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Research Article

The Implications Of Industry 4.0 Adoption On Clean Supply Chain Operations With Respect To Production Planning In The Automotive Industry

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ABSTRACT

By taking into account essential drivers and demanding for the Industry 4.0 concept, the research intends to check the influence of Industry 4.0 installing on supply chains and create an implementation structure. The complexity of these difficult problems cannot be met by the strategy development approach. Employing new technologies in chain of supply chain and logistics has a prominent position. To solve some of the operational faults in the chain of supply, Industry 4.0 attempts to integrate intelligent activities with supply chain design and operations. In this study, Industry 4.0 technologies are discussed along with how they might advance the supply chain in manufacturing systems. The study's outcome restates the advantages of achieving significant levels of performance improvement and implementing trying cut technology across all viewpoint of the supply chain network.

Keywords- industry 4.0, smart production planning and control, connected organization, readiness factors

Introduction

The 4th industrial revolution, or "Industry 4.0," has currently started as a consequence of the quick advancement of information and connection technologies and their integration into supply chain operations (Stăncioiu, 2017). Business competitiveness has increased as a result of technological advancements and altering customer needs. Operational models/frameworks and managerial methods will be severely affected by this fundamental change in existing organizations in order to observe and combine with new issues in a changing ecostructure. Since the introduction of Industry 4.0, several businesses have adopted the ideas and innovations of the industrial age to enhance production and efficiency (Garay-Rondero et al., 2020). Industry 4.0's broad influence on various societal sectors is a major strength. From the viewpoint of the typical consumer, Industry 4.0's impact on the areas of business, residence, and community is more obvious. Smart homes, smart buildings and workplaces, and e-health networks are just a few various of the potential world-revolutionizing effects of the new standard.
Similar effects of Industry 4.0 are expected in the fields of business process management, logistics, and industrial manufacturing and management. Supply chain (SC) systems must go digitally in order to succeed in the highly competitive and dynamic business climate of nowadays (Szász et al., 2020). For the good operation of next-generation digital SCs, companies must take in emerging technologies among their business processes and maintain the increasing data in their supply chain. The remain of the work is arranged as requirement. After that, the objective of the study is discussed and section 3 which is a literature review is divided into 3 section which shows the influence of industry 4.0 implementation on chain of the supply, the effect of industry 4.0 on supply chain systems. the impact of Industry 4.0 in the automobile industry, and the research framework.

Objectives of the study

- To statistically examine possible Industry 4.0 readiness elements for the automotive company's production control and planning.

- To make several suggestions for ways to incorporate Industry 4.0 into the operational management and planning of the automotive sector.
- To evaluate those readiness elements employing MCDM procedures with a fuzzy basis.

Literature Review

Digitalization is changing the whole industrial and consumer markets as part of the fourth technological revolution. In 2019 according to Okkonen et al., the primary purpose of Industry 4.0 is to create a network of autonomous and digitally altered manufacturing plants where all various sorts of equipment and products may be manufactured and communicate with each other with a minimum of human interference.

3.1 Impact of Industry 4.0 implementation on supply chains

As per Fatorachian & Kazemi (2021) tremendous opportunity to go further into the field of integrating industry 4.0 into the industrial plan, develop research knowledge in this area, and understand how to use industrial revolution 4.0 to production scheduling in companies with more options and subdivisions. De Giovanni & Cariola (2021) explained the plan and culture area and the smart manufacturing facilities class help compensate the assessment model for the capability of creativity and advanced factory that is discussed in the literature. These two factors were frequently used to assess the state of manufacturing companies. The first one involves a technologically-based smart factory solution, it asks whether a company is supplied with the appropriate hardware, software, and configuration settings, as well as if it has adequate operational capacity were displayed by Benitez et al., (2020).
Ciliberto et al., (2021) showed that Industry 4.0 utilizes a variety of trying-to-cut technologies and tools as was discussed in the previous section, assisting help rethink classic manufacturing processes. As per Oliveira-Dias et al., (2022) more digital, automatic, and agile in their activites, supply chains are making important strides. In order to create accessible, flexible, and chain reactions in many phase of SCs, including production, sourcing, planning, product innovation, shipping, and advertising, current online SC connection that make use of a variety of technologies are displayed by Ghadge et al., (2020). The impact of 4.0 can be evident in supply chain management (SCM) strategies and at various levels of SCs. Improved circulation and enhanced track-and-trace of materials and goods lead to improved forecasts and planning. better supplier performance as a consequence of real-time exchange of information, provider management, sophisticated goods storage, and path optimization systems.
Ding et al., (2020) conveyed that the companies must reevaluate how the SC system is designed in view of the instability put on by digitalization. Ivanov & Dolgui (2021) explained the competition in supply chains is driven by the openness and availability of a wide range of choices for what and when to purchase, in addition to where to shop. These elements are made possible by e-commerce sites. Especially, Sharma et al., (2021) mentioned the Internet of Things (IoT) has a massive effect on the conversion of SCs by giving a large variety of possibilities including distant and real-time surveillance of position, condition of fresh produce via temperature measurement, status and performance of equipment, etc. Evaluating the impact of Industry 4.0 classification on the SC connection level is essential due to the growing significance of stakeholder involvement and enhanced communication between SC condidates. Industry 4.0's Smart Supply Chain criteria includes retailer, partners, digital platforms with suppliers and customers. Available information transfer and operation coordination between SC members aid in lower fee costs and increasing the efficiency and responsiveness of SCs as a whole. Increased trust and better connections amongst SC partners are also consequences of the SC network's greater transparency and teamwork.

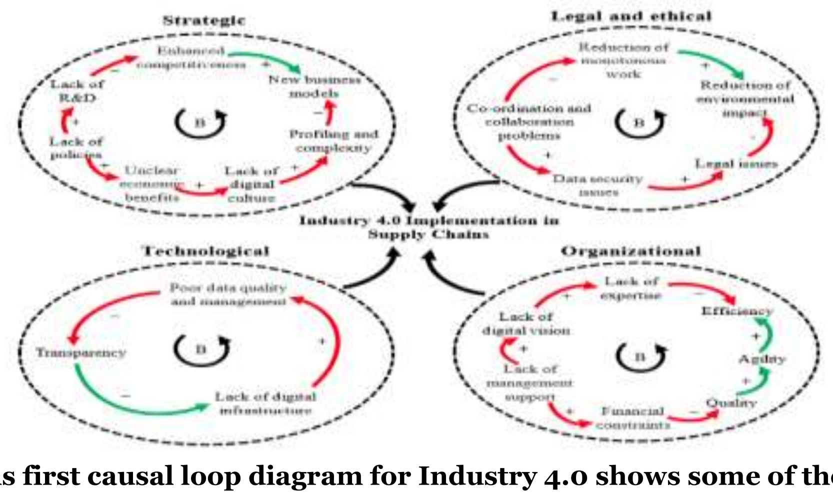


Figure 1: This first causal loop diagram for Industry 4.0 shows some of the possible drivers and roadblocks in the field

The value chain's overall performance is enhanced, and risks are minimized, due to Industry 4.0- allow capabilities with more structured interrelated and real-time control and monitoring of goods, machinery, and SC variables. As per Di Maria et al., (2022) the use of Industry 4.0 technologies also results in changes to these networks' organizational structures and management approaches. In contrast, Soni et al., (2022) showed the requirements and trends operate supply chain digitalization, the altering business environment, and the trend in respect of digitalization are also producing new obstacles and dangers. These problems have included lack of competent workers, lack of data, a risk to data security etc. Consequently, Naseem & Yang (2021) explained that conceptual frameworks and empirical studies are required to assist businesses to create effective and reliable Industrial 4.0-adapted distribution networks and adjust quickly to quickly shifting markets and technologies. Decreasing plan cycles and freezing times by more rapidly reacting to changes in need, supplier, and price are just a few examples of how companies may be flexible and agile in answer to constantly shifting conditions according to the introduction of Industry 4.0 in supply chains. The ability to predict future trends and events such as consumer habits, time delivery, and industrial output, is given by business intelligence approaches. Logistics operations may be adaptable, economical, and agile due to real-time delivery routing and tracking.

The knowledge about almost everything happening outside must be available to us all in one go because of the time and place wherein we find ourselves. Customer behaviour influences agility. This is evident by Saldivar et al., in 2016 that Industry 4.0 is now under growing pressure from customers. The apparent impediments and accelerators could have an effect on a company's ability to adopt a fresh launch. According to Shao et al., (20121) a new initiative can be encouraged by catalysts or drivers while still being hindered by impediments or barriers. Industry 4.0-enabled companies require qualified manpower, but there is now a lack of adaptability among technical colleges, institutions, and companies that must engage in teaching young employees and staff for the factory of the coming days. Raj et al., (2020) displayed that another barrier or obstacle to Industry 4.0 is a lack of the necessary expertise and exact knowledge. The lack of rules regulating the involvement and advancement of cloud computing, virtual reality, cyber-security, and intelligent systems in all developing nations is the barrier or obstacle to the affecing of Industry 4.0. The Covid-19 era's developments and changes to social and economic life have also generated policies that assist industry digitization. People require tasks fast and simply since they lack sufficient time, and modern digital technologies offer only that. Kayikciet al., (2022) showed that Industry 4.0 is built on top of an upgraded Hi-tech Plan, and a number of the most current and desired innovations are also what drive its expansion. Impacts geared to deploy Industry 4.0 technologies face additional obstacles such as enough development and research practices, an absence of infrastructure, faulty data, a lack of a digital world, and a loss of partner trust. based on conversation with two experienced specialists and a thorough review of the literature on the execution of Industry 4.0 at both the business and SC levels. SC managers need to rethink their perception of and attitudes towards Industry 4.0 by taking into consideration both its motivators and implementation barriers in order to effectively digitally transform supply chains.

Industries are hesitant to adopt Industry 4.0 as they are unsure of the word, inexperienced with it, and unaware of the benefits of digital transformation. The expansion of business networks and markets has led to an increase in the sophistication of management and operational systems. Companies are more hesitant to adopt Industry 4.0 technologies as a consequence of their lack of experience managing global data and the newest technical advancements.

3.2 Effect of Industry 4.0 on supply chain systems

The concepts of smart manufacturing and smart logistics are assuming to have the influence on the structure of supply chains. According to the digitization of all supply chains, their implementation will have an impact on the entire supply chain from a technological and structural viewpoint. Overall, the Fourth Industrial Age had four major effects on business: altering consumer expectations, enhancing performance, encouraging cooperative creativity, and changing organizational structure.

As explained by Fatorachian & Kazemi (2021) due to the substantial integration that will come from this change, there will be major production advantages that will present to the development of better manufacturing. As per Benitez et al., (2021) proper implementation will evaluate based on profitability, cost reduction, increased reliability, good management control, and higher productivity. Industry 4.0 calls for a substantial shift in all aspects of business operations. To bring about its shift, a set of economic contributions and considerable planning are necessary. Competitive strategies that necessitate an active approach to reactivity and diversity in every part of supply chain operation are essential since many companies are striving to be at the forefront of their industry in the real revolution. Industry 4.0 has been facilitated by the usage of technologies in both business surroundings and production. Garay-Rondero et al., (2020) displayed this concept of a digitalized, interrelated to the world that includes extremely associate single, trustworthy customers, and adaptable constructive model. The new era has made it practical for supply chain activites to be fully promptly because employees are always related to up-to-date facts via delivery plan, application software, supply and other required tools for timely utilization to and exchange of information. The current transformation will help enterprises rapidly adapt to constantly shifting trends in supply chain operations, concentrating on customer behavior, and reacting both to unpredictable and predictable daily operations at all stages.

According to de Vass et al., (2021) the effects of Industry 4.0 will be felt first in the supply chain. With the advent of this new industrial standard, manufacturing will be dispersed and digitized, with production elements capable of identifying themselves, starting processes, and reacting to changes in their surroundings. Additionally, Rai et al., (2021) explained the emerging paradigm encourages complete product and process convergence, changing the industrial vision from large production to customization, leading to an increase in the complex. As a result, trying to cut technologies and the development of smart factories will have a big impact on manufacturing and operations, allowing for more operational agility and more successful resource efficiency. The supply chains, industries, and production systems will all be greatly affected by Industry 4.0. The old approach usually used in manufacturing organizations is time-consuming and fundamentally based on estimates regarding different quantiles, which has never ensured optimum in terms of replacement approach. Inventory management is mainly part of the supply chain. For perfect inventory control in the age of the fourth industrial era, it is essential to use AI technology that's also concentrated on deep boosting learning, where the learning process is continuous, the procedure is rapid, and no perception are required. Considering the chance of a gradual agreement.

Figure 2: Comprehensive research and development structure for optimising stock-keeping systems

The manufacturing sector has reached a turning point in which technology can increase labor and employment productivity of employees even while enhancing the further expansion of their educational qualifications, according to Strandhagen et al., (2022) came to the result that there is a big effect of the shift to Industry 4.0 on the increasing need for new knowledge and skills in order to increase productivity. As a result, as the Industry 4.0 period has started, the expected growths of examined manufacturing indicators indicate that the negative effects of digitalization in the recent past were just transitory. However, further restrictions are required to encourage long-term growth prospects. The IoT and computer systems work well together. Intelligent machines can collaborate with humans to carry out basic assembly tasks in the industrial sector. Additionally, machines can function autonomously, communicate with production systems, and use the IoT to independently solve complicated problems and make decisions. This will have a big impact on how business is conducted in the upcoming days. For example, quick application development and enhanced production methods will make it very simple for customers to purchase any kind of product without experiencing a big price increase. These advances will significantly lower the cost and time involved in the design and engineering of the production process while encouraging simulation and initiatives running across a whole supply chain.
Real-time supply chain monitoring is a characteristic of Industry 4.0 supply chains. They are capable of pinpointing the location of things in transit, on order and in a warehouse. By mixing with IoT data with changes from supply chain members, advanced solutions enable inventory management simple. Big data evolution is a branch of digital method that has been recognized in academia as being quite complex and useful in supply chain operations. A study by Ivanov & Dolgui (2021) that investigated the analysis and application of big data in the retail channel acts as a suitable reference. The investigation was carried out using a price optimization technique as businesses work to boost their sales, profitability, and share price. This technique has also been demonstrated by Yu et al., (2021) to be a common technique in transportation and logistics. Transport and logistics, warehousing inventory systems, routing optimization, and workplace safety are some areas where big data analytics has been utilized in supply chain management. Big data will give good tremendous opportunities

for consumers, enhancing consumer service, making new logistical models, and decreasing system risk.
Aceto et al. explained in 2020 how the high-level computing technology known as cloud computing can manage and store vast quantities of information in a way that allows enterprises a greater possibility of developing and operating in a bigger range. Based on cloud computing technology, supply chain design and processes can be acquired, analyzed, and stored for later use. According to Eslami et al., (2021), the 4th industrial revolution's next and most powerful paradigm and driver of manufacturing will be cloud manufacturing. Data sharing and exchange can be easily facilitated by cloud computing, which enables hard decision-making in manufacturing process. Smart computing is the basis for Industry 4.0 establish success, and cloud-form production is a necessary element.

3.3 Impact of Industry 4.0 in Automotive Industry

Henry Ford, the founder of Ford Motor Company, introduced the assembly line technique of mass production and manufacturing in 1913. This marked the beginning of a time in which the automotive industry underwent significant transformation. Llopis-Albert et al., (2021) stated that since that time, the primary emphasis of the automotive industry has been on developing forward-thinking manufacturing methods in order to break through quality and innovation roadblocks on the path toward making automobiles a dependable means of transportation. Today, there was a significant shift in the way that vehicle industry is conducted. The potentials of industry 4.0 are pushing significant transformation throughout the whole of the value chain involved in the production of automobiles (Bai et al., 2020). Beyond optimization and automation, the primary goal of industry 4.0 in the automotive sector is to make the entire manufacturing process more customer-centric and efficient in terms of logistics management. This objective is in addition to the goal of making the manufacturing process more efficient.

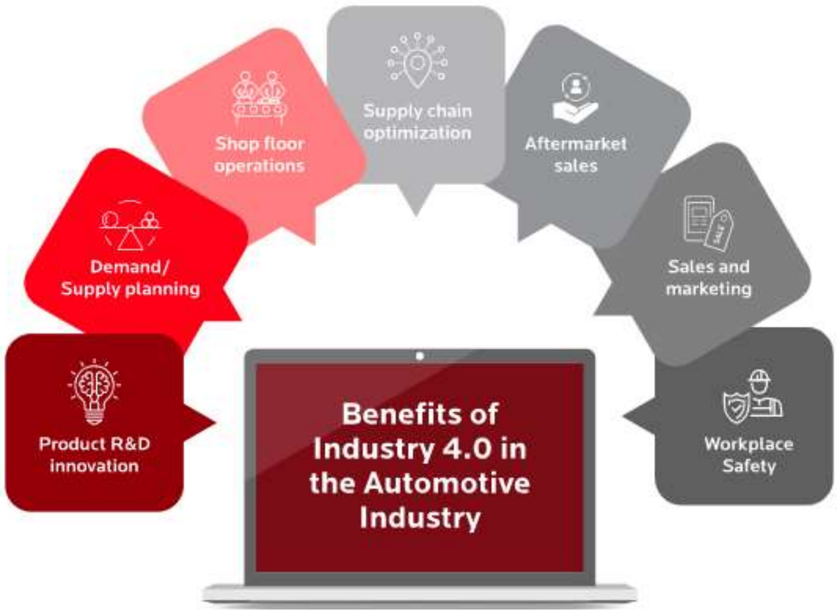
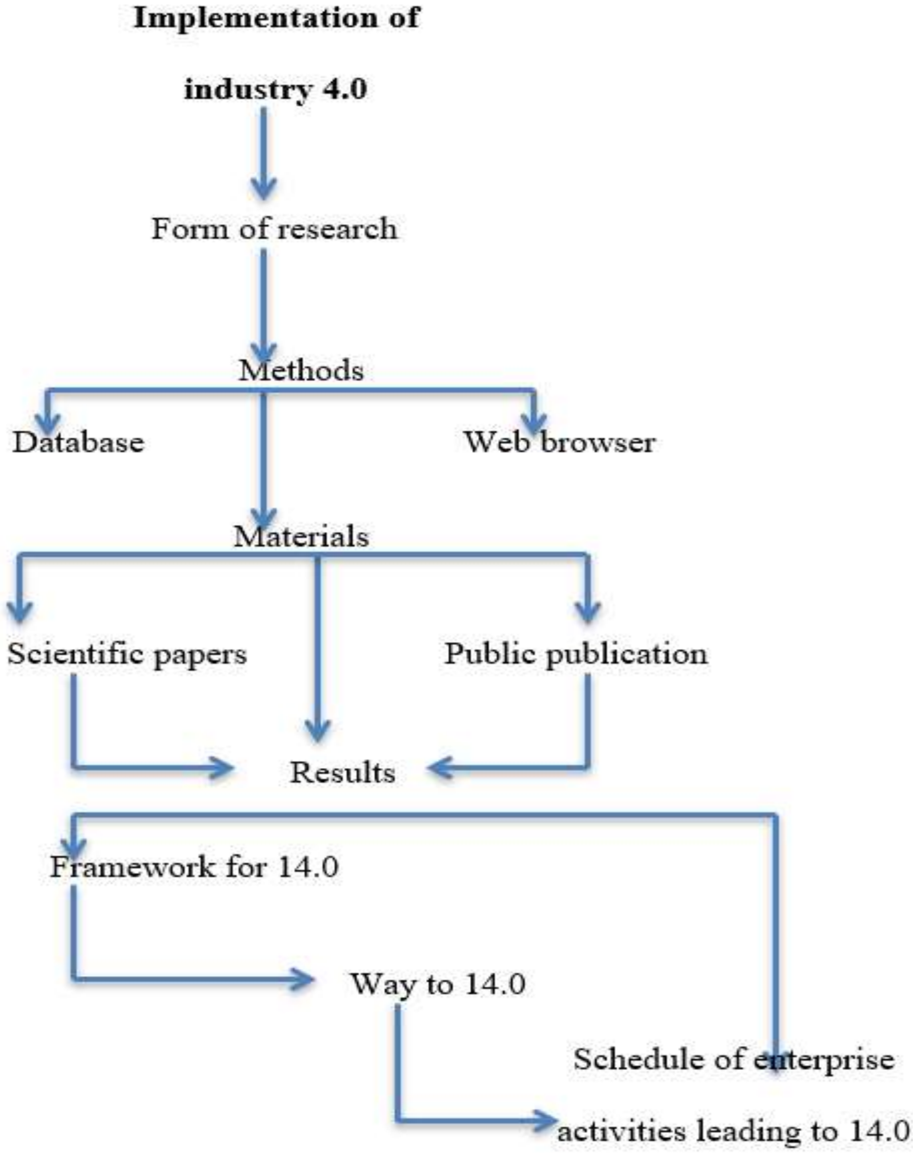


Figure 3: Benefits of industry 4.0 in the automobile industry

As a result of utilising the cognitive potentials of technologies such as artificial intelligence, digital twins, robotics, and cloud computing, businesses across the value chain of automotive manufacturing and original equipment manufacturers are becoming more efficient in their production processes, more flexible in their business operations, and more responsive to the engagement of their customers. Nagy et al., (2018) stated that an investigation of the sector found that by the end of 2022, 24% of manufacturing facilities owned by automobile manufacturers would be considered "smart." In addition, the report reveals that 49% of automobile manufacturers have already invested more than 250 million dollars in smart manufacturing. According to these statistics, the automotive industry is keen to implement the technologies of Industry 4.0. The automotive industry stands to gain in a number of different ways from the introduction of Industry 4.0 technologies (Ghadge et al., 2020).
The automotive industry has been successful in a wide range of areas, including the innovation of processes, the production of value, the reduction of risk, and the optimization of costs. The fundamental driver of technical innovation in the automotive sector is the ever-evolving behaviours and expectations of the industry's target customers. As per Ungerman et al., (2018) manufacturers are now able to keep an eye on production in real time and engage in two-way communication with their customers thanks to the networked ecosystems made possible by Industry 4.0. The increased capability of original equipment manufacturers (OEMs) for two-way communication with their end users enhances their ability to anticipate and react to consumer requirements,

ultimately leading to an improved customer experience and fewer bottlenecks in production and innovation.
Industry 4.0 covers the way for the automotive industry to swiftly adopt the efficient and versatile methods and techniques of manufacturing without the lack of real-time data, restricted product customization, and struggles with using upgraded machinery that pose significant challenges in conventional manufacturing. According to Helper et al., (2019) the manufacturing ecosystem is having an effect on the management practises of automobile manufacturers, encouraging them to adopt a more proactive approach to the management of their production processes by using automated monitoring systems. Automated monitoring is made possible by technologically advanced, interconnected systems and sensors. This makes it possible to aid in the anticipation, avoidance, and reduction of maintenance issues, production downtime, and isolated logistics.
Industry 4.0 supports strong collaboration between automotive R&D centres, production facilities, supply chains, and other firm activities via the use of real-time data and cognitive intelligence. Communication between the various regions of the plant and between the many departments located on the factory floor itself is what makes efficient operations management feasible (Ligarski et al., 2021). Customers in this day and age have a strong desire for vehicles that have been customised, which is not achievable with the traditional way of producing automobiles. The implementation of industry 4.0 will make it possible for automobile manufacturers to rapidly adjust processes for the production of individualised vehicles and to maintain time-to-market parity with manufacturers of mass-produced automobiles.

3.4 Research Framework



4. Research methodology

4.1 Tools and techniques

As a part of this transformation, the human interface has to become more dynamic and live, and all processes that are now mechanical or manual need to be digitised. Production planning is the backbone of day-to-day operations in any business, and keeping them under control is a monumental undertaking that requires support from beyond the domain of human beings. Within the scope of this investigation, we use a Fuzzy COPRAS method for the analysis of the most significant readiness criteria after conducting a Delphi study involving the industry's most prestigious automobile manufacturers (Shaikh et al., 2020). This article provides an analysis of the relative influence that a number of different readiness factors have in connection to the implementation of Industry 4.0 in production planning and control.

An exploratory study project to examine the potential of Industry 4.0 will be carried out inside the Indian Automobile Manufacturing industry. Reading this will directly result in you gaining a better understanding of the challenge that is preventing the implementation of I4.0 at the moment. A strategy that utilises a variety of research approaches is employed in order to achieve the objectives of the study (Ren et al., 2014). By engaging in brainstorming sessions and conducting polls with a panel of experts, one may utilise the Delphi approach to arrive at a choice that is acceptable to the group as a whole. The use of a fuzzy tool has the potential to improve upon the characteristics of human vision that are characterised as being subjective, vague, and foggy.

Fuzzy COPRAS method is selected for current research as it helps to evaluate performance and also supports to measure the total productive maintenance. The current study is based on analyzing the implications of Industry 4.0 adoption on real-time supply chain operations so in this context this method helps to measure the performance and operations of the organization. This research is basically used when the research is related to business operations as it effectively evaluates the productivity and performance.

In addition, the inclusion of measurable indicators will allow the instruments of MCDM to assist in evaluating how relevant each criterion is in comparison to the others. For the purpose of this inquiry, a systematic literature review, a fuzzy Delphi study, and a fuzzy COPRAS were used. The objective that was determined as a result of looking into the published works on production planning and control with a view toward putting Industry 4.0 into practise has been described in this manner (Aghdaie et al., 2013). The aforementioned objective will be investigated utilising the Fuzzy Delphi methodology as well as the Fuzzy CoPrAs technique. Both of these methods involve doing an extensive literature review in order to discover pertinent readiness components.

4.2 Fuzzy Delphi Method

It is a hybrid approach that incorporates aspects of both the Delphi method and fuzzy set theory (1993). Including FDM into a group decision enables the fuzziness of common understanding to be addressed via the use of expert opinion. This is possible because FDM allows for the consideration of several perspectives. The FDM is put to use in order to produce a fresh collection of weights which are determined by a variety of criteria (Padilla-Rivera et al., 2021). Anonymity, controlled feedback and iteration, and statistical group response are the three aspects that make up the Delphi approach, which is used to collect the opinions of subject matter experts. In spite of the fact that it has earned a reputation for simplifying the comprehension of the conclusions reached by groups by providing participants with a pair of questionnaires that are similar to one another, the Delphi method does have some limitations.

By integrating fuzzy theory with the Delphi method, fuzzy decision making (FDM) provides researchers with the additional advantage of spending less time and money on surveys. In this investigation, we utilise fuzzy data modelling to investigate the decisions made by groups and display the attributional components that are present throughout the process by combining fuzzy theory with triangle membership functions. The use of fuzzy theory may be used to determine how well you understand the world around you by consulting a variety of experts and considering their points of view (Bui et al., 2020). When a relevant or adequate measurable data base is not available, such as in the case of assessing the feeling for a new product for market launch, traditional statistical and forecasting techniques and models cannot be used.

One example of this scenario is determining how consumers will react to the introduction of a new product. In order to arrive at an estimate for the market, the research forecaster is forced to rely on less definite facts, such as anecdotal evidence or the judgement of industry professionals. Models that do not rely on data from the past to form their basis are known as qualitative forecasting models. The original Delphi approach was updated and improved upon to create the Fuzzy Delphi Method (FDM). The FDM is a separate alternative to the Delphi method, which is founded on mathematical concepts, when it comes to dealing with ambiguity in the decision-making process (Hernandez et al., 2019). The Fuzzy Delphi Method (FDM) was developed by academics who took into consideration the linguistic preferences of individuals throughout the decision-making process by combining fuzzy theory with the traditional Delphi Method.

The Delphi approach involves carrying out a number of processes, one of which is soliciting the involvement of a group of knowledgeable individuals, in order to reach a conclusion or come to a decision as a group. The experts are polled many times, and after each round of polling, the findings are analysed and discussed with the original group of people who participated. After each round, these experts may alter their responses based on how at ease they are with the "group answer" that has been provided to them. A true consensus of the panel's viewpoints is the result of numerous rounds of debate and is referred to be the final decision. To get the most

accurate membership function fits, the new fuzzy Delphi technique makes use of the tools and methods offered by fuzzy statistics (Mabrouk, 2021). This is done in order to make use of triangular fuzzy sets. Because of the massive volumes of information that are already available to us, it is possible for any industry to confidently implement the ideas of Industry 4.0.
Fuzzy calculation steps
To begin, a hierarchical diagram has to be created.
Second, in order to utilise fuzzy numbers in the pairwise comparisons, they will need to define fuzzy numbers.
Third, while creating a comparison matrix of pairings, utilise fuzzy numbers wherever possible.
The following is a formula that may be used for the pair-wise comparison matrix:
A triangular fuzzy number is one of the components of a full pairwise comparison matrix that is used in the fuzzy AHP approach. The first component, denoted by the letter l, represents the fewest comments, the second component, denoted by the letter m, represents the mean of the numbers, and the third component, denoted by the letter, represents the greatest number.
In the fourth step, they will find the value of each cell in the pair-wise comparison matrix by using the formula that is provided below.
I is used to indicate the row number, while j is used to indicate the column number. A fuzzy triangular number of a pairwise comparison matrix is used in the formula. You may determine what and are by using the relevant formulae, which are as follows:
In the computations described above, the first, second, and third components of the fuzzy numbers are used, respectively.
Fifth, establish the sizes of and in comparison to one another.
If and are two fuzzy triangular numbers, then the magnitude of with respect to may be defined as shown in the following graphic. If and are not two fuzzy triangular numbers, then the magnitude of with respect to cannot be determined.
On the other hand, the following formula may be used in order to calculate the magnitude of a triangle fuzzy number, provided that k is also a triangular fuzzy number.
Calculate the relative relevance of each of the criteria and the alternatives in the pairwise comparison matrix as the sixth step.
To do this, you may make use of the formula below:
The weight vector, which has not been normalised, may thus be stated as:
The 7th STEP is: Find out what the maximum weight vector is.
After the computation of the intermediate weight vector and its subsequent normalisation, the final weight vector may be calculated via the following methods

4.3 Relevant literature

This study has generated a significant number of readiness criteria based on a comprehensive review of the relevant literature by using a technique called the Delphi method. After being organised according to the parent group to which they belong, these variables are then presented in the form of questionnaires to a large number of experts in order to determine which readiness aspects are the most pertinent (Pandey & Pandey, 2021). There are approximately ten overarching groups that have been established. Some of the topics that these groups cover include "capacity planning for driving and execution," "strategic decision for planning and execution," "involvement of leadership decisions for planning and execution," and "recruiting and developing right talent for driving and execution."

4.4 Sampling method

Even though systematic sampling is very similar to simple random sampling, it typically requires much less effort on the part of the researcher. Rather than assigning numbers to members of the population at random, specific individuals are chosen according to a predetermined schedule.

5. Findings and Discussions

While examining likert scale it was found that For fuzzy Delphi, 18 decision makers were taken into account, and their answers to each of the 182 readiness factors were written down in a column and given a rating scale as shown in Table-2, where Strongly disagree is 1, Disagree is 2, Not sure is 3, Agree is 4, and Strongly agree is 5.
While examining at the Triangular Fuzzy scale matrix, it was discovered that the outputs given to each of the 182 readiness factors are based on the fuzzy sets listed in Table 02. Strongly disagree is 0.0, 0.1, and 0.2. Disagree is 0.1, 0.2, and 0.4. Neutral or not sure about the decision is 0.2, 0.4, and 0.6. Agree is 0.4, 0.6, and 0.8. Strongly agree is 0.6, 0.8, and 1.0. For further fuzzy calculations, these fuzzy sets will be used instead of the rating scale. For each Readiness factor decision made by 18 decision makers, the average of each column is found and written as m1, m2, or m3.
While examining at the Threshold matrix, the value "d" for all 182 readiness factors was found to be 0.313. This was found by doing an in-depth literature search. Using the criteria of d0.2 and expert group consensus of 75%

or more, we came up with 21 readiness factors that were declared to be the most likely readiness factors for putting Industry 4.0 into practice in Production Planning and Control. The value of the construct is found by defuzzifying the fuzzy matrix with the threshold value formula and then taking the average of each column to find the threshold for that readiness factor and rating them with group consensus.
In order to look at the Fuzzy Delphi results, it was found that 18 different experts thought that the sales and marketing, capacity, and governance readiness factors were the least important or did not matter at all when it came to putting Industry 4.0 into production planning and control. After the Fuzzy Delphi Study was done, 182 readiness factors were whittled down to 21 readiness factors, which were named the most important factors and are shown in Figure 03.
While focusing at the results of the Fuzzy Delphi study on readiness factors, it was found that the list of the 21 most likely readiness factors out of 182 readiness factors came from a thorough review of the literature and calculations using the Fuzzy Delphi method. These 21 readiness factors are the most likely and most important ones for putting Industry 4.0 into practice in Production Planning and Control. These readiness factors can be used to plan future production, where digitization will play a very important role.
While focusing at linguistic variables, we took the linguistic variables from the Fuzzy Triangular Number Matrix, which has three points. The rating scale goes from Very Low to Very High, with Very Low having 0.0, 0.0, and 0.17 and Low having 0.0, 0.17, and 0.33. Medium Low is 0.17, 0.33, and 0.5, Medium is 0.17, 0.33, and 0.5, Medium High is 0.5, 0.67, and 0.83, High is 0.67, 0.83, and 1, and Very High is 0.83, 1.0, and 1.0. These fuzzy sets will replace the rating scale used by the Fuzzy CoPrAs Method to rank the most likely readiness factors found by the Fuzzy Delphi study.
While focusing on Linguistic variables-2, it was found that the rating scale from VI to VU describes from Very Unimportant (VU) to Very Important with three vertices as Very Unimportant with 0.0, 0.0, and 0.25, Unimportant with 0.0, 0.25, and 0.5, Medium Important with 0.2, 0.5, and 0.75, Important with 0.5, 0.75, and 1.0, and Very Important with 0.75, 1.0, and 1.0. These fuzzy sets will replace the rating scale for future fuzzy CoPrAs calculations to find the parameters for rating the 21 most likely readiness factors.
Triangular Fuzzy set-2 Each group has its own set of Triangular Fuzzy numbers, which will be used in the Fuzzy Copras method to find the best readiness factors for putting Industry 4.0 into practice in Production Planning and Control.
For the Fuzzy Complex Proportional Assessment method to work, it needs a fuzzy set of linguistic variables that can be used to figure out which readiness factors are most important and how much weight they should have. The evaluation includes a survey of five senior leaders in different Indian auto industries. This helped this study build a Decision matrix and a Weighted matrix.
For Industry 4.0 to be used in production planning and control (PPC), a study needs to be done to create the framework from which any industry can start its journey toward Industry 4.0 in PPC. After careful analysis and using the MCDM method, the study's ranking of the best readiness factors was finalized. At first, the study came up with 182 readiness factors for the Delphi study. After multiple rounds of the Delphi study, the number of readiness factors was cut down to the 21 most preferred ones. For the MCDM method, the Fuzzy CoPrAs method was created to rank the most important readiness factors. With 18 experts from different Automotive Industries and their survey reports as Decision Makers (DM), the study came to the conclusion that digitizing the supply chain should be the top priority for any industry that wants to use Industry 4.0 for planning and controlling production. The second rank was given for the availability of Industrial Internet of Things, which helps collect data digitally through scanners, barcode readers, etc., to support the digitization of Supply Chain. The third rank was based on the availability of Hardware line data storage, such as clouds, hard drives, supercomputers, etc., for connecting IIOT and Digital Supply Chain. The fourth place was given to IT Integration software for IIOTs, which we try to include in the digital supply chain from different locations and different parts that have been put together for Industry 4.0 implementation in Production Planning and Control. Fifth rank was given to Collaboration network for all parent and Tier1 and Tier2 industries to alarm the on-time feedback and feed forward for implementation of Industry 4.0 in Production Planning and Control. Sixth place was given to data-driven services for industries, such as sharing changes to schedules, drawings, feedback on deliveries, priority changes, linking purchase orders based on the order of building vehicles, etc. The seventh rank was determined by evaluating the industry's skills in upgrading to a digital platform so that vendors could know the latest live rollout for their production planning and shipping. Parent plant knows the limitations of each supplier and makes changes to the plan based on that information.

6. Conclusion and Recommendations

6.1 Conclusion

As a part of this study, the researcher undertook an exhaustive literature review in order to uncover a total of 182 preparation criteria that have some influence on, either directly or indirectly, the implementation of Industry 4.0 inside PPC. These criteria may be broken down into four categories: In the second step of the process, the researchers used Fuzzy Delphi to determine which of the approximately 182 factors that had been identified previously through extensive literature review were the most important, and then they used the Fuzzy CoPrAs technique to come to a conclusion regarding the classification and prioritisation of the most important factors that should be focused on for the implementation of Industry 4.0 throughout PPC.

These ratings would be of use to any industry in getting a fast start on their path toward implementing Industry 4.0 inside PPC. This research has prioritised, and highlighted, just those variables that are important for the early stages of adopting Industry 4.0 in Production Planning and Control. Discovering the elements that would either slow down or speed up the implementation of Industry 4.0 in PPC is a rewarding field of study that should be pursued. A small number of professionals from well-known automakers took part in this study to contribute to the process of narrowing down the specified qualities based on their respective areas of expertise and priorities.

6.2 Recommendations

Supply Chain 4.0 refers to the utilisation of the Internet of Things, the utilisation of sophisticated robots, and the application of advanced analytics of big data in supply chain management. This entails the inclusion of sensors in everything, networks everywhere, automation of everything, and analysis of anything. The introduction of Industry 4.0 will undoubtedly cause a commotion and will force businesses to rethink the manner in which they organise their supply chains. Several new technologies have emerged in recent years, and they are causing traditional modes of operation to become obsolete (Kosacka-Olejnik & Pitakaso, 2019). The playing field is further shifted as a result of megatrends as well as the growing demands of customers.

Not only are supply chains required to adapt, but they also have the opportunity to reach the next level of operational performance, to capitalise on emerging digital supply chain business models, and to transform the organisation into a digital supply chain. The management of supply chains is being strongly influenced by a number of macro developments, including the following: there is a constant rise of rural regions all over the world, with wealth shifting into locales that have not been supplied in the past (Nagy et al., 2018). The strains that are being placed on logistics are being exacerbated by factors such as the need to reduce carbon emissions and the need to regulate traffic for socioeconomic reasons. However, altering demographics are also a contributor to a decrease in the availability of workers, as well as an increase in the need for ergonomic accommodations brought on by an ageing workforce.

7. Research implications

The proposed I4.0 factor stratification model will serve as a basis for the development of a strategy, the implementation of an I4.0 readiness index, and the defining of a course of action for the implementation of I4.0 in the manufacturing industry. In order to avoid drawing conclusions that are too general, however, the implications must be supported by data, the limits of the research must be established, and the constraints of the study must be taken into consideration. Only then can one avoid drawing conclusions that are too general (Kosacka-Olejnik & Pitakaso, 2019). In this study, we define and validate a collection of I4.0 variables that might serve as a roadmap for anybody trying to bring Industry 4.0 to life, including policymakers, researchers, academics, and practitioners. These groups include those who are actively striving to bring Industry 4.0 into existence. This article presents the groundwork that must be done in order to develop an I4.0 maturity model for the manufacturing sector.

8.Future scope

This research has solely focused on highlighting and prioritising the factors that will be most significant in the early phases of integrating Industry 4.0 in Production Planning and Control. A significant amount of unrealized potential lies in the investigation of the factors that promote and inhibit the implementation of Industry 4.0 in PPC (Benitez et al., 2020). This survey was carried out among the leading vehicle manufacturers, and only a very limited number of industry professionals took part in it. The goal was to determine which of the stated elements were most important to them, based on their past experiences.

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