Journal of Advances in Science and Technology
Vol. 18, Issue No. 2, September–2021, ISSN 2230-9659

A Review of Quality, Productivity and Safety Relationship in Manufacturing Setup

Pujari Nitin Vishvanath[1]*, Dr. V. C. Jha[2], Dr. Rupesh Jagatarao Patil[3]

[1] Research Scholar, Kalinga University, Raipur

[2] Professor, Department of Mechanical Engineering,Kalinga University, Raipur

[3] Principal, Navsahyadri Education Society's, Navsahyadri Group of Institutes, Faculty of Engineering, Pune

Abstract- In a country like India, where the economy is still expanding, industrialization is crucial. The manufacturing sector in India has been important to the country's recent economic success. One-seventh of our country's gross domestic product has come from manufacturing. So, it is necessary & appropriate to do an analysis of the industry. Advanced operations, an increase in product complexity, and strong national and international rivalry are just a few of the many obstacles that today's businesses must overcome. India is a rapidly developing nation, making quality, productivity, & safety enhancements particularly important. Quality, reliability, productivity, risk, flexibility, & safety are just few of the many factors that must be considered simultaneously if a company is to thrive in today's global marketplace. So, it seemed reasonable to look at the connection between Quality, Productivity, & Safety in a manufacturing environment.

Keywords- Manufacturing, Quality, Productivity, Safety, Product life cycle

----------X----------

INTRODUCTION

In the manufacturing industry specifically, quality, productivity, & safety have long been considered three key measures of success. They are seldom stressed together, though. It is because the goals of quality management and productivity management are seen as competing that these three concepts are rarely stressed all at once (Omachonu and Ross, 1994). According to recent studies, there should be a positive correlation between quality, productivity, & safety. However this theory relies more on inference and deduction than on tried and true models in the real world. The correlation between quality, productivity, & safety has been the subject of few mathematical models. Yet, these current models suffer from serious flaws. As a result of these flaws, current models are useless in practice.

In this post, we look at the logic behind the connection between efficiency, effectiveness, & protection. It is vital to choose a common base through which to relate quality, productivity, & safety as their definitions vary. Two industries, Maruti & Shree sai techno, will be used to test the models' viability in the manufacturing industry.

Quality is a relative term and is used with reference to the end use of the product (Mahajan, 2017). It is also termed as: “The totality of features & characteristics of a product / servicethat bear on its ability to satisfy stated or implied needs.” (ISO 8402:1994) .Needs may include performance, usability, maintainability, reliability, dependability, safety, environment, aesthetics & economy (Untawale,2017).

The definition of quality depends on perception of a person in a given situation, which can be cost oriented, user oriented, supplier oriented etc. Quality is defined as fitness for purpose (Juran, 1994). If the component perform in the safe manner in the required situation, it is called Quality product (Mahajan, 2017). The collection of activities through which we meet the quality needs of society is called quality function. In a manufacturing concern, the means through which the company meets the needs of customers is the quality function. Hence in general terms, quality function is the collection of activities which involves all the departments, vendors, links in distribution chain & consumers.

DEFINITION OF QUALITY

The "product quality" or "lots quality" is what is meant by "quality" in this study. Product quality is referred to as the extent to which a product's characteristic(s) conforms to the requirements of the consumer (s). The minimum acceptable product quality refers to the point at which the compliance level for a product barely satisfies the customer's requirements.

Product quality, as appears to be in terms of the individual product because the conformance level can be interpreted either in terms of the individual product or in terms of the lot. Lot quality is what is required when a lot conformance level is needed. The level of compliance at which a lot satisfies the customer's criteria is known as lot quality. Similar to this, the minimal acceptable lot quality is the threshold at which the conformance level barely satisfies the customer's stipulated demand for a lot.

Lot quality is usually specified when 100% inspection is impossible (e.g., destructive inspection) or uneconomical. In such situations, sampling inspection is the only choice. However, because of the sampling risk, the customer must allow for a defined level of defective product.

For example, if ten thousand fluorescent lamps are ordered, it is impossible to test the product characteristic, (e.g., lighting duration for 1000 hours), for all ten thousand lamps. In this case, sampling inspection is inevitably applied and a lot quality (e.g., 99.5% of the ten thousand lamps exceed the duration 1000 hours) must be specified. The minimum acceptable lot quality is 99.5% in this case.

DEFINITION OF SAFETY

Safety improves quality and productivity. When operations are unsafe, they aren't well-managed. Employees will not be motivated nor mindful, and employee churn will be far greater. Quality and productivity both suffer when employees are under stress, unsatisfied, or unable to complete their mission. But when businesses are safe, it frees up employees to focus on their quality and their productivity. The safer the organization is, the less frequently the organization will experience large scale disruption.

DEFINITION OF PRODUCTIVITY

In this research, productivity is describe as the profit-based ratio of valuable output to measurable input during a specified period. The term "valuable output means that the output has a market value. Also, "measurable input" refers to all the input that can be measured by or transferred into rupees. Therefore, the unit of measure for productivity used in this research is rupees, and productivity is profit-based.

Because of the influence of inflation or deflation, the same amount of dollars has different values at different times. Since the output always lags behind the input. It is necessary to take into account the inflation or deflation factors. For the purpose of measuring the productivity of a product, three assumptions are needed here. First, the time lags between the output and input of the same product are assumed constant. Second, the influence of the time lags among input costs are negligible. That is, the input costs incurred at different time points within a short period of time are assumed having no deflation of inflation. Third, the influence of the time lags among the outputs sold are negligible. That is, the output (resulted from the same input) values produced at different time are assumed having no deflation or inflation. Because the object of this research focuses on manufacturing companies, valuable output refers to the products that are to be sold to customers, either external or internal customers. "External customers" are the customers who directly purchase the products outside the manufacturing company. "Internal customer" refers to the other divisions, departments, etc. that are users of valuable products in the same manufacturing company. On the other hand, input is usually viewed as synonymous with total cost in the manufacturing environment. In addition, productivity, as defined above, implies the Total Productivity only. Total Productivity, as defined by Sumanth (1994), is a ratio of total tangible output to total tangible input. It is a ratio measuring the overall productivity.

DEFINITION OF PROFIT

In this study, productivity and quality are linked using profit as the foundation. The difference between income & costs is referred to as profit. Three things need to be mentioned in addition to the definition:

1. The term "profit" in this study refers to the gross profit before taxes. Only the profit before tax is taken into account because variable tax rates have an impact on net profit and may therefore alter how quality, productivity, & profit are related.
2. Base-period equivalent values are used to calculate all profits, revenues, & expenses. This criteria aims to eliminate the effects of inflation & deflation on connection models.
3. Product sales are the primary source of profit. Profits that are not derived from product sales are not taken into account in this research to prevent misunderstanding the links between quality, productivity, & profit.

DEFINITION OF COST

Cost and profit are closely related. Although in this research, the Quality- Productivity relationship is developed based on profit, it does relate to the calculation of cost. Therefore, cost must also be defined for this research. Except where specified, cost in this research is defined as the production cost. Since this research focuses on the quality-productivity relationship, the costs incurred in the production activities are the main concern. The marketing costs and administrative costs are not included in the production cost. Production costs include the direct material, direct labor, and factory overhead incurred to produce a product. Direct material cost is the cost of any raw material that becomes an identifiable part of the finished product. Direct labor cost is the wage earned by a worker

who transforms the state of material or part to another state, e.g., finished product. Factory overhead includes all production costs other than direct material and direct labor. Since cost is referred to production cost, factory overhead is simply called overhead in this research. Both profit and cost are measured in terms of Rupees in the base period. Profit and cost in the confirmatory study are converted from Taiwanese currency values into the equivalent Rupees based on a fixed exchange rate.

PRODUCT LIFE CYCLE

A product goes through four stages in its life cycle: introduction, growth, maturation, and decline. The previously displayed figure depicts the sales & profits related to each stage, along with a few real-world examples of products.

1. Introduction

Sales start now, & profit moves from negative to positive. At this point, there is little demand. Because the customer is unfamiliar with the goods. To familiarize customers with the goods, the company must make significant advertising investments. Sales volumes are modest, and if necessary precautions are not taken, there is a danger that the product will fail.

2. Growth

The product then moves on to a phase of fast expansion. Early on in this stage, sales & profit climb dramatically (because the customer finds the product acceptable). Due to little to no competition, this is the case. The goal of operating at this point is to somehow meet demand; efficiency is less important.

3. Maturity

Sales plateau at this point, & profit starts to fall. In order to reduce costs &, eventually, unit profit margin, new competitors is created. Now, operations must place a premium on efficiency, yet marketing might lessen the strain by stepping up product differentiation.

4. Decline

Finally, the current product reaches a decreasing stage & become obsolete. Demand hateful people, or find a better, less expensive goods. The life cycle suggests when to retire the current product & launch a replacement. The life cycle of each product differs significantly. For instance, it took "Xerox" 15 years to produce electrostatic copy machines, whereas in the computer & semiconductor industries, goods become outdated in a matter of months.

Figure 1: A product's life cycle

PRODUCTION SYSTEM TYPES

A company's production system primarily makes use of its facilities, tools, & operational procedures to manufacture things that meet consumer demand. The aforementioned specifications for a production system are based on the kind of goods the business sells & approach it takes to service its clients. The table provides an explanation of the production system classification.

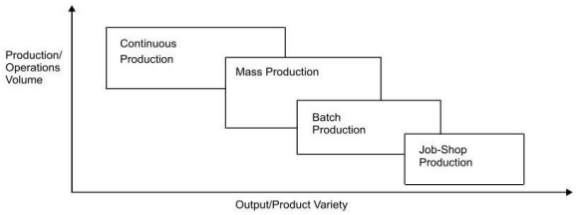

Figure 2: Production system classification

Job shop production

- Job shops are appropriate for producing small batches of a variety of goods, each of which is custom-designed & necessitates a separate set of processing steps or a different route through the production process.
- The production process, in which various product categories move through several shops in different sequences. Example: a restaurant, a furniture manufacturing business, or a prototype business.
- It takes a long time to get equipment access. Some machinery was overloaded.
- A process technology appropriate for a number of volumetric custom-designed items.
- This production system uses a process layout because it allows us to produce a greater diversity of items at a lower product volume.

Batch production

- Limited product diversity that is fixed for one batch of products;
- A process technique that is suitable for a variety of products in fluctuating volumes. For instance, a pharmacy or bakery.

- Several of the facility's numerous products get frequent & substantial demand.
- When there are many different items in many different volumes, this form of production method should be favored.

Mass Production

- Mass production is the manufacturing of large quantities of standardized products, often using assembly lines or automation technology. Mass production facilitates the efficient production of a large number of similar products.

- Mass production is also referred to as flow production, repetitive flow production, series production, or serial production.

- In mass production, mechanization is used to achieve high volume, detailed organization of material flow, careful control of quality standards, and division of labor. An early example of the demand for standardized products in large quantities came from military organizations and their need for uniforms and other supplies.

Continuous Production

- Continuous production is a flow production method used to manufacture, produce, or process materials without interruption. Continuous production is called a continuous process or a continuous flow process because the materials, either dry bulk or fluids that are being processed are continuously in motion, undergoing chemical reactions or subject to mechanical or heat treatment. Continuous processing is contrasted with batch production.

- Continuous usually means operating 24 hours per day, seven days per week with infrequent maintenance shutdowns, such as semi-annual or annual. Some chemical plants can operate for more than one to two years without a shutdown. Blast furnaces can run from four to ten years without stopping.

LITERATURE REVIEW

Mathieu Jonathan et al. (2019) Australian construction workers have been killed by falling from heights in recent years, according to reports. Much research has been done on safety and human error in an effort to reduce accidents by implementing organizational and hazard-related tactics, but psychological distress and its effect on the link between human error and safety measures have gotten scant attention. As a result, the purpose of this research is to investigate the connection between safety measures & human mistake in order to determine the impact on the relationship of psychological discomfort among construction workers operating at heights. As a result of the findings of this study, future research can investigate whether effective psychological safety measures can reduce human errors & accidents when working at heights.

Joel G. Brawner et al. (2019) Over the past 40 years, this publication has compiled a list of lean manufacturing (LM) safety and ergonomics research. To gain a deeper understanding of the relationship between LM approaches and specific safety and ergonomic results, the goal is to determine the consequences of each method. One hundred and one studies with one hundred &seventy outcomes were found. "Twenty-three negative, eleven neutral, and three positive safety/ergonomic consequences arose from the use of just-in-time (JIT) production. On the other hand, there were twenty-six good, two negative, and no neutral results related to the 5S system. Stress and mental strain were the most common negative JIT outcomes, while hazard exposure was the most common positive 5S consequence. Fewer and with more varied results were the studies that used other methodologies. Individual LM methods, such as JIT and 5S, appear to play a key role in the safety & ergonomic benefits of LM.

Metin Bayram et al. (2019) An economic advantage of occupational health and safety is to evaluate the linkages between safety behaviors (compliance & participation), their determinants (safety motivation, knowledge of safety), and their antecedents (safety training) impact employee safety productivity (OHS). Methods. The study was conducted with employees who were required to attend basic OHS training every two years as a legal requirement. 453 employees were surveyed as part of the study process. The acquired data was then examined using exploratory & confirmatory factor analysis methods. Results. Safety training, safety awareness, motivation, and compliance all have a role in the development of worker productivity, which is one of OHS's economic benefits. According to the findings, employee productivity gains are unaffected by safety participation. In addition, the safety literature now includes a new scale for measuring productivity in terms of worker safety. Conclusion. Workers should be trained in their safety knowledge, skills, motivation, & compliance in order to boost productivity in their workplaces.

Sibabrata Mohanty et al. (2019) The steel industry has undergone a dramatic shift during the past few

decades. We're in an extremely competitive market now. Quality, delivery time, and price are the primary concerns of customers. An organization's quality & productivity can be improved by using a value system. The purpose of this study is to examine how Total Productive Maintenance (TPM) can improve the steel industry's production performance (TPM). The goal is to increase output and improve quality. The effectiveness of the proposed strategy is tested in a manufacturing unit case study, which reveals considerable improvements in equipment production efficiency. In this industry, the implementation of TPM pillars appears to be quite promising in terms of improving productivity and quality. According to the findings, maintenance is not an additional expense for the organization, but rather a way to boost production. The higher the quality of the goods, the better the maintenance. The goal of the method is to demonstrate the value of TPM implementation in Indian industry as a competitive advantage.

Sanket Manohar Nawghare et al. (2019) A significant explosives industry in India & Asia (Solar Industries India Limited, Nagpur) was chosen as the focus of this study to examine the impact of proper maintenance management on productivity, profitability of the production system, & effective workplace management. It's a challenge for the maintenance department to look forward to process improvement, plant-process optimization, effective utilization of existing resources, and so on, all while keeping in mind the safety of the operations of explosive industries. With the full realization of industrial objectives, it must resist a competitive and explosive production environment. KAIZEN, 5S, TPM, Lean 6 and TQM are also examined as part of this research project. If implemented in a rapidly growing manufacturing industry, such a continuous improvement philosophy can help boost production output while also improving workplace management & helping employees grow personally and professionally as a whole. Using data from an explosive manufacturing company, the study looks at issues such as how to maintain machines in an acidic environment, lack of effective space utilization, difficulties in setting up processing machines in a plant, and how to reduce downtime caused by a hazardous work environment and maintenance issues associated with it. Finding the core cause of a maintenance problem in a manufacture of explosives industry is the primary goal of the research strategy. In order to reduce production system downtime & improve productivity ratio while also implementing tools for continuous process improvement, the study includes solving maintenance issues and making effective and productive modifications to plants through root cause analysis (RCA), why-why analysis. Strategic maintenance management strategies have been shown in the study to contribute to overall improvement and the elimination of the need for maintenance.

Mohd Javaid et al. (2021) A new generation of Lean 4.0 technology has made it feasible for manufacturers to take a more holistic approach of waste reduction, allowing them to better serve their customers. The Internet of Things, artificial intelligence, 3D printing, robotics, real-time data, cloud computing, predictive analytics, & augmented reality are just a few of the tools that can help you get to Lean 4.0 faster and more efficiently than you might have thought possible. Research in this area is focused on developing an understanding of Lean 4.0, its related tools, and its connection to Industry 4. In addition, it outlines how to adopt Lean 4.0, cultivate a lean culture, and emphasize the applicability of Lean 4.0 in the manufacturing industry. This research focuses on Lean 4.0 and the tools it employs. Scopus, ScienceDirect & Google Scholar are used to identify the most relevant research for this investigation. It is this lean revolution that offers customers with a demand for personalized & connectivity, high-quality and useful products. With Lean 4.0, you may gain insight into your supply chain and the manufacturing process. Because of this transformation, manufacturing processes have been improved to be more flexible and less expensive. Lean 4.0 and its ability to reduce waste are briefly discussed in this study. Lean 4.0 and its connection to Industry 4.0 were topics of discussion for the authors. An illustration shows how Lean 4.0 can be used to improve the manufacturing sector using both traditional and cutting-edge tactics. Finally, 14 major Lean 4.0 applications for industrial industries were identified and explored. As a result of this research, manufacturers in the near future will have a better grasp on Lean 4.0 and its associated tools and tactics.

XiaojieSun et al. (2019) Asymmetric or symmetric demand information is used in this paper to examine if manufacturers can encroach on the decision to reduce costs. Only when the direct selling channel is substantially efficient does encroachment inspire the manufacturer to increase investment in cost reduction. As a result, both members profit from the cost-cutting activity without encroachment, but encroachment permits the manufacturer to monopolize the benefit. When direct selling costs are low, incursion favors manufacturers, while benefiting retailers when these costs are high. Information management is the final topic covered in this course.

Rekha Guchhait et al. (2019) The primary goals of this study are to reduce setup costs and enhance process quality while also providing a free, minimum repair warranty for production systems that aren't flawless. Research in this study examines the impact of reduced setup costs and improved process quality on an imperfect manufacturing process with a free product minimum repair warranty. An unpredictable collapse from a managed system to an out-of-control condition occurs in this industrial system. There are no more open orders. Production run time, setup cost and process quality are all factors that contribute to a lower total cost. According to the suggested model, a solution algorithm and several numerical experiments are provided. The model's optimal solution with respect to the system's primary cost parameters is embellished with a sensitivity analysis section, and the ramifications of the analysis are explored.

Ephrem Gidey et al. (2018) Experts in industry and academia often used the terms "quality" and "productivity" interchangeably, adding to the confusion. Even though studies have attempted to explain how quality and productivity have evolved, no studies have looked at how they reached into their current shape and their link, if one existed. In order to determine what is causing the confusion & concept-intermix, this study will look at the key advancements in the evolution of the two conceptions. Their relationship to one another & timing for their evolution are established using natural selection & biased mutation procedures. According to the article, there looked to be a lot of productivity in the first era, a lot of quality in the second, a lot of productivity based on quality in the third, a lot of both quality & productivity in the fourth, and a lot of both in the fifth (Primarily Quality & Productivity). It takes intelligence to comprehend how these two ideas will interact in the future since they will be equally, seemingly in opposition, & concurrently crucial for organizational development; one will never exist without the other and following the other; one will never exist without the other.

Wen-Ruey Lee et al. (2018) despite the belief of many studies that quality and productivity should be linked, managers in manufacturing contexts are not uncommon to question this link. Rather than using empirical mathematical models to support their claims, the vast majority of quality and productivity experts rely on logical reasoning. This could be because there are so few models that connect these two ideas. One alternative is that the existing models are flawed in fundamental ways, rendering them useless in practice. This article explores the mathematical connection between quality and output. A novel mathematical model of the quality-productivity link is provided. An entirely new model was created for the purpose of describing and applying to industry. This model's applicability & validity were confirmed by a field research involving two different manufacturing businesses. This study's findings should interest engineers, managers, & engineering economics experts because the model's cornerstone is that quality & productivity increases enhance profit.

CONCLUSION

The philosophy of QPS covers all the business functions within the organization. High levels of QPS practices have become key to success for many organizations. This research explores implementation factors responsible for initiating mainly safety and quality improvement factors without decreasing productivity. This study has been carried out in manufacturing industries to develop a QPS performance improvement model. Similar type of studies can be carried out in service sector also for their performance improvement. Further research can be carried out for performance improvement of manufacturing industries in various regions of the country as well as in global context.

REFERENCES

1. Abrey M and Smallwood JJ . 2018. The effects of unsatisfactory working conditions on productivity in the construction industry. Procedia engineering. 85: 3-9
2. Agus A., Ahmad S. and Jafar M. 2017. An empirical investigation on the impact of Quality Management on productivity & Profitability: Associations & Mediating Effect . Contemporary Management Research.5, (1): 77-92
3. Ahire S.L., Golhar D.Y. and Waller M.A.1996. Development and validation of TOM implementation constructs. Dec. Sci. 27: 23-56
4. Ahuja A.P.S. and Khamba J.S. 2017. Strategies and success factors for overcoming challenges in TPM implementation in Indian manufacturing industry. Journal of Quality in Maintenance Engineering .14(2):123-147
5. Aleksander Janesand and Armand Faganel. 2017. Instruments & methods for integration of company's strategic goals & key performance indicators. Instruments & methods. 42 (6),: 928-942.
6. Anderson M. and Sohal A..1999. A study of relationship between quality management practices and performance in small businesses Int. J. of Quality & Reliability management . 16 (9): 859-87
7. Arumugam A.V., Mojtahedzadeh Rouhollah, Malarvizhi C.A. 2017.Critical Success Factors of Total Quality Management and their impact on Performance of Iranian

Automotive Industry .International Conference on Innovation, Management and Service IPEDR . IACSIT Press. Singapore.14: 312-316.
8. Bayram, M. (2019). Factors affecting employee safety productivity: an empirical study in an OHSAS18001-certified organization. International journal of occupational safety and ergonomics, 28(1), 139-152.
9. Benson P.G., Saraph J.V.and Schroeder R.G.1989. An instrument for measuring the critical factors of quality management. Decision Sciences. 20: 810-829
10. Benson P.G., Saraph J.V.and Schroeder R.G.1991.The effects of organisational contexton quality management : An empirical investigation. Manage Science. 37(9) : 1107-1124
11. Berg George and Dutmer Richard . 1998. Productivity, quality and safety: A relationship for success.Constructions Dimensions.:96-105

Corresponding Author

Pujari Nitin Vishvanath*

Research Scholar, Kalinga University, Raipur