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Sustenance Of Automotive Quality Organization Management Practices In The Era Of Industry 4.0

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Abstract: Sustenance of Automotive manufacturer Quality organization management existing practices in the era of fourth Industrial revolution "Industry 4.0" involves adapting and maintaining high standards in quality management systems while integrating new technologies and methodologies associated with Industry 4.0. The major issue for the manufacturing companies is not only to achieve a high level of performance but to sustain the position in the competitive global market while dealing with all upcoming unpredictable unknown challenges. Existing traditional manufacturer facing the survival of business as the industry fourth revolution has begun the unpredictable competition for digital technological domain, physical and ecological system. To overcome this digital challenge the organization still need to require identify and adopt new technology in quality management system to deal with the digital transformation era in manufacturing Industry 4.0. which has increased the challenges for company's quality leadership. The leading quality managers revealed a service need to upgrade plant quality department all sections like receiving quality, In-process quality, final Inspection, customer quality through digitation technology. New business model forcing to organization to adopt essential pillars of Industry 4.0 technological advancement in quality control and quality assurance department. This study is a detail investigation to determine the 4th industrial revolution revised approach of manufacturing quality management leadership. Accordingly, this paper aims at discussing the digital practices to be accommodate in manufacturing quality department including all sub section of quality such as supplier quality, new product development quality, final quality, customer quality etc. In this paper we reviewed the best quality management system (QMS) practices and proposes a modern framework of a quality management integrated model with respect to Industry 4.0 digital manufacturing process, where quality digital practices directly link with Industry 4.0 production environment. Digitizing processes allows for two-way communications. The current study intends to discover the effect of Quality Management system sustainability in the context of Industry 4.0 of Automobile manufacturer of India. Sustainability of Industry 4.0 in Quality Organization drastically improve plant manufacturing efficiency and quality of product by reducing internal rejection and prediction of defect before it occurs. So, it will help to reduce manufacturing plant cost of poor quality (COPQ) which lead to improve profitability of product.

***Index Terms* -** TQM, Quality Management System, Industry 4.0, intelligent quality control systems.

I.Introduction

At the end of 18th century Industrial revolution Industry 1.0 started; it was first wave of industrial change where work done by human hand started to take over by machine operated by steam. Steam power enable to run machine automatically to produce more product compare to hand manufacturing. James Watt's steam engine made more impact on manufacturing. Major difference happened during first revolution in manufacturing & transportation of product. Major drastically changes happed in textile industry where spinning jenny, created by James Hargreaves. After first industrial revolution beginning of 20th century another innovation has happed where steam energy replaced by electrical energy and machine run on electricity to do mass production, its known as Industrial revolution 2.0. This was the second brake through in the industry, transforming manufacturing sector. Further going ahead at beginning of 1970s of 20th century 3rd Industrial revolution started which has used electronics and IT to automate machine production. Actually, its digital revolution which was reshaped old industries and started digital era. In this third revolution uses of computer become common in manufacturing where use of programmable logic controllers, and the birth of the internet has happened. Due to internet communication system has change over traditional system

After third industrial revolution around 2011 birth of fourth Industrial revolution has started which has started to use cyber-physical production system and merging of real and virtual worlds in manufacturing. Main pillars of Industry 4.0 is based on the concept artificial intelligence and machine learning, which allow machines get smarter on their own during manufacturing of product. New innovation like Internet of Things (IoT), which enable devices to connects & talk to each other and share soft information to each other. Big Data involves analyzing bigger amounts of information to make smarter decisions.

The intend of this research paper is to discuss the major impact of Industry 4.0 on manufacturing quality management system (QMS) practices such as “Quality Assurance& Quality control”, “New product development APQP”, “Failure Mode Avoidance” and “Total Quality Management (TQM)”.

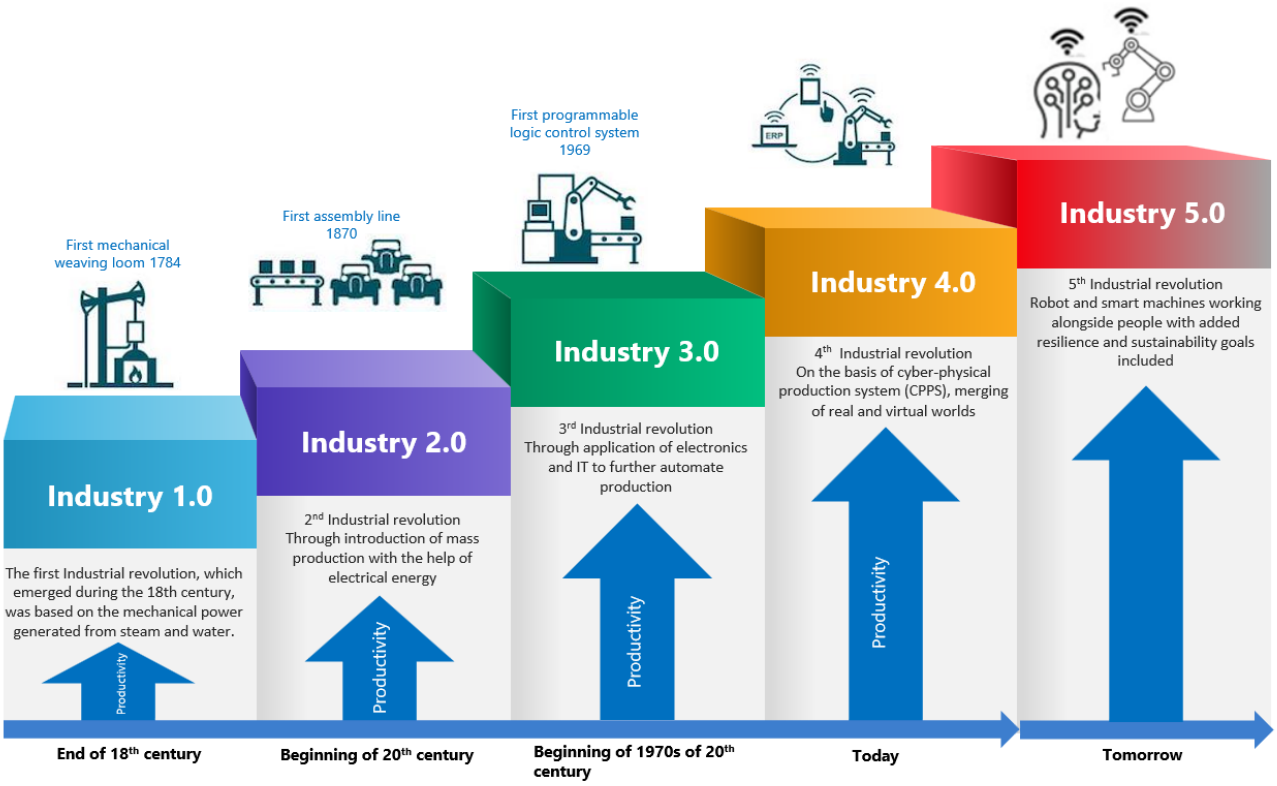

Figure 1.1 Industrial Revolution

II. LITERATURE REVIEW:

2.1 Industry 4.0 digital technologies for manufacturing system

The term Industry 4.0 was initially originated in Germany in 2011, relating to major transformations specifically associated with automation technologies combined with information technology. (1 Jesús Hamilton Ortiz, Industry 4.0–Current Status and Future Trends, 2020 Page-6, 16)

The manufacturing machines automation is leading to enhanced productivity via “Smart Factories,” marking the 4th industrial revolution, which merges the internet with production processes by incorporating small sensors and AI-Artificial Intelligence into manufacturing equipment. There are several features that characterize Industry 4.0. Industry 4.0 pillars are including 1) Collaborative robots technology are built to work alongside humans in industrial settings, enhancing precision in processes and increasing productivity. 2) Augmented reality seeks to merge virtual elements with our real-world environment, using digital content as a key tool in real time. 3) Digital Simulation involves testing a design by creating an environment that resembles real-world usage patterns (RWUP) in computer software. 4) Additive manufacturing is a technology that facilitates the creation of physical objects through "3D printing." 5) Cybersecurity plays a crucial role in

Industry 4.0 by safeguarding the data stored within systems. 6) The IoT technology primarily focuses on linking "things" or items to the network. 7) The cloud computing technology pillar pertains to the capability of providing specific services via the Internet or a network to clients. 8) Big Data pertains to a vast volume of data that can be classified as either structured or unstructured. The data produced by emerging technologies is utilized for analysis and decisions are made based on the interpretation of this data. 9) Artificial Intelligence involves employing computer software to carry out intricate tasks. These software applications are embedded in various types of robots (regardless of whether they are sensitive or collaborative) to execute tasks or duties. 10) The fastest speed of 5G network features a software-defined structure that facilitates dynamic programming, enabling distinct layers for various applications.

European Union (EU) designed Industry 5.0 aimed at facilitating an economic shift and reorienting industry, research, and the economy. (2. Susu Nousala, Gary Metcalf, David Ing Editors -Industry 4.0 to Industry 5.0 Publication Springer, page – vii) The 5th Industrial Revolution envisions robots and intelligent machines collaborating with humans while incorporating enhanced resilience and sustainability objectives. Industry 5.0 aims to tackle issues of diversity within the economic realm, which stem from various sources such as societal norms and behaviours, political and economic colonialism, and past challenges that can now be addressed through medical or alternative solutions.

The Industry 4.0 framework has opened up new avenues for leveraging a variety of technologies in the manufacturing sector, as like the IoT-Internet of Things, Augmented Reality, Virtual Reality, Machine Learning, Advanced Robotics, Additive Manufacturing, System and Process Simulation, as well as Computer-Aided Design, Engineering, Manufacturing, and Process Planning systems, in addition to Product Lifecycle Management platforms. (3.Nikolaos Papakostas, Carmen Constantinescu and Dimitris Mourtzis -- Novel Industry 4.0 Technologies and Applications, page 1).

Industry 4.0 signifies the current evolution taking place in the global manufacturing sector. Large organizations are rapidly adjusting to its demands and are proactively engaging in the adoption of essential new technologies. Small and medium-sized enterprises (SMEs) frequently do not have the personnel and financial resources necessary to investigate the advantages and the challenges associated with Industry-4.0. Nonetheless, small and medium-sized enterprises play a vital role in many economies, accounting for the largest share of GDP and generating a significant number of jobs. As a result, it is crucial to tackle the difficulties and possibilities of Industry 4.0 particularly for small and medium-sized enterprises, assisting them in evolving into smart factories. (4.Dominik T. Matt · Vladimír Modrák · Helmut Zsifkovits Editors -- Industry 4.0 for SMEs Challenges, Opportunities and Requirements, page -vii). Manufacturing firms, particularly small and medium-sized enterprises, face challenges in embracing Industry 4.0 and maximizing its potential to enhance productivity on the production floor.

Industry 4.0 has an impact on various socio-economic sectors, prompting researchers to examine its effects at multiple levels. Scholars are particularly focused on how Industry 4.0 impacts quality management systems and practices, including quality control, quality assurance, and total quality management. It examines successful quality practices and presents a contemporary framework. This framework merges Industry 4.0 with quality practices, establishing a new standard of quality management. (5. Sami Sader, Istvan Husti, Miklos Daroczi -- Quality management practices in the era of Industry 4.0- 2019)

2.2 Quality Management:

Quality involves fulfilling or surpassing what customers anticipate from product. "Quality is the degree to which a set of inherent characteristics fulfills requirements." (Source: ISO:9000). As per Joseph M. Juran's Quality means a product or service is suitable for its intended purpose. According to ISO 9000 Quality means "Degree of Excellence": Quality is the degree to which a set of inherent characteristics fulfills requirements. (8). There are several approaches to quality management, such as quality control, quality assurance and total quality management. Kanji (1990, p. 11). Quality in Total Quality Management (TQM)- Quality represents a management approach centered on the ongoing enhancement of processes, products, and services to fulfil or surpass customer expectations.

IATF 16949 is a worldwide adopted standard for manufacturing QMS-quality management systems in the automobile manufacturing industry and its supplier domain. It is created to ensure continuous improvement, focus on defect prevention, and reduce waste in the supply chain. Below are its key uses. Helps organizations consistently deliver high-quality products that meet customer and regulatory requirements. Ensures a focus on defect prevention and product reliability. Aligns processes with customer-specific requirements to meet and exceed expectations. Builds trust and long-term relationships with customers by maintaining consistent quality. In automobile manufacturing numerous tools and methods are outlined in APQP. Each tool has its own capability when we use it at the correct time in new product development and production. The Core Tools are anticipated to be utilized in automobile manufacturing organizations (including suppliers) for adherence to IATF 16949. The following are the five fundamental Core Tools (10. Advance Product Quality Planning 1994),

1) IATF 16949
2) Design & Process Failure Mode and Effects Analysis (DFMEA & PFMEA)
3) Evaluation of Measurement Systems uses of core tool "Measurement Systems Analysis (MSA)"
4) To check process capability Statistical Process Management uses core tool "Statistical Process Control (SPC)"
5) For Production Component Approval uses of core tool "Production Part Approval Process (PPAP)"

III. RESEARCH METHODOLOGY & DISCUSSION

This chapter examines the ways in which Industry 4.0 enhances quality management practices and suggests a theoretical model for incorporating its digital core tool characteristics into quality management

Integration of Quality Management with Industry 4.0 for Sustainable Development:

In the manufacturing industry, economic productivity with quality always has challenges to compete with competitors. In the automobile industry customer expectations day by day increasing high-quality demand with good high-quality features. The Indian market has many car-making OEM local as well as overseas manufacturers, where market competition is very high. Industry 4.0 gives a good opportunity to digitize and make manufacturing processes to produce high-quality products.

Traditional quality methods need to be transformed into a digital transformation of quality management that uses technology to enhance the quality of an organization's products and services. Quality management system based on Industry 4.0 uses technologies like AI-artificial intelligence, machine-learning, cloud computing, sensor technology and big data to monitor, detect, and predict quality issues in smart manufacturing processes that impact product Quality, identify trends of CTQ (Critical to Quality) parameters in production running line, support to create quality goods, improve production line control plan, and its monitor conditions with the production team to eliminate rejection. Before Industry 4.0, digital quality management required manual data entry and updates. Today's digital quality management systems automate tasks like data processing, communication, security alerts, text analysis, and threat detection.

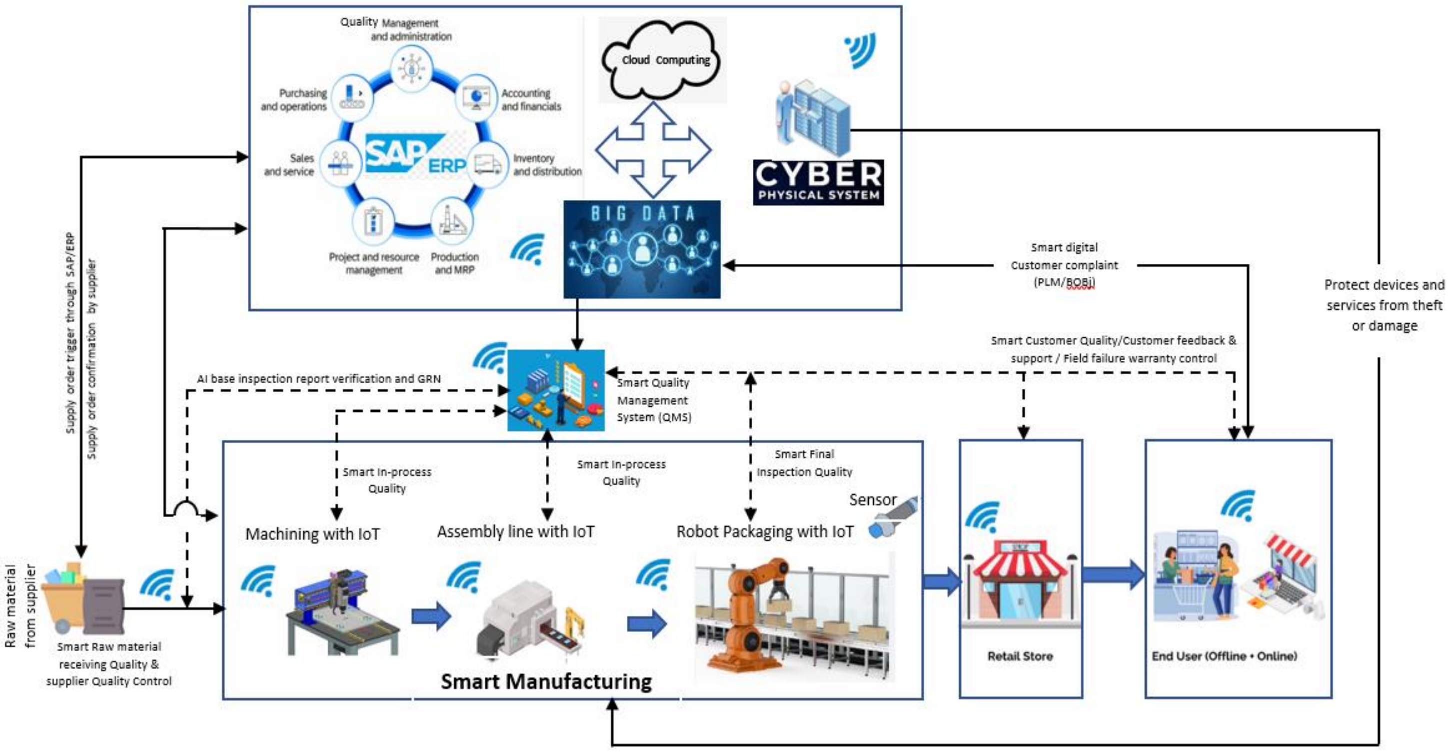

Figure 1.2- Quality management System integrated model with Industry 4.0

Quality in products, services, customer support and manufacturing processes is crucial for automobile manufacturers to remain competitive and economically sustainable in today's automobile industry. Smart factories that utilize Industry 4.0 must have more advanced quality control and quality assurance management systems than traditional smart manufacturing systems. To make smart quality management system we can use effectively Industry 4.0 tools such as

- IoT-Internet of Things,
- Big Data Analytics,
- Edge Computing,
- Smart Sensors,
- AI-Artificial Intelligence and ML-Machine Learning,
- Cybersecurity Tools,
- Augmented Reality,
- Virtual Reality,
- Automation and Control etc.

These tools are interconnected through smart systems, creating more adaptive, efficient, and sustainable industrial QMS operations. Major sections in Automobile Quality Management System are as below,

1. QMS (Quality Management System) as per IATF16949
2. Quality Planning
3. Raw material receiving Quality & supplier Quality Control
4. In-Process Quality
5. Final Inspection Quality
6. Customer Quality/Customer feedback & support / Field failure warranty control
7. New product development Quality

1. QMS (Quality Management System) as per IATF16949

The IATF 16949-International Automotive Task Force is a quality management standard (QMS) that can be integrated with digital tools to help manufacturing organizations to meet its Vision, Mission and Objectives. Combining QMS as per IATF 16949 Integrated with Industry-4.0 technologies amplifies efficiency, quality, profitability (ROI-return on investment) and competitiveness in automotive manufacturing world. QMS digital documentation and audit, use of blockchain and digital platforms for tamper-proof documentation & records to enhances compliance with IATF's requirement for robust QMS documentation. Continuous Learning Systems to upgrade employee skill: AI-driven analytics provide insights for continuous improvement in skill through digital skill matrix and tracking system. Aligns with the IATF's principle of ongoing quality enhancement. PLM, SAP, and ERP software are effectively used in QMS to digitize and streamline quality management as per IATF:16949. Advantages of digital QMS is to simplifies adherence to standards like IATF:16949, ISO:9001, or industry-specific requirements. Digital records ensure transparency and traceability to meet IATF:16949, ISO:9001 standard compliance.

2. Quality Planning

Digital Quality Planning uses digital tools to improve quality with greater precision, efficiency, and adaptability, ensuring compliance, reducing errors, and supporting continuous improvement. Quality Planning in Industry 4.0 focuses on integrating advanced technologies to ensure smarter, faster, and more reliable quality management processes. Industry-4.0 integrates automation, real-time data, and digital tools to transform traditional quality planning into a dynamic, data-driven system.

Key features of digital Quality planning in Industry 4.0 are,

- Real-Time Quality Data Monitoring: - Internet of Things (IoT) devices collect and analyze data during manufacturing process. Its enables quality engineer instant identification and resolution of quality issues without stoppage of production line.
- Predictive Quality Analytics: - Machine learning models predict potential failure defects or process deviations. Its Facilitates to production supervisor and quality engineer proactive decision-making to avoid quality problems before it occurs in actual. It saves the downtime of production line and increase productivity.
- Digital Twins: - Digital/Virtual simulations of products and processes allow quality testing in a virtual environment to detect potential failures and rejections in product and process. It reduces time and costs by detecting potential root causes before actual production.

- Automation in Quality Control: - Robotic systems and AI automate product & line inspections and quality checks. It strengthens consistent and reliable results of production line.
- Seamless Integration: - Now a day in systems like PLM, ERP, and SAP provide unified platforms for managing quality management data like internal rejections percentage defect wise, customer complaints etc. Connects design, manufacturing, and quality assurance teams to get effective results from production process.
- Enhanced Traceability: - Barcode system, Blockchain and digital records ensure end-to-end traceability of products. It improves compliance with quality standards IATF:16949 QMS.
- Collaborative Platforms: - Cloud-based tools enable real-time collaboration among stakeholders LIKE Design, Production, Quality, Maintenance, Marketing. Enhances transparency and reduces errors in quality planning.

3. Raw material receiving Quality & supplier Quality Control

Industry 4.0 technologies Substantially boost raw material receiving quality system and supplier quality control management by automating processes, providing real-time data, and increasing product traceability, ensuring that materials meet required quality design specifications and suppliers adhere to product drawing quality standards.

Key features of Raw Material Receiving Quality & supplier Quality Control in Industry 4.0

- IoT Sensors for Real-Time material Monitoring: - IoT devices helps to monitor conditions of material such as temperature, humidity, and vibrations during material transportation. IoT sensors are ensures materials arrive in the desired condition, reducing the risk of defects during transportation.
- Automated AI-based Material Inspections: - AI-based vision inspection systems and automated dimensional inspection tools detect defects in raw materials. It helps to speeds up the inspection process and improves accuracy by reducing human associated error.
- Digital Quality Inspection Records: - Digital documentation systems store and manage raw material data, such as raw material certifications, specifications, and inspection reports as per AOI (Agreement of Inspection). Raw material data is integrated with ERP (Enterprise Resource Planning) and QMS (Quality Management Systems) for seamless quality approval workflow.
- Raw material Predictive Quality Analytics: - Machine learning models predict potential defects in raw material based on historical data and environmental conditions. Allows for proactive issue resolution before production begins.
- Data-Driven Supplier Evaluation: - Big Data analytics provide insights into supplier performance, such as defect rates in PPM 9Part Per Million) or percentage, on time delivery, and compliance to quality standards. AI (Artificial Intelligence) helps in selecting good performance suppliers based on their past performance, capabilities, and risk profiles.
- Remote Digital Supplier System Audits: - Digital tools enable customer remote quality audits using real-time video feeds, shared dashboards, and data exchanges online. It reduces the need for on-site audits, travelling time to supplier end and allow continuous monitoring of supplier quality in real time results.
- Predictive Supplier Monitoring: - AI-driven analytics monitor supplier performance in real-time, predicting potential issues such as delays in shipment or defects in supplier supplied batch. Allows OEM manufacturers to take corrective actions before issues affect production line.
- Supplier Collaboration via Cloud Platforms: - Cloud-based platforms allow real-time collaboration between manufacturers and suppliers, facilitating the exchange of quality data, specifications, and corrective actions. Improves transparency and fosters a more agile response to quality issues.

4. In-Process Quality

Production In-Process Quality intend to the continuous monitoring and control of manufacturing product quality during the production process. In the context of Industry 4.0, manufacturing in-process quality management is enhanced by the integration of smart technologies such as IoT, AI, machine learning, automation, and real-time data analytics, ensuring that quality is maintained at every stage of manufacturing process.

Major proposed concept of In-Process Quality in Industry 4.0 is as below,

- In-process Real-Time Data Monitoring: - IoT Sensors are used to monitor key process parameters in manufacturing process which can affect product quality and functions, variables such as temperature, pressure, speed, welding parameters, leakage testing pressure and vibrations during production process. This data is transmitted in real time to control systems, enabling immediate adjustments or correction of process parameters to maintain quality standards.
- In-process Automated Inspections and Defect Detection: - AI and Machine Vision Systems automatically inspect in-process products at respective inspection station during manufacturing process, checking for defects such as surface imperfections, dimensional variations, or incorrect assembly done. In this AI based and Machine vision system we need to calibrate machine means need to scan first ok product and save this image as master sample in machine AI base memory and during in-process inspection machine compare on line product with ok master image and find out rejected pieces and separate out from ok product. AI based models learn from past inspection data to continuously improve defect detection accuracy.
- Machine Learning to Predictive Quality defects: - Machine Learning Algorithms analyze historical data and real-time data to predict potential quality issues before they occur in in-process manufacturing. Machine Learning Algorithms Allows manufacturers to take preventive actions (e.g., correct machine process parameters) before defects impact on production and starts rejection in process. Advanced Process Control systems use real-time data to continuously optimize machine setting critical parameters and production settings. his minimizes variations in the manufacturing process, ensuring consistent product quality.
- Closed-Loop Quality Control: - Data collected during the manufacturing process is fed back into the system for automatically adjust manufacturing process in real-time. If any parameters deviate from the desired control plan specification, the system can adjust production processes automatically to correct the issue. A digital twin of the production system simulates and monitors in-process activities, identifying any potential problems in the manufacturing
- Cloud-Based Collaboration and Data Sharing: - Cloud based platforms enable user real-time sharing of manufacturing process data among different teams in organization like quality control, production, and maintenance etc. and even with suppliers. This ensures that everyone has access to the latest manufacturing process data for correct decision-making on real facts and to identify corrective actions.

5. Final Inspection Quality

With regard to Industry 4.0, Final Inspection Quality in the automobile manufacturing sector has evolved significantly with the adoption of advanced digital technologies such as process inspection automation, data analytics, artificial intelligence, and the IoT-Internet of Things. Here's an overview of how these technologies are impacting final inspection quality processes:

- Automation and Robotics: - Robots system equipped with sensors and vision systems can perform final inspections with high accuracy and rapid measurements. These systems can inspect various vehicle parts such as body panels, weld joints, casting parts, press components, rubber parts and interior cab components. Automated Guided Vehicles technology can use to transport completed vehicles to inspection stations, reducing human involvement and enhancing process efficiency and accuracy.
- Artificial Intelligence and Machine Learning usage in final inspection process: - Defect Detection and Classification: AI-powered defect detection systems can analyze inspection data (images, videos, sound, surface, missing components etc.) and identify critical defects in real-time with higher accuracy than manual inspections method. Machine learning models can be utilized to recognize specific patterns of defects based on historical manufacturing final inspection data. AI having capability to predict potential quality issues during final inspection by analysing data from various manufacturing stages and maintenance records, allowing for proactive quality management and improve decision making.
- Internet of Things (IoT) role in Final Inspection: -Connected Devices such as IoT sensors embedded in various parts of the vehicle or in the inspection tools provide real-time data to monitor performance of product and quality. These sensors is utilized to alert quality inspectors to deviations from quality standards or operational process issues during the final inspection stage. IoT systems can be utilize to gathering real-time performance data, enabling faster feedback/alert loops for continuous quality improvement.

- Big Data and Analytics: - Collecting together final inspection data from various other stages of production allows for comprehensive analysis or study of the entire manufacturing process. This collected data helps to identify trends and root causes of quality issues. Big Data and Analytics can track inspection CTQ (Critical to Quality) parameter metrics and their quality trends, providing feedback to operators to adjust processes, reduce defects.
- Augmented Reality and Virtual Reality: - AR and VR are enveloping technologies that simulate real-world experiences using digital elements which can be helpful for final inspection of finished products. For training and support AR and VR can be used to train quality inspectors and operators in quality inspection method, which is improving accuracy and consistency in inspections without any miss skip rate. In Real-time Visual Assistance AR can assist quality inspectors during final inspections by placing digital information on physical objects, guiding them to areas that require closer inspection or additional quality functional testing of produced components.

6. Customer Quality/Customer feedback & support / Field failure warranty control

Industry 4.0 brings advanced technologies such as IoT, AI, machine learning, and big data analytics into Customer Quality/Customer feedback & support / Field failure warranty control management processes, transforming traditional methods into proactive digital result driven, data & fact-driven systems. Customer Quality ensuring finished products meet customer requirements and quality standards throughout product lifecycle. Industry 4.0 Integration tools utilize to monitor real-time product performance through IoT-enabled sensors. We can to identify potential issues before they impact to customers by using predictive analytics.
Customer Feedback & Support is a customer complaint management process to collect and analyze customer irritant issues to improve products design quality and services, while offering timely support to end user customers. Industry 4.0 Integration with customer feedback management process will reduce complaint frequency by using AI-powered tools for automated feedback analysis and complaint tracking. Chatbots and virtual assistants is digital platform which is available for 24/7 customer interaction to support for first aid action to resolve customer issues. Machine learning helping to data visualization and analytics to derive actionable insights from big data feedback from customers.
Field Failure Warranty Control system is managing product failures in the field and improving warranty processes to reduce costs and improve customer trust by taking design and detection recommended actions. Industry 4.0 Integration can help in predictive maintenance through IoT sensors to reduce field failures by before failure servicing of product. Machine learning, Power BI strongly utilize to analysis Big data for identifying recurring failure patterns, city wise failure trend, Kilometer wise failure trend, Dealer wise failure trend and root causes analysis. Blockchain utilize for transparent and faster efficient warranty claim processing management.

7. New product development Quality

Industry 4.0 has transformed the process of new product development by integrating advanced technologies such as IoT, AI, digital twins, digital project management software, e-DFMEA software and data analytics into every phase of product design, development, and quality assurance. E-DFMEA software is analytical tool to predict potential failures in new design concept and mitigate that potential failure by taking recommended design prevention actions and detection actions, so such failure will not come during testing and validation as well as after launching product in market. Digital Twins like 3D modelling software, simulation software, CATIA, SOLIDWORKS, ANSYS, Creo Parametric is a 3D CAD software create virtual replicas of products to simulate performance, identify potential defects, and optimize designs before physical prototypes are made. Digital design review and digital mock up (DMU) is one of the effective quality verification tools where design getting reviewed in software to identify gaps in design and also to verify past lesson learned action accommodate in new design.

IV. CONCLUSIONS:

The systematic literature review reported in this research paper mostly focused on the technologies enabled by Industry 4.0 that can strengthen & make major digital changes in the IATF:16949/ISO:9001 Quality Management System (QMS). A total of 22 articles were analyzed some of them proposed how Industry 4.0 can improve QMS (Quality Management System), Quality Planning, Raw material receiving Quality & supplier Quality Control, In-Process Quality, Final Inspection Quality, Field failure warranty control, New product development Quality which are major core functions of organization quality department. Industry 4.0 has significant potential to enhance quality management approaches. Quality control (QC) and quality assurance (QA) benefit from the advanced features and possibilities of Industry 4.0 technologies. These innovations integrate the physical and digital worlds, providing more precise, efficient, and automated organizational quality management systems. Dramatical transformation from traditional to smart (product, factory, and augmented operator) production systems, which enhanced productivity and minimized defects. By using Industry 4.0 advanced techniques in the Quality Management System, organizations can detect defects early or avoid defect generation in the manufacturing process which saves the cost of poor quality (COPQ) of the production process. Early failure detection or failure mode avoidance (FMA) is always beneficial to organizations to enhance profitability and increase ROI (Return On Investment). By using Industry 4.0 advanced technique in Quality Management Systems, an organization can detect defects early or avoid defect generation in the manufacturing process which is saving the cost of poor quality (COPQ) of production process. Early failure detection or failure mode avoidance (FMA) is always beneficial to organizations to enhance profitability and increase ROI (Return on Investment). With the advancement of Industry 4.0, quality management teams require skilled engineers capable of leveraging new technologies within the quality department.

V. REFERENCES:

1. Jesús Hamilton Ortiz, Industry 4.0 – Current Status and Future Trends, The Editor(s) and the Author(s) 2020, Published in London, United Kingdom.

2. Susu Nousala, Gary Metcalf, David Ing Editors -Industry 4.0 to Industry 5.0 Publication Springer.

3. Nikolaos Papakostas, Carmen Constantinescu and Dimitris Mourtzis -- Novel Industry 4.0 Technologies and Applications, MDPI St. Alban-Anlage 66 4052 Basel, Switzerland.

4. Dominik T. Matt · Vladimír Modrák · Helmut Zsifkovits Editors -- Industry 4.0 for SMEs Challenges, Opportunities and Requirements, Palgrave macmillan)

5. Sami Sader, Istvan Husti, Miklos Daroczi -- Quality management practices in the era of Industry 4.0- Research paper published in November 2019) https://www.researchgate.net/publication/337012990

6. Zaidin, N. H. M., Diah, M. N. M., Po, H. Y. & Sorooshian, S. (2 0 1 8) . Quality Management in Indu s t r y 4 . 0 E r a . Journal of Management and Science 8(2), 82-91.) https://www.researchgate.net/publication/328630839

7. IATF:16949 Automotive Quality Management System Standard, 1st Edition 1 October 2016.

8. ISO 9000:2015 fundamental quality management system requirements for automotive production and relevant service parts organizations.

9. Kanji G.K. (1990), Total Quality Management: The Second Industrial Revolution, "Total Quality Management", Vol. 1(1). DOI: 10.1080/09544129000000001.

10. Advance Product Quality Planning (APQP) and control plan REFERENCE MANUAL. Issued June 1994

11. Assessment of the application of Industry 4.0 and digitalization in the context of automotive component manufacturing in India-- UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION- ACMA

12. Barriers to adoption of industry 4.0 and sustainability: a case study with SMEs--- ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tcim20

13. Critical Barriers to Industry 4.0 Adoption in Manufacturing Organizations and Their Mitigation Strategies-- https://www.mdpi.com/journal/jmmp-- Ahmed Sayem 1 , Pronob Kumar Biswas 1 , Mohammad Muhshin Aziz Khan 1 , Luca Romoli 2,* and Michela Dalle Mura --Journal of Manufacturing and Materials Processing

14. Industry 4.0 in automobile industry-- Deloitte insights

15. Diagnosis of the Maturity Level of Implementing Industry 4.0 Solutions in Selected Functional Areas of Management of Automotive Companies in Poland-- Ewa Stawiarska, Danuta Szwajca, Mirosław Matusek and Radosław Wolniak – MDPI-- https://www.mdpi.com/journal/sustainability

16. Exploring Organizational Sustainability of Industry 4.0 under the Triple Bottom Line: The Case of a Manufacturing Company -- Alessio Maria Braccini and Emanuele Gabriel Margherita -- MDPI-- https://www.mdpi.com/journal/sustainability

17. Industry 4.0 and sustainable development in the automotive sector indústria 4.0 -- Leonardo Pezenatto dos Santos – ISSN 2179-5975

18. Sustainability in Industry 4.0 Business Practice: Insights From a Multinational Technology Company -- Edited by: Bankole Awuzie, Central University of Technology, South Africa

19. Sustainability in the automotive industry, importance of and impact on automobile interior – insights from an empirical survey -- Wanja Wellbrock1*, Daniela Ludin1, Linda Röhrle1 and Wolfgang Gerstlberger2 -- International Journal of Corporate Social Responsibility- Springer open

20. Sustainable Supply Chain Management in the Automotive Industry: A Process-Oriented Review -- S. Maryam Masoumi 1,*, Nima Kazemi 2 and Salwa Hanim Abdul-Rashid -- www.mdpi.com/journal/sustainability

21. The application of Industry 4.0 technologies in sustainable logistics: a systematic literature review (2012–2020) to explore future research opportunities -- Xu Sun1 · Hao Yu1 · Wei Deng Solvang1 · Yi Wang2 · Kesheng Wang3 -- Environmental Science and Pollution Research (2022) – Springer

22. The effect of industry 4.0 on sustainability of industrial organizations in Jordan-- aManagement Information System Department, Amman College, Al-Balqa Applied University, Jordan-- International Journal of Data and Network Science