



Article Title: A Systematic Study for Reducing Manufacturing Failures through Industry 4.0

A Systematic Study for Reducing Manufacturing Failures through Industry 4.0

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ABSTRACT

Manufacturing failure is a technical process that is faced by the industry 4.0 as they have transformed their manufacturing process. In this study, literature review involves different significant factors of manufacturing failures, effective risks, and mitigation strategies are cortically discussed here. Research finding is mainly based on survey analysis from the respondents and hypothesis analysis with the help of the SPSS. Industry 4.0 is helping the managers and determining the manufacturing process and the proper supply chain management for mitigating the issues related to manufacturing. Poor production processes or equipment as well as low-quality manufacturing parameters has been seen to cause issues in manufacturing. It can be assumed that all these above-discussed factors can help the 4.0 Industry's manufacturers to increase their productivity, and quality control, to improve their product performance as well as profitability. Conclusion is based on the importance of Industry 4.0 for the development of the manufacturing sector.

Keywords: Internet of Things, Cloud computing. Industry 4.0 strategy, AI, and machine learning, Cyber security.

1 Introduction

Industry 4.0 involves different advanced technologies like the Internet of Things or IoT, cloud computing, edge computing, big data analytics, as well as robotics for transforming its entire manufacturing processes. As per the opinion of Sahal et al. (2020), by adapting all these advanced technologies, the manufacturing process can be done with great efficiency which can help the organization reduce the rate of manufacturing failures.

The organizational manager or leader can face many issues due to greater manufacturing failure or huge loss in productivity continuity. These problems are the manufacturing skills gap, different issues in inventory, and supply chain optimization, and poor knowledge of using IoT sensors and Incorporating robotics and automation. As stated by Sahal et al. (2020), these problems can reduce the chances of opportunities for the manufacturers and besides this, manufacturers somewhere filed to collect real-time data.

Figure 1 is showing in Germany, industry 4.0 has faced many issues as they have transformed its manufacturing process. As stated by Leng et al. (2021), it has been observed that the current GDP figure is illustrating the Industry 4.0's manufacturing process in recession. Along with



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this, the graph shows a clear negative year-on-year change in the growth rate in the last two months of 2018. The rate was almost -0.70 % and -1.50 % which shows the pillar of the manufacturing process is in serious trouble (Angelopoulos et al. 2019).

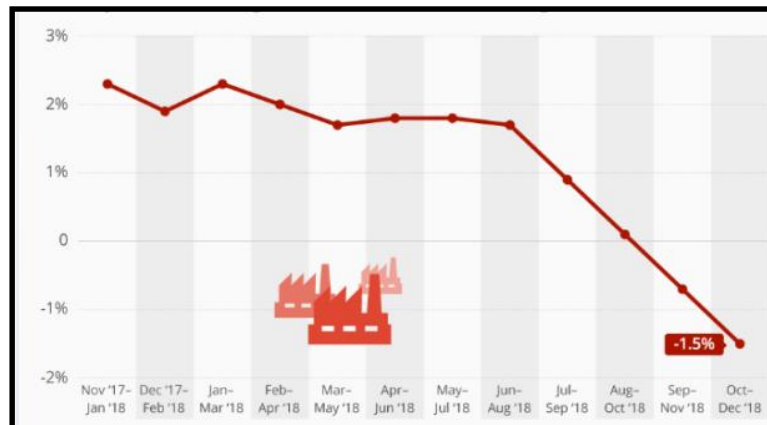


Figure 1: A significant shift in the manufacturing process

The significance of the study is to illustrate the 4.0 technologies provide manufacturers with more technical and advanced ways for optimizing their organizational manufacturing system and lower manufacturing failures.

1.1 Aim

The aim of the study is to identify the critical factors that are affecting the reduction of various manufacturing failures through the 4.0 industry.

1.2 Objectives

RO1. To examine the major factors that can influence the process of reduction in manufacturing failures in industry 4.0

RO2. To evaluate the significance of manufacturing processes and reduce the likelihood of failures in an industry.

RO3. To analyze the major challenges encountered by industry 4.0 in transforming their manufacturing processes.

RO4. To illustrate different mitigation processes for overcoming the issues regarding reducing manufacturing failures

2 Literature Review

Major factors that can influence the process of reduction in manufacturing failures in industry 4.0. There are a few significant factors that can affect reducing manufacturing failures in the 4.0 Industry 4.0. The factors are data quality, skilled labor force, inter-operability, advancement in cyber security, as well as cost-effectiveness (Rosin et al. 2020). Thus, with



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these factors, manufacturers can be able to reduce the rate of manufacturing failures and can enhance their overall product performance.

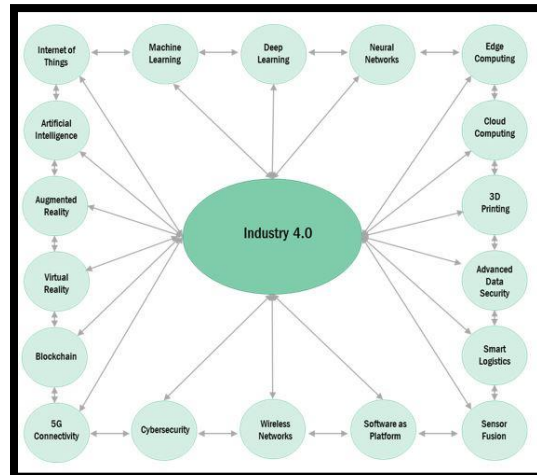


Figure 2: Market size of Industry 4.0

Mitigating ways in which Industry 4.0 can reduce manufacturing failure. There are some mitigating ways by which industry 4.0 can overcome the issues regarding manufacturing failures. These ways are predictive maintenance, quality control, digital twin, and supply chain management or optimization. As stated by Çınar et al. (2020), different AI or IoT sensors and devices need to be used by the 4.0 Industry for data accumulation from manufacturing equipment and this might help to understand the patterns of wear and tear. Thus, the manufacturer can be able to perform maintenance properly on manufacturing equipment before it fails (Moeuf et al. 2020). Hence, industry 4.0 can reduce loss in production continuity and improve its productivity rate.

Along with this, AI and machine learning devices can help in preventing manufacturing failures before they occur in the industry and lead to higher-quality product developments. As opined by Türkeş et al. (2019), a digital twin and a supply chain both are effective ways that can help manufacturers to stimulate the potential risks before they occur in the 4th revolution industry. Besides this, by integrating IoT devices through the supply chain, the 4.0 industry can allow its manufacturers to track resource availability.

Evaluation of the significance of manufacturing processes and reduces the likelihood of failures in an industry. It is important to reduce the likelihood of manufacturing failures in the 4.0 industry's manufacturing processes. There are ample reasons such as **cost savings** to save capital and improve profitability, improved quality results in higher customer satisfaction, and increased efficiency can increase the rate of productivity (Pagliosa et al. 2021). Besides this, by reducing manufacturing failures, industrial manufacturers can create a positive reputation in the global industrial market and can also achieve a competitive benefit in the entire marketplace.



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Analysis of the major challenges encountered by industry 4.0 in transforming their manufacturing processes. Though industry 4.0 technologies provide a huge amount of advantages, there are also many issues that the industry may face due to changing their manufacturing processes. The major issues or challenges are, the 4.0 Industry mainly generates vast amounts of data and proper data management can be a vital issue (Çınar et al. 2020). Besides this, using this technology industry can be more vulnerable to cyber-attacks. Thus, AI-based manufacturing processes in the 4.0 Industry can be a more complicated and challenging process.

3 Methodology

The article discussed the loss in production continuity in Industry 4.0 which creates a negative impact on the 4th revolution industrial management system (Pagliosa et al. 2021). The overall study is established on *the SPSS analysis* with the *primary quantitative data* and the descriptive approach for investigating the key factors and main concept of the study.

3.1 Findings

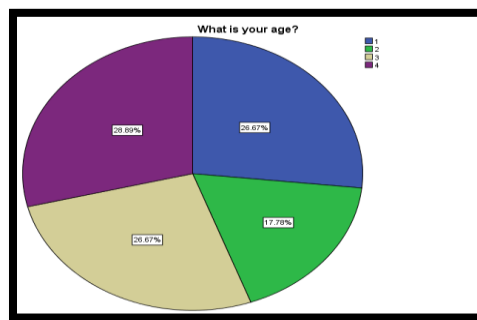


Figure 3: Response rate for different age

Figure 3 is representing the pie chart for the response are from various age group people. Those candidates belong from 20 to 30 years provides 26% responses, 17% responses take from the 31 to 38 years old people. Along with this, 26 % response collect from the 39 to 45 age group people and 46 to 55 age group people gives 28% responses. Thus, the importance of manufacturing processes as well as minimizing the loss of productivity continuity can help to achieve success in the 4.0 industry (Abdul-Hamid et al. 2020).

Therefore, it can be deduced that, by adopting the processes of improvement and development, Industry 4.0 manufacturers can reach their industrial goals, and can achieve higher levels of efficiency, and productivity, to enrich their rate of profitability.



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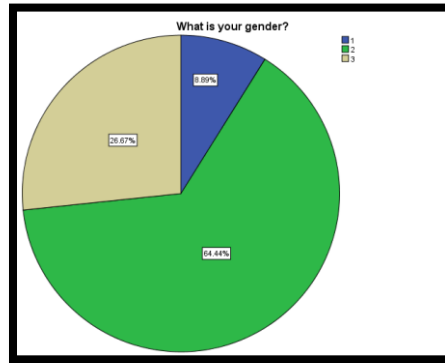


Figure 4: Response rate for different gender

Figure 4 is showing the response are from different gender, male candidates have given 8% responses. Female candidates have given highest responses approximately 65% and other gender people have given 26% responses.

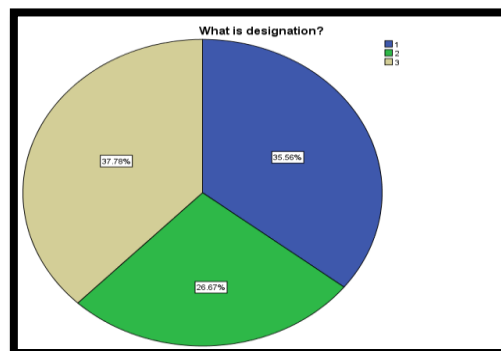


Figure 5: Response rate for different designation

Figure 5 is representing the response rate for different designation people; students have given 35% responses. Along with this, 26% responses collected from PhD scholar and 37% response collected from employee.

Hypothesis 1 (H1): there is a strong relationship between big data analysis and Reducing Manufacturing Failures

Table 1: Model summary

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.409 ^a	.168	.148	.555	1.762



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Table 2: ANOVA Table

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.667	1	2.667	8.658	.005 ^b
	Residual	13.244	43	.308		
	Total	15.911	44			

Table 3: Coefficient Table

COEFFICIENTS						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.178	.910		1.294	.203
	Reducing Manufacturing Failures	.333	.113	.409	2.942	.005

The above tables are representing the R-value as 0.409 and R square value is 0.168 for the big data analysis. Hence, big data analysis is creating an effect on the reduction of the manufacturing failures. The ANOVA table is determining the significance value as 0.005, reducing Manufacturing Failures and big data analysis is correlated with each other.

Hypothesis 2 (H2): There is a positive correlation between increasing revenue and profitability and reduction of the manufacturing failures.

Table 4: Model summary

MODEL SUMMARY					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.187 ^a	.035	.012	.598	1.642

Table 5: ANOVA Table

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.554	1	.554	1.552	.220 ^b
	Residual	15.357	43	.357		
	Total	15.911	44			



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Table 6: Coefficient Table

COEFFICIENTS						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.988	.693		4.309	.000
	increasing revenue and profitability	.113	.091	.187	1.246	.220

The above table is representing the model summary, ANOVA Table, and coefficients where the increasing revenue and profitability is co related with manufacturing failures.

Hypothesis 3 (H3): There is a positive relationship among the Global supply chain and reduction of the manufacturing failures.

Table 7: Model summary

MODEL SUMMARY					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.065 ^a	.004	-.019	.607	1.582

Table 8: ANOVA Table

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.067	1	.067	.181	.673 ^b
	Residual	15.845	43	.368		
	Total	15.911	44			

Table 9: Coefficient Table

COEFFICIENTS						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.684	.388		9.486	.000
	Global supply chain	.044	.104	.065	.425	.673

In the above table, the R-value is 0.065 and the R square value is 0.004, hence global supply chain is affecting the manufacturing industry. The significance value is less than 0.05, hence, Global supply chain and reduction of the manufacturing failures is highly correlated with each other.



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Hypothesis 4 (H4): There is an effective relationship among the Increasing productivity and reduction of the manufacturing failures.

Table 10: Model summary

MODEL SUMMARY					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.035 ^a	.001	-.022	.608	1.639

Table 11: ANOVA Table

ANOVA ^A						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.020	1	.020	.053	.818 ^b
	Residual	15.891	43	.370		
	Total	15.911	44			

Table 12: Coefficient Table

COEFFICIENTS ^A						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.968	.544		7.294	.000
	Increasing productivity	-.032	.137	-.035	-.231	.818

The above table is showing the R square value and R-value as 0.35 and 0.001 respectively, and the significance value is less than 0.05. Hence, the improvement of the productivity is helping to reduce the manufacturing failures.

Table 13: Descriptive Statistics Table

DESCRIPTIVE STATISTICS									
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Global supply chain	45	2	5	3.64	.883	-.877	.354	-.082	.695
Increasing productivity	45	2	5	3.91	.668	-1.812	.354	4.492	.695



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Reducing Manufacturing Failures	45	6.00	9.00	8.0000	.73855	-1.417	.354	3.088	.695
increasing revenue and profitability	45	5.00	9.00	7.5556	.98985	-1.338	.354	1.943	.695
Valid N (listwise)	45								

Table 13 is representing the mean value and the value for the standard deviation, for the global supply chain the mean value is 3.64, and standard deviation value is 0.883. Along with this, for the increasing productivity and increasing revenue and profitability the mean value is 3.91 and 7.55.

4 Discussion

Industry 4.0 is helping to reduce manufacturing failures by improving the process for sharing information regarding storage conditions, health, and usage level. As commented in the works by Angelopoulos et al. (2019), it is affecting the manufacturing process by developing the profitability and revenue of the company. As per the comment by Awan et al. (2021), in the manufacturing system, industry 4.0 is playing a major role in sharing data, innovation purposes, and developing efficiency and optimization purposes.

Along with this, industry 4.0 is helping in manufacturing purposes by gaining value innovation for the development of the business. As stated in the work of Lenget et al. (2021), there are mainly three major techniques for manufacturing consists of industrial internet of things, internet of things, and cyber-physical. Manufacturing failures are mainly based on inappropriate project management, lack of efficient workers, maintenance, and automation, and industry 4.0 is playing a crucial role in reducing those challenges (Pagliosa et al. 2021). As commented in the works by Nascimento et al. (2019), the features of industry 4.0 consist of digital twins, high-speed wireless networks, AI, wired networks, virtualization techniques, and cloud computing for the development of manufacturing purposes.

Industry 4.0 is using zero defect manufacturing, digital quality management, and predictive maintenance for developing the quality of the products and reducing waste for manufacturing purposes (Tseng et al. 2021). As commented in the works by Sony et al. (2020), it is providing real-time information for manufacturing purposes and developing the supply chain value for the development of the organization. For maintaining an end-to-end supply chain, industry 4.0 is playing a crucial role. As stated in the work of Sanchez et al. (2020), there is various positive impact of using industry 4.0 for the manufacturing aspects including high productivity, collaborative work, high knowledge sharing, flexibility, cost-effectiveness, and proper customer experiences. Implementation of industry 4.0 is helping to improve overall productivity and improves the strategies for the development of manufacturing purposes (Sahal et al. 2020).



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5 Conclusion

Industry 4.0 is playing a major role for reducing the failures in the manufacturing purposes. Along with this, discussed about the key factors for the development of the industry 4.0 and discussed about the challenges those have been faced by the manufacturing purposes. Primary quantitative research method has done, and SPSS has been used for the statistical data analysis purposes.

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