MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1s, 2026, Pages: 95-98

User Centric Scenario-Based Demand Forecasting in Automotive Industry

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ABSTRACT: *The fast introduction of industry 4.0 has dramatically changed the manufacturing systems and allowed them to become digitally connected, real-time data acquiring, and smart in their decision-making. Digitalization is an important element in enhancing the efficiency of operations, performance in terms of innovation, and competitiveness of an organization by incorporating automation, big data analytics, and sophisticated information systems. Nevertheless, the current digital manufacturing systems are mainly monitoring and control-oriented and do not provide much user-centric interaction and scenario-driven decision analysis. The given paper explores the digitalization role in the Industry 4.0 paradigm and advocates the necessity to adopt user-centered, scenario-based production monitoring models. The synthesis of the recent literature unveils the main challenges associated with the integration of data and analytics along with the interaction between humans and systems. The results highlight the significance of interactive digital systems that allow flexible evaluation of the scenarios, improve the quality of the decision, and overall manufacturing performance in the dynamic industrial settings.*

KEYWORDS: Industry 4.0; Digitalization; Smart Manufacturing; Big Data Analytics; User-Centric Systems; Scenario-Based Decision Making; Production Monitoring.

I. INTRODUCTION

The high pace of the development of digital technologies has essentially altered the way industrial systems are organized and presents the so-called paradigm that is often called Industry 4.0. Cyber–physical systems, Internet of Things (IoT), big data analytics, cloud computing, and artificial intelligence are combined in this paradigm to create intelligent, connected, and autonomous manufacturing environments [21], [22]. In this regard, digitalization has become an important force of operational effectiveness, innovation performance, and competitive advantage in manufacturing and service companies [1], [6].

Digitalization is not simply the process of converting analog information to digital form; it refers to the process of systematic implementation of the digital technologies in the organizational processes, decision-making, and value creation mechanisms [6]. According to previous research, companies that implement Industry 4.0 technologies have a major breakthrough in the process innovation, responsiveness, and productivity [1], [7]. Nonetheless, the scale and the success of digital transformation differ among organizations, depending on the factors of the size of the firm, the level of technological maturity, and the production environment [7], [9].

Specifically, small and medium-sized enterprises (SMEs) struggle with specific difficulties in digital adoption because of limited resources and infrastructural requirements. Although digitalization may be used alongside internationalization and sustainability solutions, empirical data indicate that SMEs should integrate digital strategies with strategic needs with caution so that they can achieve visible improvements in performance [2], [9]. Recent studies also highlight the fact that digital transformation leads to a positive effect on enterprise performance, through the reduction of administrative expenses, bettering internal control, and expanding the ability to make decisions based on data [8].

One of the enablers of Industry 4.0 is access and effective use of large amounts of heterogenous data produced in the manufacturing systems. Manufacturing spaces are constantly generating the structured and unstructured data of sensors, programmable logic controllers (PLCs), supervisory control and data acquisition (SCADA) systems, and enterprise applications [5], [18]. Although this data has a great potential as far as the optimization of operations is concerned, there are issues connected to data integration, consistency, scalability, and real-time analysis [11], [12]. Organizations do not know how to transform raw data into valuable insights without strong data management and analytics systems.Big data analytics has thus become a subject under significant focus as a tool of improving manufacturing intelligence, innovation, and business value [10], [19]. Research illustrates that quality management, coordination of a supply chain, and the overall performance of a firm may be enhanced by analytics-based systems [17], [20]. However, current digital solutions are frequently oriented at automation and monitoring, as well as little support on the interactive decision-making, analysis of a scenario, and the user exploration of alternative conditions of operation is present [18].A further significant constraint that has been seen in the modern Industry 4.0 applications is the lack of human-centred design. Even though dashboards, manufacturing execution systems (MES), and digital twins offer an idea of what is happening in the operations, they often bombard users with dense visualizations and strict working processes [4], [15]. This is because the absence of user-friendly and scenario-driven features limits the ability of the planners and operators to dynamically test the possibility of a situation and response to disruptions as well as make informed decisions in the face of uncertainty.

Current research suggests combining user-centric, scenario-based digital systems that are integrated with real-time monitoring and interactive simulation and forecasting functions [16], [18]. The systems will allow access to the users in adjusting the essential parameters, including demand, lead time, capacity, and inventory, and viewing their effect on production and supply chain performance instantly. Although possible, little research has been done on scalable, user-driven, and scenario-based digital frameworks in manufacturing, especially regarding practical application and empirical testing.

It is these gaps that drive the current paper to address the question of how digitalization and Industry 4.0 technologies can aid in facilitating the implementation of user-centric and scenario-based production monitoring and decision-support systems. The study will contribute to underlining the weakness of the traditional methods and addressing the necessity of interactive, flexible, and

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human-centered digital manufacturing by synthesizing the current state of scientific knowledge and analyzing the existing trends in the digital manufacturing. The lessons learned on the basis of this work will help to better understand how the digital transformation can be successfully used to promote the transparency, resilience, and quality of decisions in the contemporary manufacturing setting.

II. LITERATURE SURVEY

Sarbu investigated the connection between adoption of Industry 4.0 and performance of innovation among German manufacturing and service companies. The research empirically showed that the outcome of product and process innovation is highly superior with digital transformation. The results underscore the fact that those companies that encompass innovative digital technologies like IoT, automation, and data analytics in their operations are more efficient in terms of innovation and competitiveness. This publication sets a very solid base of connecting Industry 4.0 activities and the quantifiable improvements of performance. [1].

In the paper by Denicolai et al., internationalization is discussed as interconnected with digitalization and sustainability in small and medium-sized enterprises (SMEs). The analysis emphasizes that digital transformation is an initiator of globalisation and sustainable development. It also describes the synergistic and substitute relationships among various ways of strategic growth. The study is impactful in explaining how digital capabilities can be used to enhance competitiveness by SMEs operating in dynamic markets. [2].

Ashouri et al. suggested a new methodology of scaling digitalization with data collected through web-scrapers. In comparison to the conventional survey based methods, the research employed automated data mining and machine learning tools to measure the digital maturity among companies. The architecture will allow the assessment of the large-scale digitalization to be done in real-time, enhancing the quality and scalability. The study is an important addition to objective methodologies of measuring digital transformation. [3].

Rossi et al. performed the review of lean tools in the Industry 4.0 setting. The paper discussed the integration of the traditional lean manufacturing practices with digital technologies like cyber-physical systems and smart factories. The authors determined the new trends in implementations and emphasized the use of digital tools in improving waste minimization, efficiency, and operational excellence. Their results fill the gap between the concepts of lean and strategies of digital transformation. [4].

Folgado et al. reviewed Industry 4.0 through the perspective of automation and supervision systems. This paper discussed the meaning, reference architectures, enabling technologies, and the latest developments in industrial automation. It focused on the need to have real-time monitoring, intelligent control systems, and combined supervisory platforms. The paper offers a systematic knowledge of the Industry 4.0 architecture and its progression in the current industrial systems. [5].

Gobble explained the conceptual variations between digitization, digitalization and innovation. The paper has described the meaning of digitization as the concept of converting analog information to a digital one and the concept of digitalization as the utilization of the digital technologies to alter the processes of business. The author emphasized that the future of innovation lies in organizations planning to use digital capabilities as part of the fundamental business models. This article offers intellectual certainty, which is fundamental to research on digital transformation. [6].

Buer et al. examined the relationship between the features of the production environment and the size of the company and digitalization of the manufacturing companies. The analysis indicated that bigger companies and multifaceted production settings have a greater level of digital adoption. It also addressed the problems that SMEs encounter in the digital transformation because of the constraints of resources. The results provide useful information on the situational issues surrounding manufacturing digitalization. [7].

III. PROPOSED METHOD

The proposed methodology is a user-friendly, situation-based digital architecture of production surveillance and choice support in an Industry 4.0 manufacturing facility. The model combines real-time data collection, data management, analytics as well as interactive visualization to enable informed and adaptable decision-making. The entire mechanism of action is divided into six modules that are interrelated as shown below.

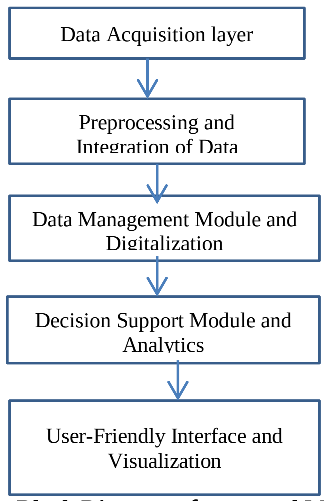

Fig. Block Diagram of proposed Method

3.1. Data Acquisition Layer: The former is the first phase of non-stop data acquisition of non-homogenous manufacturing sources such as sensors, programmable logic controllers (PLCs), manufacturing execution systems (MES) and enterprise resource planning (ERP) systems. Real time data of operational data like machine status, production rate, inventory levels, lead time, and energy consumption are recorded. The layer has ensured continuous connectivity between the physical production assets and the digital system, which is the basis of the Industry 4.0 environment.

3.2. Preprocessing and Integration of Data: Raw data that is obtained usually has noise, inconsistency, and blank values. Consequently, a data cleaning, normalization, and synchronization module are used as a preprocessing module. Standardized data models combine data of various sources into a single digital repository. Checks on consistency and validation rules are implemented to know that information is represented reliably and in a sound manner throughout the system.

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3.3. Data Management Module and Digitalization: At this level, processed data are converted into digital forms that are organized and can be stored and analyzed. Scalable data management architecture is used to process high volume and high velocity manufacturing data. Archaival of historical data, real-time streaming and secure access control are supported by this module which allows retrieval of data effectively in order to monitor and use it in analytics.

3.4. Decision Support Module and Analytics: The analytics module uses descriptive and predictive analytics procedures to derive actionable information out of digitalized data. Some of the key performance indicators (KPIs) include efficiency of production, use of equipment, downtimes, and throughput. To predict the trends in production and determine the possible bottlenecks, predictive models are employed. The output of analytics is the foundation of the scenario analysis and decision support.

3.5. Simulation Engine based on Scenarios: One of the key elements of the suggested approach is the simulation engine in the form of a scenario. This module enables users to establish and update operational parameters which include demand variability, machine availability, process time and inventory levels. The system runs the production results and measures the performance metrics on a real-time basis to every user-defined scenario. This allows the ability to do what-if analysis and be proactive in decision making in dynamic and uncertain situations.

3.6. User-Friendly Interface and Visualization: The last layer offers an interactive user-friendly interface that serves to assist the planners, managers, and operators. The interface shows real-time dashboards, comparison-views of scenarios, and performance summits with simple visualizations. They do not need high-level technical skills to create, compare and assess various scenarios easily by the user. This humanistic design improves usability, transparency and confidence in decisions.

3.7. Continuous Improvement Loop and Feedback: In the proposed structure, there is a feedback system where the real production outcomes are compared to the expected results. Deviations are used to perfect analytics models and enhance accuracy of scenarios as time goes by. This cyclical process of learning increases the flexibility of systems and helps to optimize performance in the long term.

Methodological Advantages

- Combines live monitoring and scenario decision support.
- Focuses on the user-oriented design to enhance human-system interaction.
- Favorable to fluctuating and information-driven production planning.
- Scalable and compatible with the existing Industry 4.0 infrastructures.

IV. RESULTS

The proposed work is five-stage functional pipeline which includes,

A. Criteria Selection
B. Data
C. Supply Chain Topology
D. Report
E. Scenario History

There are important steps visualized in below screens, each step is shown one by one below,

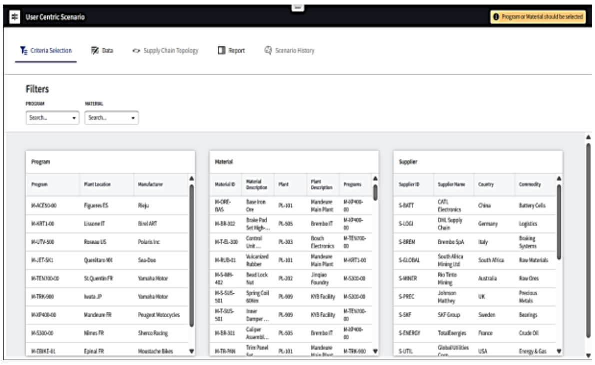

Fig. 4.1 Criteria Selection Option

In the above screen the criteria selection which is first step is shown.

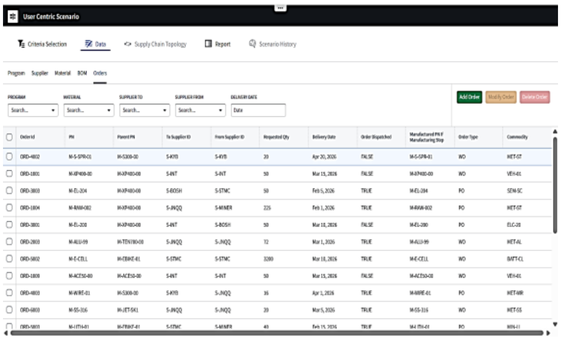

Fig. 4.2 Data Tab Details

The data in supply chain which contains the material, suppliers, programs, orders are shown in the data tab.

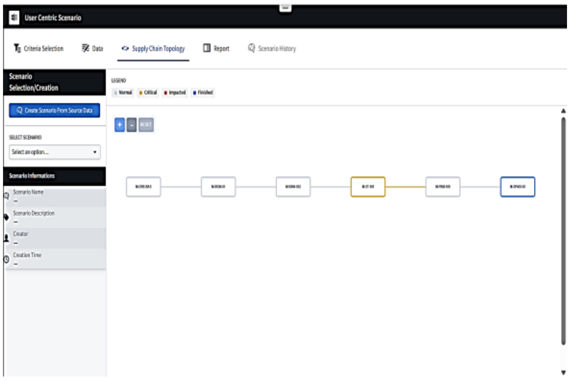

Fig. Supply chain Topology

This is core logic of the supply chain which includes core modules of the project. Core modules such as scenario management, interactive graph visualization, modifications in data workflow, report generation are shown precisely.

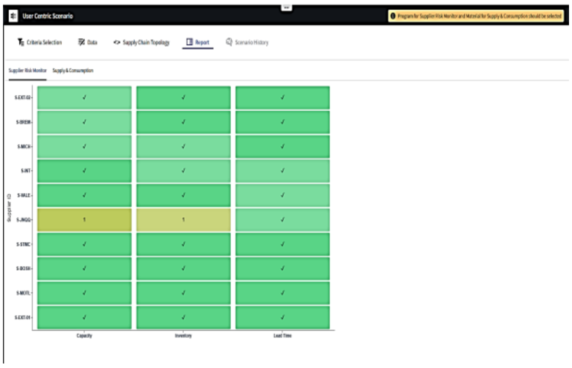

Fig. Report Generation

This report generation module shows the executive summary of project which includes charts plotted for risk visualization, etc.

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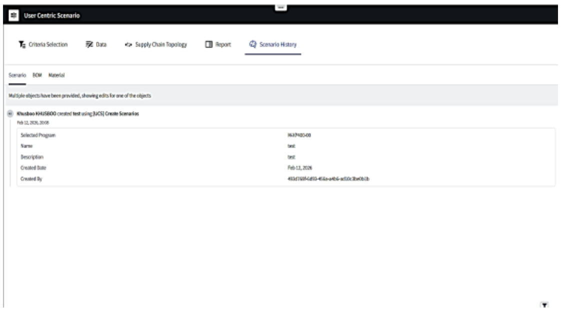

Fig. Scenario History

Within selected scenario all the modifications possible and comprehensive changes possible are shown.

V. CONCLUSION

The paper has considered the effects of digitalization with reference to Industry 4.0, specifically its contribution to improving the performance of manufacturing and decision-making. The review demonstrated that the digital technologies, including automation systems, big data analytics, and manufacturing execution systems, have enhanced the overall transparency of operations and efficiency but seldom have flexibility or user-friendliness. The lack of interactive, scenario-driven functionalities restricts the responsiveness of the decision-makers to constantly changing production circumstances. The article laments the need to incorporate humanistic strategies with online production technologies to ensure that the full potential of Industry 4.0 is achieved. In general, the concept of digitalization, when coupled with the user-centric and scenario-driven paradigm, can be of great service to transparency, adaptability, and strategic decision-making in contemporary manufacturing settings.

FUTURE SCOPE

The future studies may be directed to the elaboration and execution of fully interactive and scenario-based digital platforms, which combine real-time data and predictive analytics with simulative features. Improving the process of automated situation generation and performance prediction with the use of artificial intelligence and machine learning methods is a potential field of interest in research. Also, empirical support of user-centric digital structures by industry examples and massive implementation can enhance practice-axial significance. Other areas of interest could include cybersecurity, data governance, and interoperability issues of scalable Industry 4.0 systems, along with the importance of human-machine collaboration in the achievement of resilience in digital manufacturing.

REFERENCES

[1] M. Sarbu, "The impact of Industry 4.0 on innovation performance: Insights from German manufacturing and service firms," *Technovation*, vol. 113, Art. no. 102415, 2021.

[2] S. Denicolai, A. Zucchella, and G. Magnani, "Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among growth paths," *Technological Forecasting and Social Change*, vol. 166, Art. no. 120650, 2021.

[3] S. Ashouri, A. Hajikhani, A. Suominen, and L. Pukelish, "Measuring digitalization at scale using web scraped data," *Technological Forecasting and Social Change*, vol. 207, Art. no. 123618, 2024.

[4] A. H. G. Rossi *et al.*, "Lean tools in the context of Industry 4.0: Literature review, implementation and trends," *Sustainability*, vol. 14, no. 19, Art. no. 12295, 2022.

[5] F. J. Folgado, D. Calderón, I. González, and A. J. Calderón, "Review of Industry 4.0 from the perspective of automation and supervision systems: Definitions, architectures and recent trends," *Electronics*, vol. 13, no. 4, Art. no. 782, 2024.

[6] M. M. Gobble, "Digitalization, digitization, and innovation," *Research-Technology Management*, vol. 61, no. 4, pp. 56–59, 2018.

[7] S. V. Buer, J. W. Strandhagen, M. Semini, and J. O. Strandhagen, "The digitalization of manufacturing: Investigating the impact of production environment and company size," *Journal of Manufacturing Technology Management*, vol. 32, no. 3, pp. 621–645, 2021.

[8] D. Gao, Z. Yan, X. Zhou, and X. Mo, "Smarter and prosperous: Digital transformation and enterprise performance," *Systems*, vol. 11, no. 7, Art. no. 329, 2023.

[9] D. Radicic and S. Petković, "Impact of digitalization on technological innovations in small and medium-sized enterprises (SMEs)," *Technological Forecasting and Social Change*, vol. 191, Art. no. 122474, 2023.

[10] P. Maroufkhani, W. K. W. Ismail, and M. Ghobakhloo, "Big data analytics and firm performance: A systematic review," *Information*, vol. 10, no. 7, Art. no. 226, 2019.

[11] V. C. Storey and C. Woo, "Data challenges in the digitalization era," in *Proc. 28th Workshop on Information Technology and Systems (WITS)*, Santa Clara, CA, USA, Dec. 2018.

[12] P. Shi, Y. Cui, K. Xu, M. Zhang, and L. Ding, "Data consistency theory and case study for scientific big data," *Information*, vol. 10, no. 4, Art. no. 137, 2019.

[13] K. Gillon, E. Brynjolfsson, S. Mithas, J. Grin, and M. Gupta, "Business analytics: Radical shift or incremental change?" *Communications of the Association for Information Systems*, vol. 34, pp. 287–296, 2014.

[14] P. Krajný and J. Janeková, "Data digitalization in an industrial enterprise," in *Proc. 21st International Scientific Postgraduate Conference Novus Scientia*, Košice, Slovakia, Jan. 2024.

[15] V. M. Tabim *et al.*, "Implementing manufacturing execution systems (MES) for Industry 4.0: Overcoming buyer–provider information asymmetries through knowledge sharing dynamics," *Computers & Industrial Engineering*, vol. 196, Art. no. 110483, 2024.

[16] G. B. Benitez, A. Ghezzi, and A. G. Frank, "When technologies become Industry 4.0 platforms: Defining the role of digital technologies through a boundary-spanning perspective," *International Journal of Production Economics*, vol. 260, Art. no. 108858, 2023.

[17] A. Ashrafi and A. Zare Ravasan, "How market orientation contributes to innovation and market performance: The roles of business analytics and flexible IT infrastructure," *Journal of Business & Industrial Marketing*, vol. 33, no. 7, pp. 970–983, 2018.

[18] T. Papadopoulos *et al.*, "Towards the next generation of manufacturing: Implications of big data and digitalization in the context of Industry 4.0," *Production Planning & Control*, vol. 33, no. 2–3, pp. 101–104, 2021.

[19] S. J.-F. Ren *et al.*, "Modelling quality dynamics, business value and firm performance in a big data analytics environment," *International Journal of Production Research*, vol. 55, no. 17, pp. 5011–5026, 2017.

[20] S. S. Kamble, A. Gunasekaran, and S. A. Gawankar, "Industry 4.0 and supply chain performance: A systematic literature review and future research agenda," *International Journal of Production Economics*, vol. 195, pp. 250–272, 2018.

[21] Y. Lu, "Industry 4.0: A survey on technologies, applications and open research issues," *Journal of Industrial Information Integration*, vol. 6, pp. 1–10, 2017.

[22] R. Y. Zhong, X. Xu, E. Klotz, and S. T. Newman, "Intelligent manufacturing in the context of Industry 4.0: A review," *Engineering*, vol. 3, no. 5, pp. 616–630, 2017.