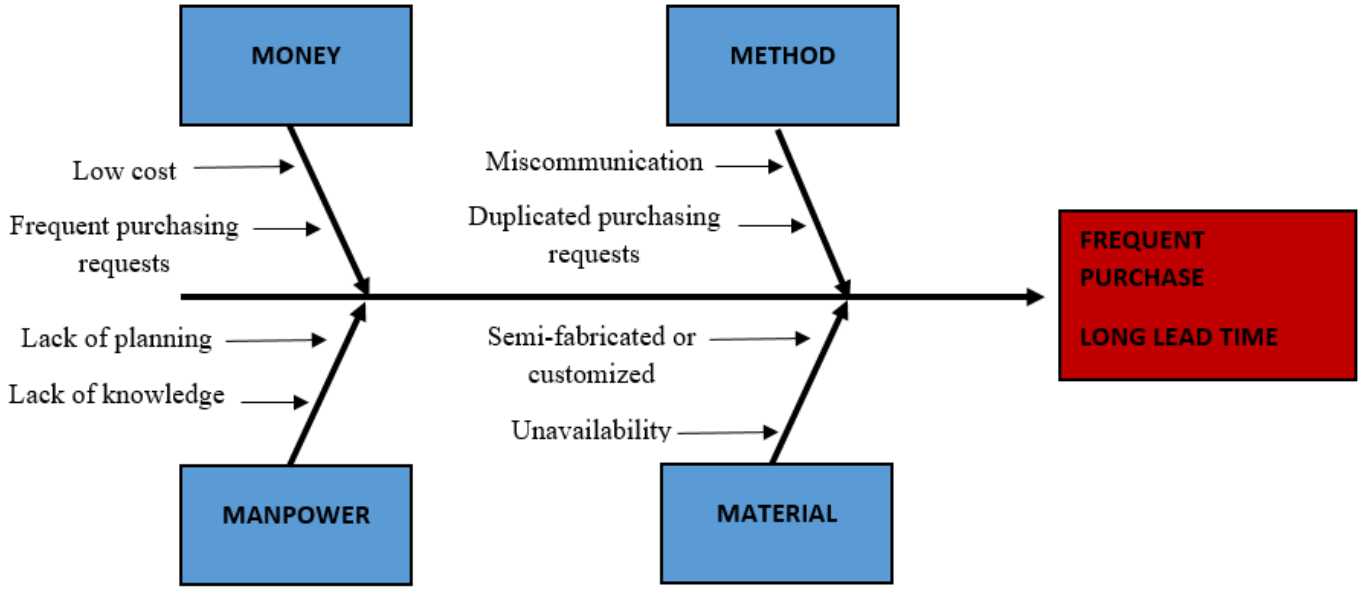

Figure 15: A demonstration for the problem causes using Fish & Bone diagram. (By authors).

- **Comment on case 1**

The causes were arranged according to importance, it was found that lack of planning followed by miscommunication are the most significant causes of the problem, and an improvement processes were conducted.

- **Action Taken**

1- As a solution for the first significant cause which is lack of planning, a training session about the concept of planning, tools used in planning process was conducted to the procurement quality circle team, this session was three hours long, and was conducted by an insider.

2- As for the second significant cause a meeting was arranged between personals representing the procurement function of the company with their counterparts from the suppling company to agree upon certain procedures to overcome miscommunication problems.

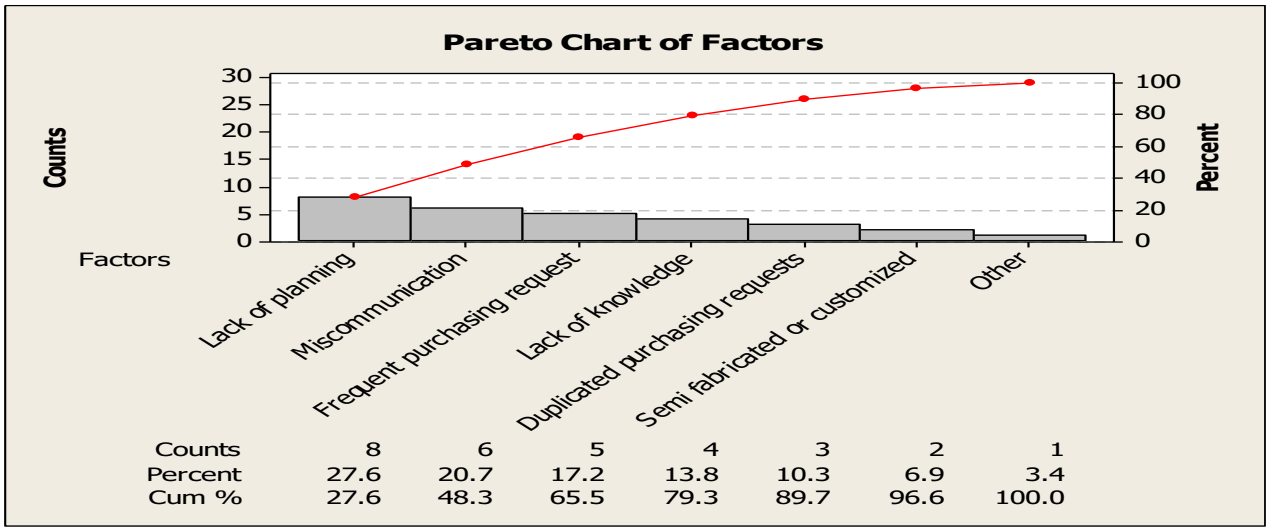

Figure 16: Pareto Chart. (By authors).

3.4.2 Case 2

The procurement quality circle team faced another quality problem, brainstorming technique was used to detect all possible ideas for solving the problem.

- **The problem**

The lead time of requesting and receiving steel supplies such as (sheets, stripes, and angles) should be minimized as short as possible due to its criticality for production process.

A Brainstorming session was conducted and resulted in three ideas:

1. First idea, make the current situation as it is with no changes.
2. Second idea, collect the requirements for the whole year and divide the ordered quantities into four shipments during the year.
3. Third idea, collect the requirements for the whole year through arranging for a several meetings with the requesters, and then conduct a forecasting process to anticipate the demanded quantity for once.

- **Comment on case 2**

1- A voting process has been applied

2- The voting result was to adopt the second idea because:

- Shipments order is more suitable for warehouse capacity.
- A price negotiation rounds can be implemented in each shipment.
- The ability to substitute the supplier in case of supply shortage.

3.4.3 Case 3

The operation function faced another quality problem. A PDCA cycle was conducted and the results were as follows.

- **The Problem:**

There is an obstruction in the movement of the billet while moving it from the roll to the fixed oven slats, due to a problem of corrosion between the slabs and the rolls.

- **Causes of the problem:**

There is corrosion in the fixed floor slabs because of the friction that happens while moving billet to be put in the oven.

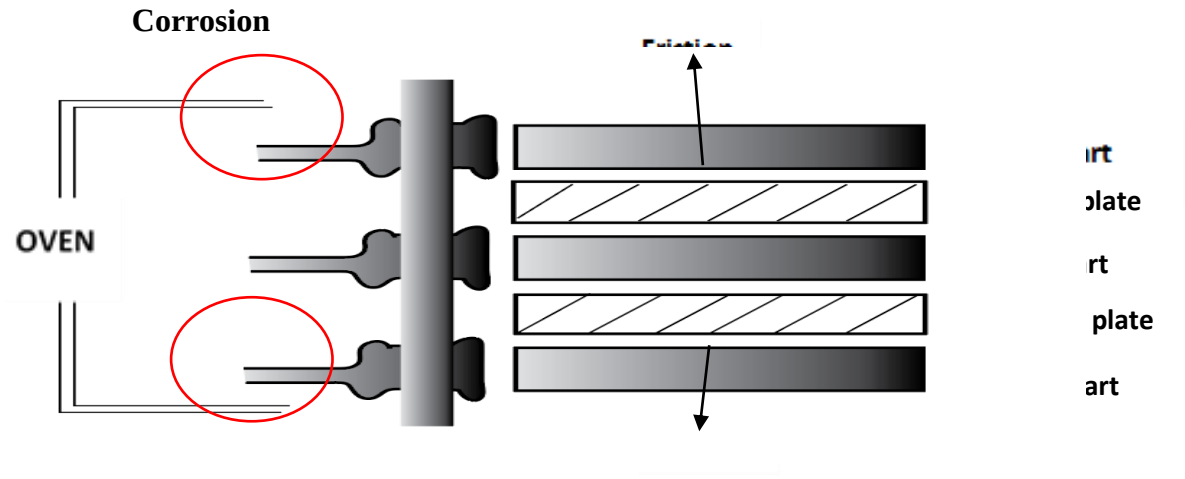

Figure 17: The Billet moving process before suggested adjustment. (By authors).

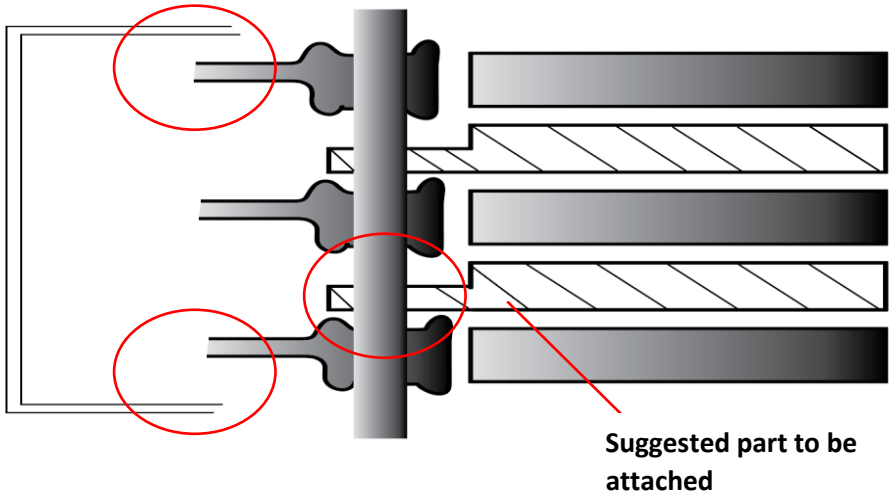

Figure 18: The Billet moving process after suggested adjustment. (By Company production function).

Comment on Report 4

It's impossible to execute this project because of technical difficulties because:

1- It's difficult to maintain those stainless steel parts after they are attached.
2- A disaster may happen if those parts broke and the whole oven will completely stop functioning.

3.5 Stage 5 (Evaluation stage)

The process conducted in stage 3 will be done once more through the dissemination of another 150 questionnaire forms over 150 of the company workforce where 55 of them are located in the procurement function, anther 45 are located in the logistics function, while the rest are located in the manufacturing function. The purpose of the questionnaires was to determine the effect of the

training program on the nature of the relationship between the usage of the 7 quality control tools and job satisfaction using employees' involvement as a mediator.

•Table below shows the descriptive statistics (mean and standard deviation) of the research variables.

Table 4: The mean and standard deviation of the research constructs (After training)

Variables	Mean	S.D.
Using quality tools	3.80	0.32
Employees' involvement	3.98	0.47
Job Satisfaction	4.12	0.41

source: By authors

- A simple regression model was developed between employees involvement as dependent variable and using quality tools as independent variable, the results revealed that the model is significant through a (P value = 0.001) which is less than (0.05), and confirmed by (F calculated = 9.70) which is greater than (F tabulated = 2.152), so it is clear that customers' satisfaction has a positive impact on customers' loyalty, to confirm the previous result the coefficient of determination was calculated and its value was (r2= 89.03%) and this result confirms that using quality tools has a direct and strongly positive relationship with employees' involvement. For, so the first hypothesis is confirmed.
- Also, a simple regression model was developed between job satisfaction as dependent variable and employee involvement as independent variable, the results revealed that the model is significant through a (P value = 0.003) which is less than (0.05), and confirmed by (F calculated = 5.63) which is greater than (F tabulated = 1.331), so it is clear that gob satisfaction has a positive impact on service quality, to confirm the previous result the coefficient of determination was calculated and its value was (r2= 83.11%) and this result confirms that employee involvement has a direct and strong relationship with job satisfaction. For, so the second hypothesis is confirmed.
- It is obviously clear that Control Quality tools are used more effectively and efficiently used through the company which in return effects both employees' involvement and job satisfaction positively.

3.5.1 Comment on stage 5:

- It is clear that there is an improvement in the level of performance between those employees who was trained on and was able to use the quality tools. Yes, the improvement level could be considered modest, but not to forget that employees are not yet familiar with quality tools, also not all of the quality tools were used.

4. Conclusions and recommendations

4.1 Conclusions

1- The validity of the used quality tools in eliminating a number of quality wastes were confirmed at the practical level with in the firm.

2- The reports submitted by the company function refer to more attention to quality issues.

4.2 Recommendations

1-Quality awareness education should be further confirmed in order to increase employees' quality awareness and sense of responsibility, and to spread a quality culture within the factory. Quality

culture means a set of values, beliefs, and assumptions revolves about quality, a set that should be embraced by every member of the factory, in order to understand, support, and effectively involve in quality approaches an initiative.

2-Competitive benchmarking should be conducted for identifying opportunities for performance improvement, as well as gathering valuable information that will help the company in improving their product design, and quality.

3-There is a need for effective communication for the development of awareness, and commitment to quality in organizations 'environment.

4-The evaluation of employee satisfaction should be conducted regularly. Such information can be used by the firm to further improve its employee satisfaction, because increased employees' satisfaction will lead to a successful quality management implementation in the factory.

5-Employees should be trained on using a collection of non-statistical tools (e.g. surveys, focus groups, failure mode effect analysis).

5. Future Perspective

Research has been conducted in order to stress on the important role of seven basic quality tools (7QC tools) within quality management system. It is shown that 7QC tools can be used in all process domains, from the beginning of a product development up to management of a process, on daily basis, in a methodical manner. In modern production processes it is necessary to implement integrated quality management system that includes an efficient and effective manage of quality, hand in hand with a responsible environmental performance and safe working environment. In the frame of integrated management system quality tools can be much wider applied with certain success. Furthermore, orderly application of 7QC tools will enable a successful implementation of quality improvement initiatives. As it is shown in selected examples, quality tools play a significant role in data gathering, analyzing, visualizing and making sound base for data founded decision making. Although the seven basic quality tools have been reach its maturity, and there are a great number of new quality tools that are on disposal for different purposes in a frame of quality management and quality engineering, the research have shown that the application of basic quality tools in industry and services are not so common. It is necessary to point out that quality tools are not so wide spread as expected, although they are quite simple for application and easy for interpretation. With today computer capabilities and automated data acquisition there should not be any technical obstacles for wider quality tools application. In spite, during research, it is experienced certain discomfort towards quality tools. This state should be changed through continuous staff education and training.

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