Collaborative Manufacturing Techniques: A Review

1 INTRODUCTION

Collaborative manufacturing (CM) involves the sharing of information or collaboration between enterprise processes over internal or external stakeholders to implement a software product to the desired taste of the end user (Winroth & Danilovic, 2003). According to (Chunquan et al, 2006), as it is common in businesses, collaboration is desirable in a non-collaborative model as it assures the developer is on the right track with the implementation. The collaborative inventory management software makes available to both the manufacturers and the suppliers a genuine privilege to attain their aims. To maximize their money flow and enterprise relationship by making use of modern equipment and keeping on the final aim of minimizing costs, this is done through the reduced inventory stages and mobilization costs (Lu & Yih, 2001).

CM is recognized as a business paradigm for more than a decade ago by the advanced research Centre (ARC)-2002 and mathematics engineering science association (MESA)-2004, in which software producers work together and use their professional competencies to attain agility, flexibility, low cost and customer-centric end product.

As technology has evolved, a new algorithm for providing a solution to age-old problems has surfaced. Before this computer age, when standard of living was moderately balanced, enterprise resource planning (ERP) was in high usage, and holly-grail with companies incorporating its plant floor with the ERP system (Choy et al, 2004). This serves as driving force behind this study’s exploration of CMT for exchange of information about engineering products, which is essential for the efficient design, development, and upkeep of high-quality products in the field of engineering using artificial intelligence and machine learning techniques.

To integrate these systems into different plant systems, simple approaches were utilized, and more robust systems started to incorporate bar code readers via terminal emulation (Nagalingam & Fretes, 2009). Integration or simply means inserting all pieces of data into general database. In addition, a few specific data-distribution requirements were singled out, customized, end-to-end connections, and data transformations were generated. Often, this process was achieved using a simple file-sharing technique (Fan et al, 2008). Enterprise application integration (EAI) suppliers started building their products to support business-to-business (B2B) requirements and they recognized that their technology was perfect for B2B integration. Hence, the new type of incorporation/integration technique utilizes plant stage manufacturing management systems to manage, commit, and plan to manufacture according to an actual expectation rather than abstract permutation (Ho & Lin, 2004).
2 LITERATURE REVIEW
This section focuses on previous research works on collaborative manufacturing that have been investigated by researchers and experts (ARC Advisory Group, 2002). CM has been explained by some scientists and researchers, as the coming together of companies to work as a unit, using their professional competencies to produce a software product to achieve the utmost business network results (Johansen et al. 2005), (Mesa International, 2004), (Johansen et al. 2005). The idea of CM is far beyond connecting the plant floor to the internet which is possible through technology (McClellan, 2003). CM is a basic change in the strategic value proposition for producers, a collection of processes, systems and technologies which support and allow producing companies to effectively compete through collaboration with strategic partners (Cai et al, 2004).

Wang in conjunction with Zhejiang School of Business, Wanli University and Institute of Manufacturing Engineering, Chongqing University, examined the networked collaborative manufacturing model based on manufacturing services (Mi et al, 2005). It was concluded that designing and implementing networked CM had become a vital step for recent manufacturing corporations to improve market competition capabilities (Mi et al, 2005). Wang suggested that depending upon the discussion of the idea and properties of manufacturing businesses, a networked CM mode based on the manufacturing services. In addition, some important challenges for networked CM mode were examined in detail, which is itemized below: Semantic-based modelling technique for manufacturing services and Construction strategy for manufacturing services chain.

Therefore, based on the networked manufacturing interface of Chongqing city, the networked CM mode was practiced in a car section manufacturing enterprise and obtained genuine application results (Wang et al, 2008). Also, (Zhou & Wang, 2009), researched the integrated collaborative manufacturing management system for a complex product. It was concluded that they put ahead a workshop on real-time incorporated, CM management devices for advanced software, based totally on the analysis of the necessities of collaborative digital management for complex software implementation. According to (Zhou & Wang, 2009), they first examined the components and software framework. In addition, they then deeply examined. Dynamic job management is fundamentally based on workshop real-time information, Manufacturing resource management and Real-time control technology.

Based on the examination, the equipment was developed and tested in a car-engine production lab and achieved appropriate software effects (Zhou & Wang, 2009). In (Guixian & Qingsheng 2008), they worked on enterprise interoperability hub (e-hub) incorporation to enhance CM information software. In this paper, they surveyed the lookup in the place of e-hub (Qingsheng, 2003). They equally analysed enterprise surroundings and discussed the manufacturing information system (MIS) design and implemented the proposed platform based totally on an e-hub (Kaplan & Sawhney, 2002). The e-hub facilitated engineering collaboration and extended the capabilities and strength of its enterprise stakeholders with joint engineering information and community manufacturing resources of engineering service providers (ESPs) through the provision of engineering carrier brokerage (Li & Xie, 2005).

Lastly, it was concluded that as a result of the partnership with RosettaNet, the SMEs could clear up their complicated engineering duties and engage in projects which are far beyond their strength. In (Xie et al, 2021), they researched an intelligent CM mechanism with full-processing parallel interaction based on data-driven. Based on the cloud of smart manufacturing operation platform (COSMOPlat), this work proposed an intelligent collaborative manufacturing mechanism to understand the parallel interactive smart collaborative manufacturing with customer centric. The mechanism was supported by using three basic technologies: large-scale customer information processing, emotion modelling and statistics processing structure primarily based on distributed parallel computing model. It was also suggested that in future work, they would consider deeply refining the emotion classification mannequin primarily based on customer categories, which would assist manufacturing enterprises to respond to customer demands greater,
shortly and accurately, to improve the interaction impact of purchaser feedback.

In (Wuling & Ningning, 2010), they worked on the implementation of a CM business interface based on workflow technology. Wuling achieved the implementation of the CM business platform which was a new software model originally based on workflow technology. Wuling’s software’s goal was to acquire interoperability between businesses, and it was also to make sure that there exists an easy flow of data between those businesses (Qinning & Meichun 2000). The implemented support software program had to be heterogeneous, distributed and swiftly adapt to alterations in an incorporated software program structure league. A cross-inter-business workflow model to proffer a solution to the aforementioned challenge was proposed. The proposed model utilized the modelling method according to the process decomposition and dynamic allocation or partition of activities by way of the position and then suggested a 3-tier figure to back the mannequin architecture to support businesses in the cognizance of CM. Wuling utilized CORBA, Agent, XML which is a distributed workflow, and other relevant applied technologies in the software integration to build this platform.

According to (Ying and Lijie 2007), who worked on a novel collaborative control strategy for CM, it was concluded that the desired collaborative management system architecture and collaborative control design support collaboration and agility in CM configuration devices including the relationship, and the laid down rules of lifecycle's statuses (Heekwon et al, 2006). They envisaged that the accuracy and quality of the products, which bring about competitive benefits for the company are guaranteed by configuring objects with producers' exact manufacturing processes to format completely the whole CM's operation flow. Ying recommended that further research would focus on exploring a good task-structuring algorithm and discovering more operation kinds of CM task configuration management (CMTCM), which allowed CM to be more environments friendly and be accepted by more businesses.

In (Hao Li et al, 2009), they researched the dynamic performance analysis model of the collaborative knowledge chain in the CM process. It was proposed that a qualitative problem for running an assessment of knowledge chain (KC) in the CM process, and how to trade the qualitative challenge into a quantifiable one was a tough issue. Hao Li et al stated that the evaluation model of KC could explain its running condition numerically, thereby skipping baseless and subjective analysis, and equally giving a knowledge-based and rational reference for manufacturers’ making of decisions (Luo & Li, 2008). In addition, it was also concluded, however, how to look into the relevance between indices in numerical contrast, and how to set a bigger rational contrast index mannequin and the weight factor are however tough challenges, and as such, needed to improve in future research works (Holensapper & Singh, 2001), (Liu & Wu, 2002), (Wen & Xu, 2004).

Elsewhere, Yuan et al. (2020) did a presentable work on collaborative design, manufacturing and supply chain for manufacturing companies based on the internet. Yuan designed methodology and frameworks based on collaboration with design, manufacturing, and supply path (Alsaffar, 2016). Detailed framework and workflow in every part showed the collaborative and incorporated connection among the parameters, and they supported quick cash turnover, perfect, smart manufacturing, cost transparency, the smart interconnection of tools, and supply chain management model with the smaller investment and the speedy and robust results (Pakdeechoho & Sukhotu, 2018).

Xu (2009) singlehandedly worked on the identification of the duty dependence in computer-aided large-scale CM via the E-CARGO model. The task dependence scenario was brought up in robust scale CM. Xu conducted research to utilize an extended E-CARGO model to mastermind the process step priority based on the usage of equipment. The extension of E-CARGO and the detailed iteration of the symbols were being put forward. The step-by-step solutions to check the misuse of material, priority determination and conflict removal were suggested. It was also stated that they were building the step-by-step solution in a robust collaborative framework which was also utilized to enhance the business of a large clothing-producing corporation in Zhejiang Province, (China Huang et al, 2003).

Meanwhile Xuedong et al. (2020), researched on manufacturing incorporation of auto parts business based on internet-of-manufacturing things (IoMT). Xuedong puts forward enterprise-level incorporation design and industry chain-level integration architecture of automotive parts based on manufacturing IoT technology, because of the change and upgrade requirement of intelligent manufacturing encountered by automotive parts businesses (Huang et al, 2019). Manufacturing emphasized heterogeneous device integration and application scenarios of business manufacturing incorporation and multi-business CM were put forward (Zhang et al, 2014). It was proposed and recommended that the integration of IoMT with cloud manufacturing would be further researched subsequently (Hou et al, 2014).

According to (Mao et al, 2008), who researched the CM platform for Chinese automobile companies orienting to a supply-domain network (SDN), it was proposed that these days, with the evolution of global economic incorporation, the dominance of Chinese manufacturing businesses in functioning at smaller price had already not been conspicuous. Mao et al. (2008) posited that they could only obtain the newly created opportunity by disregarding barriers, being open-minded, and subjecting themselves to transparency and cooperation with stakeholders. MAO envisaged that more and more
businesses’ attention was being attracted to SDN by collaborative works as the important factors were leading to triumph and success (Zuo, 2006).

Focusing on the analysis of the automobile companies, MAO et al built CM systematic model of automobile producing businesses originated to SDN, and they revealed the collaborative relationship among the inner of the automobile producing company and with the participants in SDN systematically and robustly, have the active guiding importance to a collaborative system in automobile producing industries. Mao et al. (2008) posited that the model had a value to another CM system of compounded products as they had the same properties as automobile products, which include many jam-packed fittings, large results, a plenty gain of scale and more (Li, 2007). Also, Jian-Feng et al. (2006), worked on a design and implementation for the CM platform originated from the distributed interface. In their research, Jian-Feng explained explicitly, the data descriptive mechanism, the construction of dynamic alliance, and distributed interface-oriented task planning for creating the CM platform. In addition, a CM system prototype based on the agreed design system initially built by (Jian-Feng et al, 2006) was actualized. It was recommended that a theoretical and practical background for improved research on CM could be investigated in subsequent works. In (Nan et al, 2008), they researched a design and implementation of a web-based CM management platform in a complex manufacturing business workshop.

3. Categories of Collaborative Manufacturing Strategies

There exist four fundamental categories of CM strategies. These include manufacturing enterprise collaboration (MEC), production synchronization (PS), and product lifecycle management (PLM), which are explained below. CM demands that industries have mutually related interests or aims.

3.1 Product Lifecycle Management (PLM)

This can be explained as the act of monitoring software’s lifecycle from the very start of requirement gathering, through the system analysis and design, coding, integration, and implementation and then production, to marketing, service, and finally retirement. PLM product helps companies to build new software and deliver them to point of sale (Michael & Andreas, 2019). PLM also means the management of data and processes used in the design, development, production, sales, and service of a software product across the entire lifecycle.

3.1.1 Why Manufacturing Industries Cannot Do Without PLM

Today, Suppliers, customer support, advertising, selling, and partnership networks are now included in the approach of PLM to a greater extent. Initial PLM systems were designed with engineers in consideration due to the heavy emphasis on engineering. Prestige PLM was developed to aid engineers in maximizing production, reducing cost of production, and accelerating cycle times. Next-generation PLM software available now offers additional advantages of PLM for the entire organization, allowing for better quality of product even for complicated goods, quicker profitability, and speedier product to marketplace (propelplm.com).

3.2 Inventory/Product Synchronization (I/P-S)

Products synchronization happens from the finance and operations app (FOA) to the Dataverse table. This means that the product table columns value can be changed in Dataverse, but when the synchronization is triggered (when a product column is modified in an FOA app); this will overwrite the values in Dataverse, meaning product dimensions. When a business ecosystem is made up of Dynamics 365 applications, such as Finance, Supply Chain Management, and Sales, businesses often use these applications to source product data. This is because these apps provide a robust product infrastructure complemented with sophisticated pricing concepts and accurate on-hand inventory data. All application users, including Power Platform users, can benefit from the rich product data that comes from the Finance and Operations app thanks to the integrated product usage, which incorporates the integrated product database structure into Dataverse.
3.3 DISTRIBUTION ORDER FULFILMENT (DOF)

This is a process that comprises the processing and receiving of the software for delivery to customers as shown in Fig. 6. What does order fulfilment mean? Order fulfilment refers to completing a customer order in accordance with the client’s requirements. Distributing software in the manner specified at the time of purchase. In other words, when a business performs a sales order according to the client’s demands, that undersells the significance of orders fulfilment. Greater authority than before lies with the consumer. Order fulfilment includes the crucial duties of putting together the order, shipping it to the customer, and the systems that help with those tasks. Sustainable procurement is the first step in the overall order fulfilment lifecycle, which includes five key phases before shipment or mailing. Order fulfilment is a term used by many firms to describe activities including customer assistance, supply chain management, inventory management, quality control, and order processing. Regardless of the size of your company, most of the order fulfilment procedure can be completed in an organized warehousing under one building. Many smaller companies employ a straightforward procedure to fulfil orders internally. Large businesses require a multi-layered, more sophisticated delivery centre plan. But in all cases, the key objective is to effectively deliver the client’s purchase in the quickest, most trustworthy, and most affordable manner feasible.

3.4 MANUFACTURING ENTERPRISE COLLABORATION (MEC)

This is a CM strategy that is used for assessing designs and switching orders with the design group. It enables interfacing with tooling designers. It helps to verify tooling gathering and operation. It is used in reviewing manufacturing process plans and factory layouts. Nowadays, industries usually have operations dispersed over many locations in the world and production equipment and designers are usually situated in different locations as compared to the past whereby most of the engineering and production was carried out at a single site. As a result, the issues have been complicated due to the increase in the usage of outsourcing and supply chains. As of 2000, companies outsourced more than 40% of manufacturing, which made the percentage continue to increase concerning 1998 when industries farmed out 15 percent of manufacturing. Sequel to this, genuine styles to distribute information were proposed to be adopted. However, manufacturing globalization implies that industries should be able to design, build, implement, supervise, and maintain anywhere at any time (Noori & Lee, 2009). In a nutshell, doing the is faster and significantly more useful than telephone calls/chats, mail, or faxes, and it is more efficient and more economical than physical meetings (Jiao et al, 2006).
consumer satisfaction or other strategic plans; Activate collaborative support and maintenance of manufacturing programs.

4 APPLICATION OF AI/ML TO CMT

This section discusses the possible application of ML and AI to CMT. The ML types such as supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning can be employed to train and predict some of the performance metrics of CMT in science and engineering-based problems. Briefly, as depicted in figure 8, AI is a branch of intelligence theory that deals with the design and development of systems that can perform human tasks, which is synonymous with using human intelligence. This drastically emerging theory is subdivided into ML, natural language processing (NLP), expert systems, speech recognition, visual perception, planning, and robotics. More so, the ML is branched into deep learning which is based on artificial neural networks with multiple layers of the processing being used to extract progressively higher-level features from given data. As for the NLP, which is the use of advanced computational methods to analyze and synthesize natural language and voice, it is branched into text generation, question answering, context extraction, classification, and machine translation. Also, speech recognition is disintegrated into speech-to-text and text-to-speech. They involve the ability of an intelligent system to identify and react to sounds or speeches emanating from humans. Lastly, the visual perception which entails the processes that start in our eyes is divided into image recognition and machine vision.

Consequently, the application of AI/ML to the four CMT categories could be summarized below:

PLM: After eliciting the requirements from the end-users, they could be fed into a system and be used to train the system before carrying out the next stages of the lifecycle. This will intelligently monitor the software development stage by stage to ensure it conforms to the gathered requirements, thereby serving as a real-time customer review.

I/P-S: Since product synchronization occurs from the FOA to the Dataverse table, deep learning could be applied to automatically synchronize the modification of data. The deep neural network is designed for efficiently and concurrently processing the data provided by the Dynamics 365 applications Finance-App, Supply-Chain-Management-App, and Sales-App that make up the business environment.

DOF: For achieving a satisfactory order fulfillment, the customer’s requests and location could be fed into a robotic system and trained with it, especially for physical products. As soon as this product is subjected to the robot for delivery, it intelligently matches it with the data it was trained with for a pre-review. Robots are being used to deliver goods in United Kingdom’s supermarkets to customers (Shi & Gregory, 2005).

MEC: As this is all about product design assessment and order switching, the suitable AI theory to apply here is visual perception which takes all the design descriptions from the customers as its intelligence. Perhaps it receives pictures of the ordered product from clients and uses its intelligence and machine vision theory to locate it in the groceries for delivery.

5 CONCLUSION AND FUTURE DIRECTION

In this review paper, each of the four categories of CMT carried out was discussed in detail in this work as issue(s) addressed, which symbolizes part of the manufacturing cycle. The seven fundamentals of CM were itemized. Also, this paper presents a review of that potential model combination’s importance, identifying some of the challenges and thereby proposing some suggestions for further research. With the advent of the internet of things, researchers have been able to carry out research and implementation of IoT and intelligent CM based on data driven. In all, this paper provides a detailed guide to carrying out further works on CM. A detailed review of some published works on CM was iterated in this work which would serve as a guide for any researcher who wishes to carry out further research on CM for any software.

With the emergence of the new technology called the IoT, it is recommended that researchers should explore the
new adventure of its kind called the Internet of Manufacture of Things (IoMoT). This for sure provides real-time collaboration with software end users and quick access to requirement gathering in future research. This paper gives a simple guide to the application of AI/ML for further research on CMT.

REFERENCES
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