Collaborative Manufacturing Platform For Industry 4.0

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Abstract

Information and communication technology are undergoing on the rapid development phase,and many innovative technologies, such as the Internet of Things (IoT),artificial intelligence (AI), cloud computing and big data have appeared. Today, advancements in technology are taking place exponentially. The Internet of Things (IoT) need rises; the application of computer technology is becoming ubiquitous. These technologies are filling the manufacturing industry and enable the integration of virtual and physical worlds through cyber-physical systems (CPS), which lead towards the fourth stage of the industrial revolution (i.e., Industry 4.0). Considering the area of Manufacturing, machines and industries are becoming smarter. However, considering the bigger picture, as the society is now thriving for mass-customization, in this work, we propose an operation management system that will enable industries to achieve the goal of "mass-production with mass-customization" which is the next challenge for the industry. The project is on Industry 4.0 the application of Cyber-Physical Systems (CPS) and Industrial Internet of Things(IoT) and in the manufacturing industry to create a platform capable of remote monitoring, intelligent production planning, and autonomous real-time decision making. It intelligently works towards the goal of mass-production with mass-customization and make data-centric decisions using cyber-physical transformations and the Internet of Things.

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***Key words**: IoT,* Cyber-Physical Systems (CPS), artificial intelligence (AI), mass-customization.

INTRODUCTION

The collaborative manufacturing platform acts as a medium that connects the pillars of Manufacturing, which are Customer, Supplier, and Co-Industry. The aim is to enhance the smartness of existing models via incorporating technological enablers and integrating these models on a common platform. The model is specifically designed to serve the needs of attaining the concept of Mass Production along with Mass Customization.

The Collaborative Manufacturing Platform can be designed to work independently without human intervention and advantages being able to monitor, communicate events, and make smart decisions briskly in the future. The system includes the concept of Cyber-Physical Systems (CPSs). However, for the proposed system to function at the foreseen level of intelligence and independence, the system may take years of technological advancement and its implementation. Hence provision is made for an interface to be provided for human intervention. The algorithm can be easily implemented and assessed. More importantly, industries, as of now, can use this algorithm to test the project, dependencies of various factors involved in Manufacturing, and its impact on cost and operation. It provides and an all-in-one tool for optimization and decision making.

The system can is intense and handles the enormous number of factors and engage in their dynamic independencies. The model can be further divided at modular levels. Breakdown of the system at the modular level will yield the following sections:

- Customer-Industry Interaction
- Supplier-Industry Interaction
- Interaction with Neighbouring Industry

Overview of Cyber-Physical System:

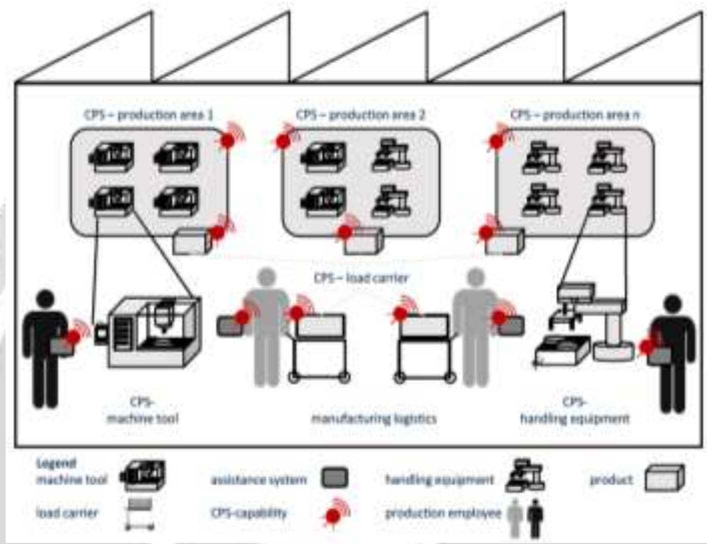

Fig. 1 Production System

Literature survey

Reference papers

Mamad, review the overview of Industry 4.0 meaning, challenges occur during implementation and benefits after implementing the Industry 4.0. He also has given a thorough definition of Industry 4.0 and explains the research methodology behind it. Further, he presents the review for the current and future concept of Industry 4.0 and the connection of humans, objects and systems that forms dynamic, real-time optimized and self-organizing. By implementing Industry 4.0 productivity, flexibility, and quality standards can be increased .

Jeevitha et al. presented and facilitate an understanding of Industry 4.0 concepts and its drivers, goals, enablers, and limitations. The core of Industry 4.0, the Internet of Things (IoT), which the connection among machines, people, and things. They reported basis for Industry 4.0 was the availability of all relevant information at real-time. The execution of the Industrial Internet is a multi-year transformation process. Alsocommented on digital business models which will expand the existing product and service methods to ensure future growth in demand and sales.

Min et al.discussed the significant features of Industry 4.0, and the opportunities, and the challenges of the fourth industrial revolution. They have examined the benefits of Industry 4.0, like a large number of people worldwide are likely to use socialmedia platforms to connect, learn, and share information. Also,a variety of innovative manufacturer and competitors industry will have easy access to digital platforms of marketing, sales, and logistics,so improving the quality and price of products and services offer. They also saidcustomers would be more involved in the production planning process and the distribution process. The primary effects of this revolution on the business environment that it move toward collaborative innovation, and innovations in organizational forms .

Dorleta et al.conducted a review to expand our knowledge about how Industry 4.0 will affects the business model and identify a suitable business model innovation. From the results, they recognise the set of features, issues and requirements for Industry 4.0. They also suggested three different approachesto make firms getting closer to the industry 4.0 phenomenon such asnetworked ecosystems, service orientationand customer orientation.They give even the suggestion of Business Model components for Industry 4.0.

Judit et al. done research onwhat critical issues industry facedto adapt to Industry 4.0. They had sent an onlinequestionnaire to the manufacturing industry and logistical service companies to investigate the Internet of Things tools they were usingand the problems they were facing. They found that sharing of real-timedata across the industry andthe availability of proper analytical methodshave a remarkable impact on the entire industry .

Proposed System

For simulation purposes, we considered a model with a pool of customers that raise the demand, a parent industry, a total of 6 suppliers (3 of parent industry and 3 of co-industry), and three co-industries all having individual characteristic specifications. All the machines are connected. The parent industry produces a single type of product, which is an assembly of 2. The total product comes out after goring through 3 stations. All stations have specified characteristics. Suppliers havedifferent aspects, and raw material hasvariousaspects considered. The distance of each supplier and the neighbouring industry is considered to keep the account for transportation costs. The model is flexible, perfectly suitable for the study of dependencies and the impact of elements in the system.
The model was considered to visualize the changes that this Collaborative Manufacturing Platform will induce in Manufacturing and how variable demand can be dynamically managed and cost minimized.

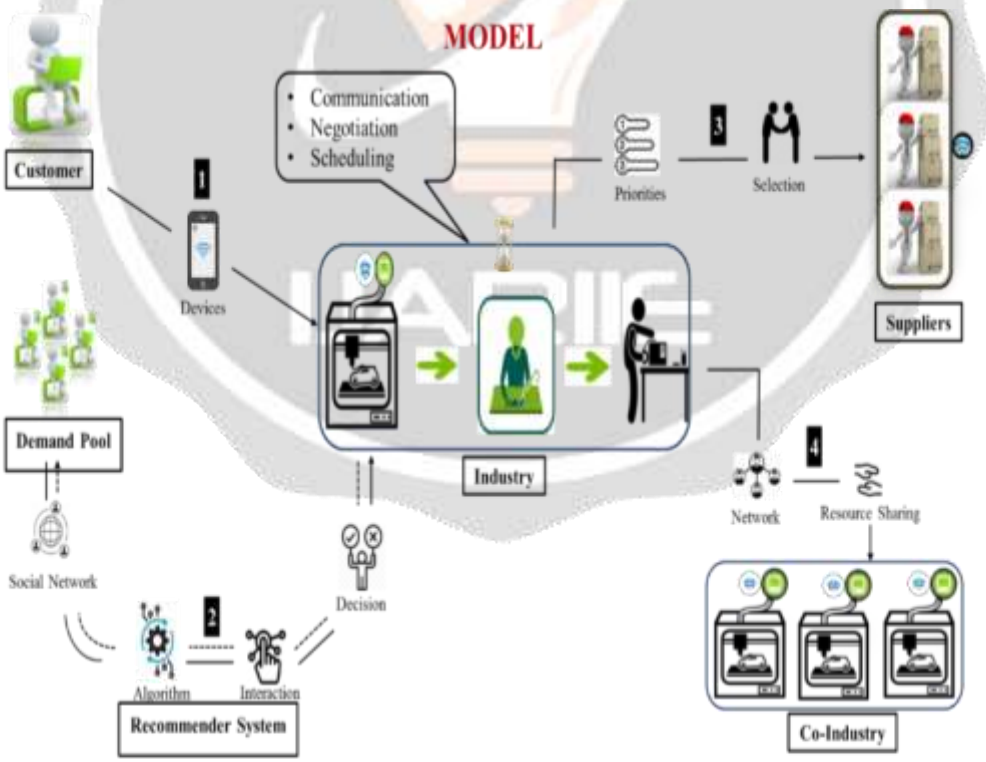

Fig.2. Collaborative Manufacturing Platform

Objectives

Overall Objective

The overall objective is to develop a platform based on "Cyber-Physical Systems" and "Internet of Things" technologies, which help manufacturing industries in faster, and more real-time data-driven decision making and intelligent manufacturing planning.

Intermediate Objectives

- Small or medium enterprise and large manufacturing industry would be interested in adopting this system to increase the demand for their products and hence the profit.
- Industries that provide customization of their products can produce a customized product on a large scale by alluring new customers over the globe interested in buying the same product.
- Customers form the demand pool and the ones involved in this system will be benefited as they can get easy recommendations of the product they want and at a lower comparative cost.
- Develop algorithms for communication between assets, in the cyber network,for operations planning, and demonstrate the feasibility of distributed operations planning for job scheduling.
- Suppliers can have a clearer and dynamic tab on the demand of products industries.
- Other industries would be seeking opportunities to collaborate and expand their business by involving in resource sharing.
- Develop a method and design a system for generalized intelligent group-based communications between assets in the industrial network based on the concept of the human social network, such as Whatsapp, Facebook, etc.
- Software industries would be interested in developing the applications and other software modules, etc. for the proposed system.
- The software can be used to simulate various possible scenarios and for the analysis of dependencies of different factors in collaborative Manufacturing.

Flow Chart

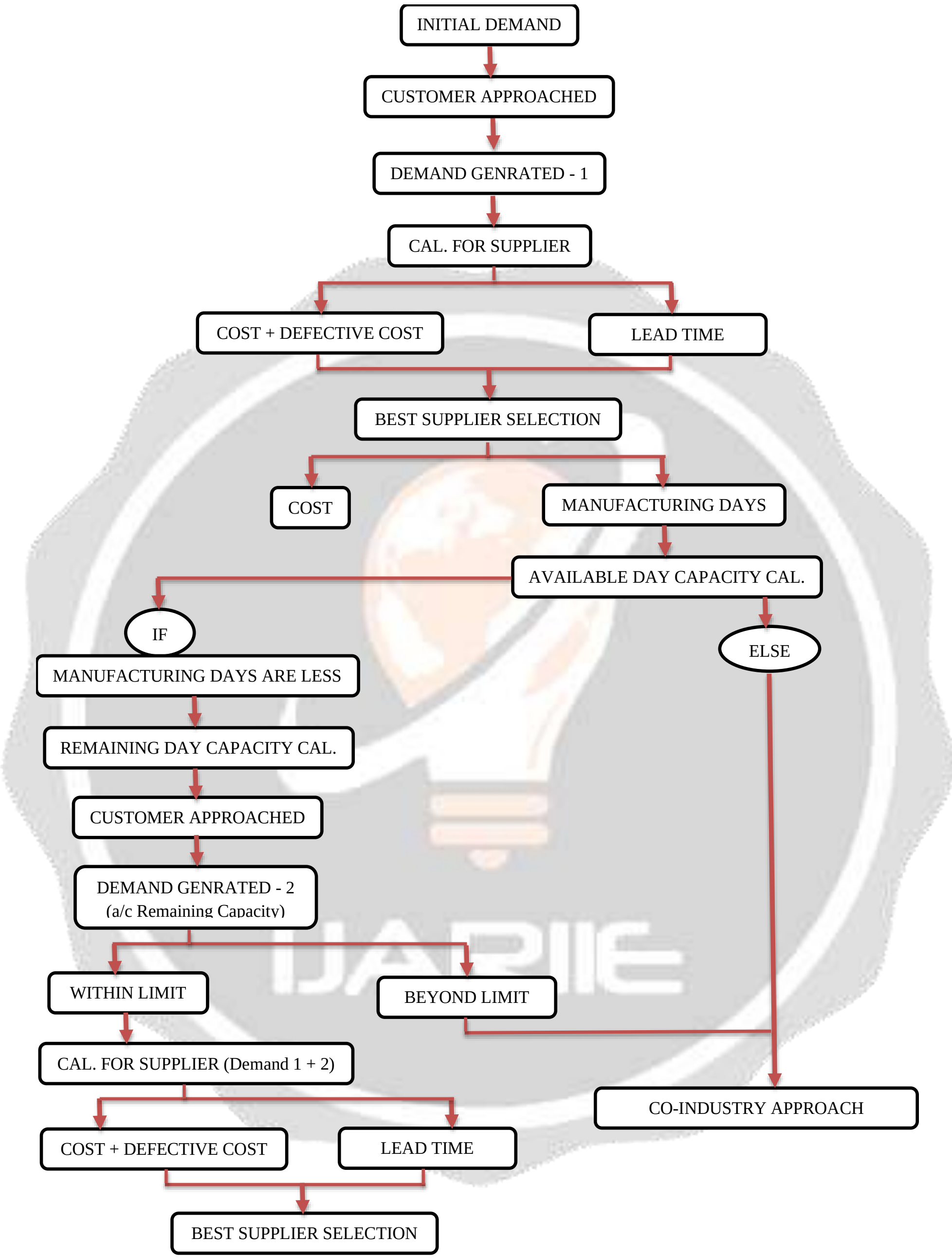

Fig 3 process flow chart working of CMP of both approaches.

Results

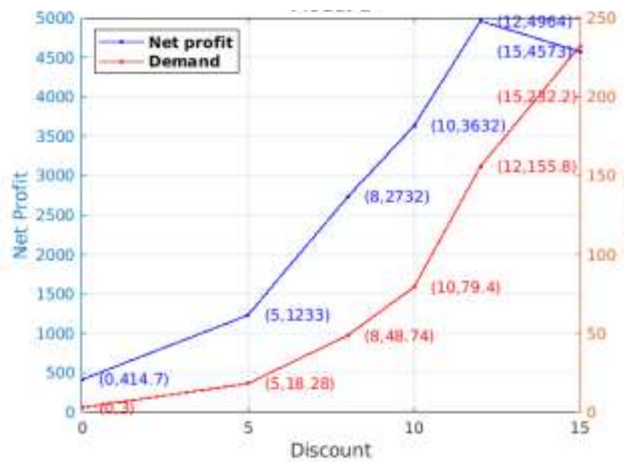

Fig 4. Results of Model 1

Fig. 5 Results of Model 2

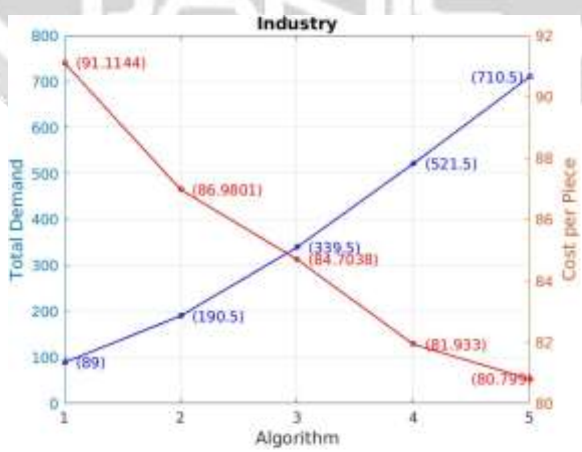

Fig.6. Total demand vs Cost/Product

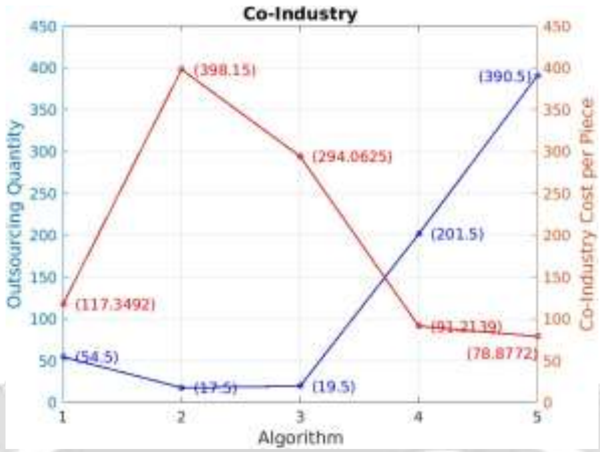

Fig.7. Outsourcing quantity vs Cost/Piece

Conclusion

The system helps in the execution of Industry 4.0irrespective of the preparedness of the infrastructure for this next revolution in the industry. The manufacturing sector is moving towards the fourth the industrial revolution. Cyber-Physical Systems (CPS) and the Internet of Things (IoT) are the primary pillars of this transformation. This work proposes the platform formation of a transient method. Characteristics advantages will get from the CMP include (i) Induced connections between a machine in the industrial network, (ii) Upgradation of the physical machine into a cyber-physical system, (iii) real-time operations planning. Using Collaborative Manufacturing Platform may lead to increased profit in the existing benefit.An overall rise in the number of demand and thus increases the profit for both the customers and industry.

Python programming based simulation has been developed in this work. Typical characteristics of the program include capacity calculation, availability of industry, failure of the machine, defective product, customer probability, cost analysis, real-time scheduling, etc. Cost analysis, according to a smart selection of supplier and co-industry every time is done with the change in demand. The intelligent selection of suppliers and neighbouring industry through the algorithm ensures best possible amalgamation of the lowest cost, best quality and availability.Data and service sharing can make effective use of the loose production resources to enlarge the utilization of the facilities and workforce of the industry, and knowledge sharing between companies can help them aim at their key competencies. The algorithm developed in this work is capable of all the decision-making ability and smart selection of supplier and co-industry. Parameters weightage can be managed according to the industry requirement.

Future Scope

The work can be expanded further by bringing in better and robust models to make predictions.In the present research, the algorithm developed is by considering the single machine and single component. Extending the current research by examining the failure, especially from the maintenance point of view. It will bring more parameters into account. Also, the weightage parameter can be monitored, and the new parameter can be introduced for more advances algorithm can be done and significantly increase the computation complexity.

Eventually, the essential domain of Industry 4.0 research,which increasingly focuses on developing more data collection and data mining to build up a more advanced intelligent operations planning system .

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