

Impact Of Technology on Waste Reduction and Production Efficiency in Automobile Manufacturing Industries

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Abstract—Automobile manufacturing industry is among the sectors that rely heavily on technology for production efficiency and effective reduction of waste. Advanced technologies have become integral parts of modern manufacturing processes since they increase efficiency, improve accuracy, and decrease any form of production inefficiencies. The study focuses on examining the main production processes within the automobile manufacturing industries and explains the use of modern technologies such as CAD, CAM, CNC machines, automation systems, and advanced inspection processes in enhancing the effectiveness and efficiency of the production process. The study analyses the influence of modern technologies on enhancing the efficiency of the production process within manufacturing industries. Primary data collected through a structured questionnaire from 130 respondents were analyzed alongside secondary data collected from research articles, journal papers, and textbooks. Percentage analysis and chi-square analysis were used to analyze the data. It is revealed that there is a significant relationship between modern technology and production efficiency in the manufacturing industries. The study concludes that technological innovation is an important factor in improving production efficiency in automobile factories.

Index Terms—Automobile Manufacturing Industry, Manufacturing Process, Adopting Technology, Improving Production Efficiency, Reducing Wastage, CAD/CAM System, CNC Machines, Automation, Quality Control, Chi-Square Test.

I. INTRODUCTION

There is no denying the importance of technology in increasing productivity, preventing wastage, and promoting production efficiency in contemporary manufacturing industries. The automobile manufacturing industry is one of the industries where

significant improvements have been witnessed in terms of production operations.

Conventionally, most manufacturing operations involved manual labor, which caused a lot of wastage, delays, and even defects. But today, new technologies including automation, robotics, CNC machines, computer-aided design and manufacture software, Artificial Intelligence (AI), and IoT have played an instrumental role in boosting manufacturing performance through increased accuracy and efficiency.

Besides minimizing wastages, technology facilitates more efficient production processes by way of planning, optimization of the production process, and quality control systems. Inspections carried out through automated systems allow identifying any defects to maintain high quality standards. Moreover, sustainable manufacturing practices and efficient energy use promote environmental protection and efficient operations.

Technological advancements have proved indispensable for industries to survive in today's competitive industrial atmosphere. Adopting advanced technologies has proven to be crucial for industries to remain efficient and productive.

This study is intended to examine how technology can affect waste minimization and productivity efficiency in automobile manufacturing industries as well as understanding the key production processes involved in manufacturing operations.

A. OBJECTIVES OF THE STUDY

- To study the major steps involved in the production process of automobile manufacturing industries.
- To understand the role of technology in reducing wastage and improving wastage and improving

production efficiency in automobile manufacturing industries.

B. NEED FOR THE STUDY

Automobile manufacturing industry is one of the most technology-oriented and competitive in the world today. Production efficiency and waste reduction can be considered among those key factors that make-or-break organizations in this sector. Rising requirements about higher quality products as well as more cost-effective production necessitates the development and use of new technologies by the industry to enhance its performance and ensure quality.

The introduction of technologies such as automation, robotics, CNC machines, CAD/CAM systems, as well as computer vision inspection, has revolutionized the manufacturing processes by minimizing the use of materials, improving production efficiency and quality. The effects of such technologies on manufacturing operations in the industry need to be analyzed in detail.

This analysis will help to determine the role played by technology in minimizing wastes and increasing efficiency. Besides, the key production processes involved in manufacturing and their improvement due to technological implementation will be evaluated.

II. REVIEW OF LITERATURE

Amarishkumar J Patel (2023) According to the findings in the article, casting and manufacturing industries have undergone much development thanks to materials technology, simulation techniques, and optimization. The article emphasizes the importance of simulation technologies in modern days, which can predict any issues such as porosity and crack, resulting in less wastage. In other words, technological development plays a vital role in increasing efficiency and managing any defects that might occur during the process of production. These findings are significant because it helps one to understand recent technological advancements related to production and wastage management.

III. RESEARCH METHODOLOGY

This is descriptive research that aims at studying the processes involved in the production process and how technology can be utilized to increase production

efficiency within the automobile manufacturing industry.

a) Sources of Data

Primary Data

Primary data was collected through the use of questionnaires from the respondents. Data was obtained from 130 respondents on their knowledge about the production process and its relationship with the efficiency in the production process.

Secondary Data

Secondary data were obtained from various sources such as journals, books, website and research papers concerning automobile manufacture and efficiency.

b) Sampling Methods

Convenience sampling method was used to sample the respondents.

c) Statistical Tests Employed

Percentage analysis

Chi-Square Analysis

IV. PRODUCTION PROCESS FOR AUTOMOBILE MANUFACTURING

The automotive manufacturing process involves a number of processes, all technology-based, which ensure efficient manufacture with minimal waste. The discussion is done in the light of research objectives.

A. Major Steps in the Production Process

1. Design and Development

The production process starts with the design and development of the automobiles with the help of advanced technologies such as Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM). These technologies are helpful to create precise digital prototypes and eliminate any sort of error and wastage of materials.

2. Material Procurement and Planning

The raw materials such as steel, aluminium, rubber, and plastic components are sourced according to production needs. Digital systems are helpful in ensuring the availability of adequate stocks and prevent any unnecessary consumption of materials.

3. Machining and Manufacturing Operations

Machining and manufacturing operations are carried out through CNC machines used in processes such as cutting, drilling, shaping, and finishing.

4. Assembly Process

The automobile components are assembled with the use of automatic assembly line facilities and robotics. This increases efficiency and provides uniformity in production processes.

5. Painting and Finishing

Automotive parts are painted through automated systems and provide uniform surface coating and save on paint material wastage.

6. Quality Inspections and Testing

Modern technologies like sensors and testing machines are used for defect detection, which helps in ensuring that quality products proceed further in the production process.

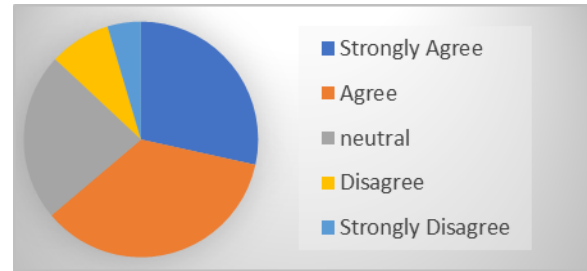
B. Application of Technologies in Reducing Wastage and Improving Production Efficiency

Technology is an important factor when it comes to reducing wastage and improving production efficiency in the automobile manufacturing industry. The use of automation and other high-end machinery optimizes the use of resources and reduces wastage in the production process.

Modern technologies including robots, machine learning, CNC machines, and IoT monitoring systems minimize the margin of error during the production process. Such technologies help in minimizing defective products and wastage in rework and rejects. Moreover, the implementation of real-time monitoring systems and other tools helps industries in managing their production activities effectively, saving time and minimizing any downtime involved in the production process. Lean manufacturing and digital production processes can also be considered efficient practices in the utilization of materials and energy.

V. PRODUCTION PROCESS ANALYSIS

1. Use of advanced casting machinery in the production process



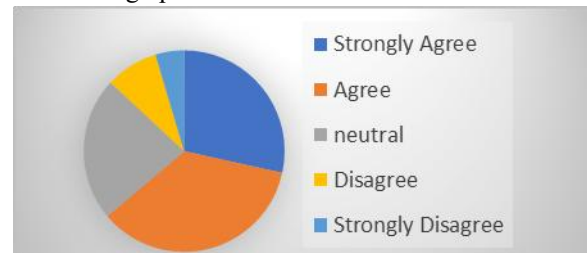
Analysis:

The table indicates that majority of the respondents had agreed (35.4%), followed by strongly agree (28.5%). Neutral was observed to be 22.3%, with a small number disagreeing (9.2%) and strongly disagreeing (4.6%).

Interpretation:

Based on the findings, the overall responses from respondents were favorable, with majority agreeing with the statement. There were only a few who disagreed with it, with some respondents neutral.

2. Implementation of automation in melting and moulding operations



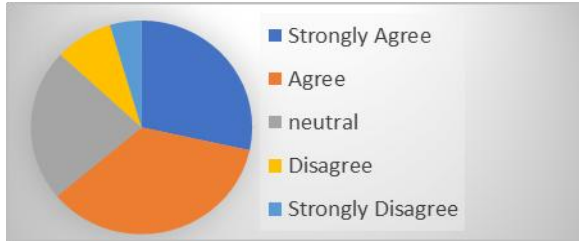
Analysis:

From the table above, we can see that a majority of respondents who agreed (36.2%) and those who strongly agreed (28.5%) have made up the majority. On the other hand, neutral opinions were provided by 21.5%, while 7.7% disagreed and 6.1% strongly disagreed.

Interpretation:

From the analysis above, one can notice that most of the respondents showed positive attitudes since most of them either agreed or strongly agreed to the statement provided.

3. Use of computer-based monitoring systems in production



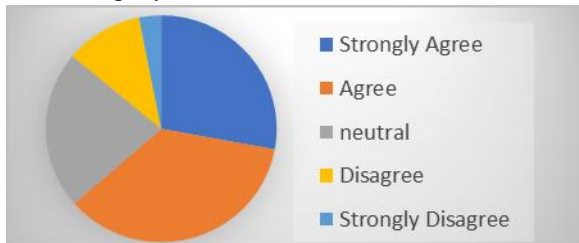
Analysis:

From the table above, it can be seen that 36.2% of the respondents agreed with the statement while 27.7% strongly agreed, representing the largest number. The number who chose “Neutral” is 22.3%, while those who disagreed was 9.2%, and strongly disagreed 4.6%.

Interpretation:

Based on the results, there appears to be a favorable reaction from the respondents since most of them agree and strongly agree with the statement.

4. Availability of modern quality testing equipment in the company



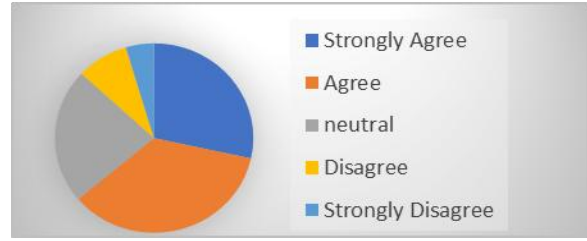
Analysis:

According to the table below, 34.6% agreed, and 29.2% strongly agreed, the highest percentage recorded. The neutral answers are 22.3%, and 8.5% disagreed, 5.4% strongly disagreed.

Interpretation:

The outcomes show a positive attitude among most of the respondents since the majority agreed or strongly agreed. There are a few respondents who did not agree, but there were also neutrals.

5. Regular upgradation of technology in the production department



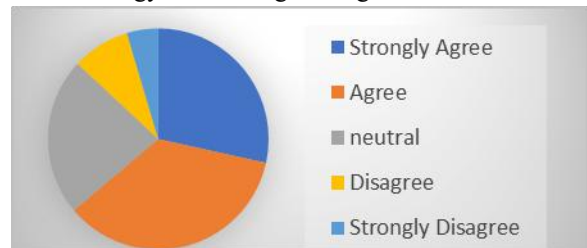
Analysis:

From the results depicted above, 36.9% of the participants agreed while 27.7% strongly agreed, which is the highest percentage recorded. 21.5% of the participants were neutral, 10% disagreed, and 3.8% strongly disagreed.

Interpretation:

These results suggest a positive reaction from most of the participants since the highest percentage either agreed or strongly agreed with the statement. Some disagreed while others had a neutral reaction, indicating slight uncertainty.

6. Technology in reducing casting defects



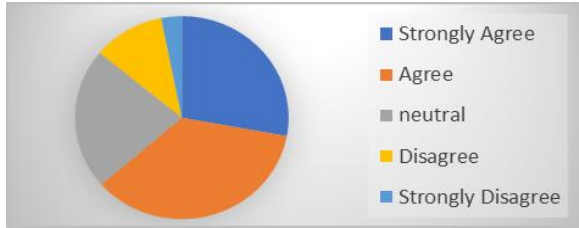
Analysis:

From the table, the figure of respondents who agreed and strongly agreed is the highest at 35.4% and 28.5%, respectively. The neutral respondents are 23.1%, disagreeing respondents are 8.5%, and strongly disagreeing respondents are 4.6%.

Interpretation:

The findings from this data reveal that there was a favorable view among the respondents, seeing that most either agreed or strongly agreed to the statement given.

7. Technology and improvement in production speed



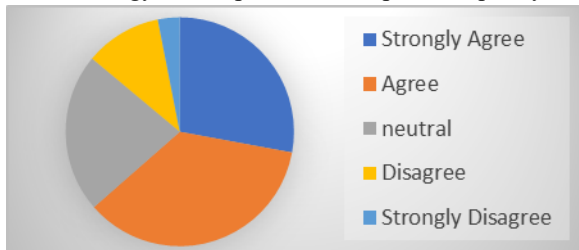
Analysis:

According to the above-mentioned table, it can be seen that 35.4% of people agree and 28.5% strongly agree, which is the highest percentage. On the other hand, neutral opinions were held by 22.3%, whereas 6.9% disagree and 5.4% strongly disagree.

Interpretation:

It can be concluded from the analysis that most respondents hold a positive attitude toward the question, as the maximum number of people agreed with the statement.

8. Technology and improvement in product quality



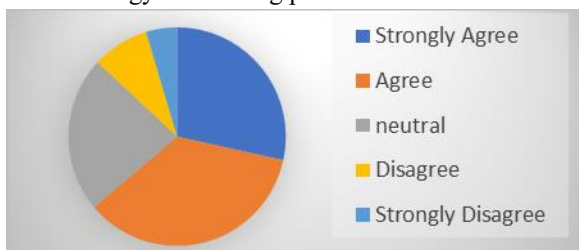
Analysis:

The percentage of respondents who answered 'Agree' was 35.4%, and those who strongly agreed was 28.5%, constituting the largest number of people. Neutral replies were made by 23.8% of the total respondents, 6.9% disagreeing and 5.4% strongly disagreeing.

Interpretation:

Based on the findings above, there is clearly a positive perception by most of the respondents because the respondents were mainly agreeable to the statement.

9. Technology in reducing production downtime



Analysis:

According to the table, 38.4% of the people agreed, while 28.5% strongly agreed, which is the highest percentage. Neutral answers were provided by 22.3% of the respondents, while 10% of the respondents disagreed and 3.8% strongly disagreed.

Interpretation:

The findings reveal a positive perception about the issue by the respondents, with most of them agreeing with or strongly agreeing to the statement. Only a few disagreed with the issue.

10. Chi-Square Test

Chi-square test was applied to investigate the relationship between the adoption of technology and production efficiency in the automobile manufacturing industry.

H₀: There is no significant relationship between the adoption of technology and production efficiency.

H₁: There is a significant relationship between the adoption of technology and production efficiency.

Results interpretation:

From the analysis, there was a significant relationship between the two variables. The null hypothesis was therefore rejected while accepting the alternative hypothesis.

Conclusively, technology adoption is positively significant in minimizing waste and increasing production efficiency in automobile manufacturing industries.

VI. DISCUSSION

The study reveals that the efficiency of production and the minimization of waste in automobile manufacturing industries is highly dependent on the level of adoption of advanced technology. It can be noted that most production process stages such as design, machining, assembly, finishing, and inspection processes benefit from the use of technology, including CAD/CAM technologies, CNC, automation and quality control.

According to the results, technology usage leads to better precision, fewer errors, and uniformity in production processes. This, in turn, leads to a decrease in waste, material and time losses. Additionally, the correlation and Chi-Square analyses reveal that there

exists a positive and statistically significant relationship between technology adoption and production efficiency.

VII. FINDINGS OF THE STUDY

- The study found that the adoption of modern technologies such as CAD, CAM, CNC machines, robotics, and automation improves production efficiency in automobile manufacturing industries.
- It was observed that technological control in production processes helps reduce material wastage, defects, and rework.
- The use of advanced machining and automated systems improves accuracy, consistency, and speed of production.
- Technology-based inspection and quality control systems help in early detection of defects and ensure better product quality.
- Automation in assembly and manufacturing processes reduces human error and improves operational efficiency.
- The study shows that real-time monitoring and digital systems help in better process control and resource utilization.
- Respondents indicated a positive perception toward the use of technology in improving production efficiency and reducing waste.
- The analysis confirms that there is a strong positive relationship between technology adoption, waste reduction, and production efficiency in automobile manufacturing industries.
- Overall, the findings clearly show that technology plays a significant role in improving efficiency and minimizing waste in the production process.

VIII. SUGGESTIONS

- Automobile manufacturing industries should increase the adoption of advanced technologies such as CAD, CAM, machines, robotics, and automation to improve production efficiency.
- Industries should implement real-time monitoring systems to control production processes and reduce material wastage.
- Proper training programs should be provided in handling modern machines and software.

- Regular maintenance of machines and equipment should be ensured to avoid breakdowns and production delays.
- Lean manufacturing techniques should be adopted to minimize waste and improve resource utilization.
- Quality control systems should be strengthened by using advanced inspection and testing technologies.
- Industries should focus on continuous technological upgradation to remain competitive in the global market.
- Better production planning and inventory management systems should be implemented to avoid overproduction and material wastage.

IX. CONCLUSION

This study provides strong evidence about the importance of technology for increasing the production efficiency and reducing wastage in automobile manufacturing industries. As per the production process analysis, it is evident that the application of modern technologies like CAD/CAM software, CNC machines, and other modern equipment leads to accuracy, precision, and efficiency. Moreover, it is concluded that technological implementation is important for ensuring minimum wastage of materials, minimizing defective products, and decreasing rework, thus contributing to increased efficiency. This is evidenced by the positive correlation established between technological development and production efficiency through the statistical tests.

Therefore, it can be said that technological developments have immense significance in efficient production systems.

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