TOTAL QUALITY MANAGEMENT IN INDUSTRY 4.0*

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ABSTRACT

Quality Management is a workflow that takes into consideration all the tasks and activities that are very essential for an industry to maintain its level of conformity of the products that are being manufactured. Due to its abilities to change the level of excellence of the products it is been into practice by almost all the industries in order to dominate its competition. In today's world it has been a priority to maintain the quality standards in order to have a good product capture in the market. Now when the industries are moving towards the implementation of INDUSTRY 4.0, similarly the quality management is believed to be anchored by the digitalization as to get the most efficiency in the processes. In this review we will be having an overview about the link between the QUALITY MANAGEMENT with the INDUSTRY 4.0 mechanics to improve the overall quality.

KEYWORDS

Industry 4.0, IIoT in Quality, Quality Management, Quality Management 4.0.

I.INTRODUCTION

The Quality Management is the department of the industry that is very crucial as it has a direct contact with the customer satisfaction [1]. This review we will discuss a brief overview about the terms Total Quality Management, Lean Six Sigma, all the tools and terms in quality control and inspection, also the most important of all the quality percussion that affects the company's performance. Obviously with all the traditional methods available for the inspection department of the quality management finding out the defects and working on it has been working fine but the entire process is very slow [2]. Also, with the INDUSTRY 4.0 implementation has made few things possible that include mass production and mass customization but at the cost of complexities in the process of production, which also needed to be assisted by new techniques in the quality management sector. For this to work according to the plan the communication

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system along with informatics tech that will help the quality management in building up the technological approach that is necessary for have a real-time quality control access [3]. With the world industries moving towards the industry 4.0 the uses of all the automation technologies that are, Industrial Internet of Things (IIoT), Cloud Computing, Big Data etc., have helped in helping the production grow its production speed, error reduction, cost reduction to increase the overall efficiency of the department. Whilst all the benefits taken out from the industry 4.0 it is important to have a good understanding of the modern management methods to know the implementation of them. Based on the technologies we will try to identify the links that can be created in between industry 4.0 and the quality management. In this study we will discuss the literature approach towards the link.

II.METHODOLOGY

There are three main points that are to be taken as a part of this study [4]: (a) Planning, (b) Execute, (c) Summary.

(a)PLANNING

The planning stage is the definition of the main research objectives and the data source that will of use to the execution phase. This phase led us to defining the goal that was to study the relation between the quality management process with the current trend industry 4.0. This is done with taking important endorsement from the most used databases like Science Direct; Research Gate. Along with reference to many sites as well as books.

(b)EXECUTION

The stage of execution is where most important part was cover that is the research and definition of what is important to link the quality with industry 4.0. For this specific study keywords like Total Quality management; Industry 4.0; Quality Control. Then a study was carried out by referring to literature review of papers on this specific topic. All the research was done in English specific papers.

(c)SUMMARY

Then an analysis was carried out to of all the content gathered and patched together the data that was helpful and would be of direct connect with the topic

III.QUALITY MANAGEMENT IN INDUSTRY 4.0

Quality Management

Quality Management is the framework that is used in every company/industry with a specific reason that is to help is gaining and maintaining a good quality of the products that are being manufactured. Various aspects that are the part of the quality management are Technology, Human resources, Strategy development, JIT (Just in Time) etc. The main responsibility of the

Quality management department is to manage and also control the data collected by the help of quality measurement. This Quality management plays a vital role when it comes to the end use satisfaction along with reducing the quality costs that are mainly involved in the process. It also leads to other benefits such as reducing the overall costs, the sustainability along with maintaining the cycle time of the process [5].

Quality Management system's specific requirements according to the international standard ISO 9001:

Now with various tools and methods that have been already implemented into the process like Total Quality Management, Failure Mode and Effect Analysis, Lean Six Sigma, benchmarking etc., for achieving an improvement in the quality sector. For this implementation to be successful there are some key processes that need to be followed in the industries like process planning, customer analysis, Employee Empowerment process management, small group activity etc.

Dimensions	Quality Management Practices
Behavioral Aspects	Management Commitment
	Customer Involvement
	Supplier Involvement
	Employee involvement
Technical Aspects	Benchmarking techniques
	Process Management
	Information and Analysis
	Formal strategic planning

Table 2: Quality Management Format

(Source: 10.1016/j.procs.2021.01.176)

The Quality management departments engagement is taken as to be very important for the product growth as it involves the implementation of a trust culture and also commitment towards the best practices by direct involvement of the managers. Also, the importance of the consumer as well as the suppliers is pledged to keep a good relation between the two by the use of various techniques and methods. The involvement of the employees through different programs like their flexibility, training, empowerment, etc. benefits the quality briefly. For the industry to know about its standings in the market bench marketing is carried out to get information through the cost and operation process. In the current production scenario, the "cross-functional product design and production" are also equally important for the quality improvement. The collection of

data of the latest products that are to be made available in the market is also an important aspect for the Dimensions Quality Management Practices Behavioral Aspects Management Commitment Customer Involvement Supplier Involvement Employee Involvement Technical Aspects Benchmarking Techniques Process Management Information and Analysis Formal strategic planning analysis of the product process. Final stages also include the “FORMAL STRATEGIC PLAN” in which the industry targets the quality plans in the short as well as the long terms to have a better control over the quality aspect of the industry along with the help of the employee involvement.

Industry 4.0

As the name suggest it is referring to the fourth Industrial revolution which is said to introduce in an integration of the machines with the internet commonly known as Industrial Internet of Things (IIoT).

Industry 4.0 has the integration that will be serving to many functions that would be in demand like automated production inside the industry with also mass customization made possible. This industrial revolution is also set to be the full communication bridge between the mankind and the machines providing more benefits to the upcoming world.

This will also emphasize more on the LEAN MANUFACTURING by the implementation of smart manufacturing which will assist in reducing not only the production time but also reduction of the wastage. The concept of industry 4.0 being surrounded by mainly the communication between man and machine also introduces lots of important things into consideration such as Industrial Internet of Things, Cloud Computing, Artificial Intelligence, Machine Learning, Augmented Reality, Big Data etc. IIOT assists the process of manufacturing for better performance along with giving access to real-time data analytics [6].

When it comes to smart manufacturing the term Big Data is of great use for analysis process of the data as it helps in identifying of any failures during the process of production which in turn help the quality management team to solve the identified problem and also to increase the overall productivity of the entire process.

Now with industry 4.0 into its growing phase has made Artificial Intelligence its best ally. Artificial Intelligence also commonly known as AI is a software base integration of the machine and human communication or we could say is a framework that is installed specifically to imitate the human actions to reduce the human work. The AI however is based on the frameworks of Data-analytics or Big Data that are basically useful for the analysis of any process with having any human effort on it. When coming to the industrial use of AI; it has been of great use for many applications like 3D-scanning, inspections that evoke the quality performance. This visual

inspection process is very important for any industry to help identify the issues on the product if any.

Artificial Intelligence and Machine Learning (AI & ML) have indeed been of help in the process of inspection and also data collection and analysis. For the data collection inside the industry various visual sensors have been implanted. This collected visual data then uses either augmented reality or virtual reality for helping with the process of inspection. This data is in AR or VR is useful also in real-time and natural working environment for getting a proper visualization using displays.

This is a brief concept of the INDUSTRY 4.0 that will be gaining its way through all the industries make it be small scale or large scale. If the concept implemented properly with all the scope can give miraculous results in the real world too.

Quality Management in Industry 4.0

Quality all in all has gained its importance in the recent years gradually. With its implementation in Industry 4.0 it has to be a part of digitalization of Total Quality Management and all the phases of that are involved in it. In quality inspection that data collection is an essential step for analysis which was previously done manually by skilled workers.

Considering all the aspects that have been discussed a table (Table 2) was created to show the connection in all the TQM tools to the industry 4.0 digitization framework that can be used for enhancing the quality [7].

Table 1: Quality 4.0 vision

I4.0 Tools and Technologies	Quality Management Practices							
	Management Commitment	Customer Involvement	Supplier Involvement	Employee involvement	Benchmarking techniques	Process Management	Information and Analysis	Formal strategic planning
Data science and statistics	X					X	X	X
Enabling technologies (IoT, IIoT, Integrated systems, VR, AR, cloud computing	X	X	X	X	X	X	X	X
Big Data	X	X	X			X	X	
Blockchain	X			X		X		X
AI	X			X			X	
ML	X						X	X
Neural Networks and Deep Learning	X					X	X	

(Source: 10.1016/j.procs.2021.01.176)

The table is created with taken into consideration of the framework of the industry 4.0 that included the seven tools of digitization.

The table has been generated using some key aspects for digitization that include,

-Data science and statistics:

It is the collection of data and also analysis on the base of the data collected.

-Enabling technologies:

It is the evolution of the important aspects of the industry 4.0 that include Industrial Internet of Things, Internet of Things, Cloud computing, all sensors, Augmented and Virtual Reality.

-Big Data:

These are very large data sets generated that are computationally analyzed for study.

-Blockchain:

These are collection of Information into groups or blocks that hold the specific block information.

-Artificial Intelligence (AI):

Simulating the human intelligence into the machines regarding specific process for performing of tasks.

-Machine Learning (ML):

An ally of AI technologies that is used for prediction of results using the history of data as an input.

-Neural Networks and Deep Learning:

Series of algorithms that aims to identify connection between different data sets [9].

Any change or development taking place the industry there must be the involvement of management for taking the required decision. To make a good accord while solving the majority of issues generated during the process the table generated can be used to recognize the different methods of the industry 4.0 framework that can be applied for solving; also assisting the time factor for finding out the perfect solution.

CONCLUSION

This review aims to state a link between the variety of framework in the quality management department with the advancements taken place in industry 4.s0 which assists the enhancement in the Quality. The creation of table with the help of the research done also acts as a bridge that gives us the connections between the quality management processes and the tools of industry 4.0. This overall has a greater scope in improving the industry's quality management whilst also improving the production speed. The scope of industry 4.0 is on the verge of becoming the new normal and hence all the aspects and the industry processes should be upgraded with it so it can grow to its full potential. Also mentioning the important factor of the growth of the Quality Department that would happen with the implementation of Industry 4.0 which will increase the productivity along with the quality.

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