INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 4 - V7I4-1874)
Available online at: https://www.ijariit.com

Role of Information Technology in mass customization of the manufacturing process

Uday Bapuji Joshi
udayjo69@gmail.com
Thadomal Shahani Engineering College
Mumbai, Maharashtra

Dr. G. T. Thampi
gtthampi@gmail.com
Thadomal Shahani Engineering College
Mumbai, Maharashtra

ABSTRACT

The current manufacturing sector is defined by rapid globalization, arbitrary and heterogeneous markets and a high rate of products customization. Considering the factor of mass customization, the review paper explores the impact of information technology (IT) in tailor-making electronic goods as per customer demands in India. The paper efficiently extrapolates the benefits of Mass Customization (MC) in a manufacturing sector and later measures its intensity when IT (Industry 3.0 application and then Industry 4.0) is applied in unison with it. Supply chain management is an important phase of manufacturing of products that can be made proficient in MC by introducing IT applications like Customer Relationship Management and Enterprise Resource Planning. Through the use of IT, supply chain planning and supply chain integration can significantly enhance the supply chain of business in saving cost, resources, and can initiate better management between coordinators along with facilitating systematic flow of information at every stage. Besides, substantiating the benefits and ways in which MC can adequately cope with individual demands, the review also dispenses information about the common challenges faced by the company in abiding MC mechanism. The main findings and discussion will evidently state the use of IT in MC manufacturing processes of consumer electronic products. The review also discusses the state-of-the-art technologies currently used for MC. Industry 4.0 applications are widely used to seek better outcomes of customization. IT with industry 4.0 applications like Big Data, Internet of Things and Cloud Computing can help in further broadening the scope of MC manufacturing.

***Keywords*:** *Mass Customization, Information Technology, Impact, Electronic Products, Industry 4.0*

1. INTRODUCTION

Mass Customization (MC) has acquired an increasing credence in the operations management literature. Mass production is defined as "the production of large quantities of a standardized article by an automated mechanical process", while mass customization is "a marketing and manufacturing technique that combines the flexibility and personalization of custom-made products with the low unit costs associated with mass production". The emergence of MC was due to the increasing discontent among customers regarding the standard products that were made available to them as a derivative of mass production. MC can help in satisfying customer' needs by producing a high volume of products that are diverse, customized and that can be manufactured without major change in cost, quality and delivery process (McCarthy, 2004). MC is a polymorphic technique that involves a number of activities, processes and capabilities. Tu. et al. (2001) suggests three main fulfilments for MC: cost, volume effectiveness and responsiveness to customers' needs. Production carried out through mass customization leads to two key advantages. Mass production is cost-efficient while mass customization provides versatility in production. When cost-efficient versatile production process is used, it will be beneficial for businesses. The benefits of customization have been understood in a variety of sectors. For example, Shin et al., (2008) emphasize the need for customization in the housing construction industry in South Korea. They state that the advent of information technology (IT) in such undertakings can help in better availability and exchange of information throughout the construction period. The paper illuminates on using the finishing information system (FIS), an application of IT in overcoming the issue of housing customization.

B. Joseph Pine II et al. (1993) put forward the concept of mass customization in the context of manufacturing strategy. The processes essential to transform mass productions into mass customization are: customization of products and facilities, customizable products, a quick response to consumers requirements, customizable delivery and flexibility of the components

used. As per another literature available on MC, it was professed that agile manufacturing can lead to development of strategies that can satisfy an individual's needs, focus on delivery value, provide a competitive edge, capability of making important changes and can leverage the impact of people and information. All of the above stated criteria hold true in the case of customization of products on a large scale as suggested by DeVOR et al., (1997). Besides, Glovani J. C. da Silveira, Borenstein, & Fogliatto, (2001) suggests, agile manufacturing change in the supply chain of products and the adoption of lean manufacturing can also help in MC. Lean manufacturing aims to satisfy customers demands while giving the companies competitive benefits by minimising wastage and effort costs as put forward by Storch & Lim (1999). In order to make such technology-based changes in the manufacturing process and to acquire mass customization of products, companies make use of Industry 4.0 applications such as information, automation and computers, right from the early 1980s says Wang et al. (2017). Currently, mass customizable operations are widely used in architecture, fashion and e-commerce businesses.

As described above, mass customization has been analysed in the construction and general manufacturing industry. However, there is limited research on mass customization (MC) of electronics products.

This review paper extrapolates the importance of IT in the manufacturing of mass customizable electronic products. This review paper describes use of IT in terms of three key parameters: the utility in MC, the enablers for MC and the challenges for IT in MC. The paper then discusses possibilities for future empirical studies. This study analyses 34 research articles from 1993 to 2019 of various countries. The paper is structures as follows: Section 2 describes literature review. Section 3 elaborates findings and discussion followed by conclusion as Section 4.

2. LITERATURE REVIEW

This part of the paper is divided into four sub-sections as follows: i) Descriptive analysis, ii) Mass customization for stakeholders, iii) Information technology as an enabler, and iv) Challenges of using IT in mass customization.

2.1 Descriptive analysis

Total 34 research articles were considered for this study. Chart 1 shows year-wise distribution of articles.

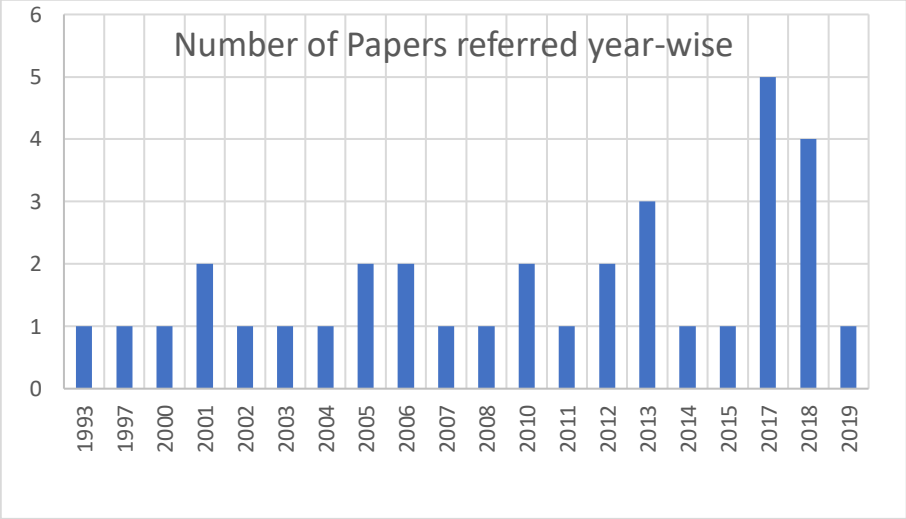

Chart 1. Year-wise distribution of literature surveyed

Chart 1 indicates the literature reviewed for preparing this paper. Though the literature was considered from year 1993, majority of the papers are from 2015- 2020. Chart 2 shows Classification of papers based on type of publications.

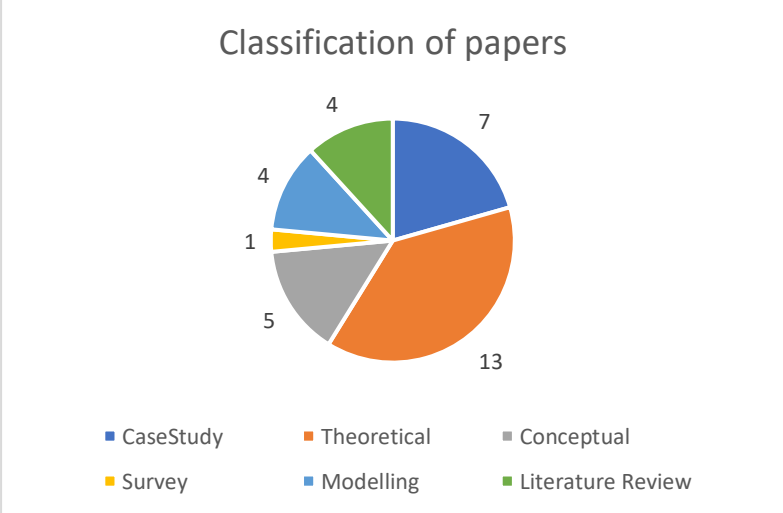

Chart 2 Classification of papers based on type of publications

The chart 2 represents the classification of the papers referred. The types of papers considered are theoretical, conceptual, literature review of other authors, case studies conducted, management surveys, mathematical models and simulations. Majority of the papers were theoretical and the authors have elaborated the points discussed in the paper. Table 1 shows Year-wise type of publications.

Table 1. Year-wise type of publications

Year of Publication	1993	1997	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	2017	2018	2019	**Total**
Case Study											1	1	1	2	1			1			7
Theoretical	1	1		2	1	1	1	1	1						1	1		2			13
Conceptual			1						1			1			1			1			5
Survey								1													1
Modelling																		1	2	1	4
Literature Review					1												1	1	1		4
Total	1	1	1	2	2	1	1	2	2	0	1	2	1	2	3	1	1	6	3	1	34

2.2 Mass customization for stakeholders:

Mass customization deals with two stakeholders: customers and manufacturers. The value of mass customization can be understood from the perspective of the two stakeholders. They are as follows.

Mass customization benefits customers as follows. Zipkin (2001) accounts that MC is a company's ability to offer vast scale tailor-made services to customers at a matching price that is needed to produce non-customized products. Through the hierarchy of effects model (HOE) formulated by Lavidge and Steiner in 1961, Park & Yoo (2018) have stated the benefits that are achievable through the operations of mass customization. The latter's research paper states that MC can enhance the cognitive instincts of customers by enabling them to engage better with the products, resultantly improving the success of the product. Therefore, MC can lead to brand awareness, knowledge and beliefs. It can be helpful in postulating effective marketing strategies, and in satisfying the intrinsic expectations of customers thereby leading to a more emotional product attachment experience. Park et al. (2006) also noted that customers who develop a strong product relationship are willing to spend more time, money and energy to sustain the relationship.

Mass customization benefits manufacturer as follows. Lean manufacturing is often used in SMEs for efficient usage of infrastructure. The lean manufacturing technique is based on lean thinking. It can help an enterprise in improving the speed of production, the scientific value and quality, can encourage technological advancements and effectively reduce the cost of the market price. The fundamental quality of lean thinking is to avoid waste at all stages of production. The focus lies in reduction of waste processes at all chains: innovation, production, management or logistics. The wastage gets substantially curbed through lean thinking in mass customization enterprises. Xiao & Wu (2017) suggests that, this particular modus operandi can reduce cost at all stages and cumulatively limit the cost of the final product and manufacturing process. Another benefit of MC that can be studied through the research works of Zhang et al. (2019) lies in the supply chain management. Supply chain management (SCM) is the formal coordination of business processes to continually improve the quality of services and products as pointed out by Zhang, Huo et al., (2015). They also pointed out that Mass Customizers can become efficient leaders of the supply chain. Mass customizers can respond to several changes in a complex environment. According to Jitpaiboon et al., (2013), this quality can help them to advance internal interactions and manage the environment duties by cooperating with different supply chain partners. Customization can help in selecting qualified and certified suppliers to deliver quality products says Flynn & Flynn, (2005).

2.3 Information technology as an enabler

An efficient way of realization of MC is to deploy it with information technology (IT) applications that can support its functionalities. IT can be influential in improving coordination within and outside the organization, increasing responsiveness, facilitating innovation and can lead to rise in precision of products in the manufacturing stage as pointed out by Peng et al., (2011). Several Product Configuration Systems (PCS) can work in unison with mass customization businesses to develop the alternatives of products and improve the sales and production processes suggests Felfernig et al., (2010). PCSs can assist companies in five ways: (a)in taking less time in quotation markings, (b) incurring less errors, (c) can meeting customers' needs easily, (d) increasing on-time delivery and (e) using less resources to deliver best quality products says Shafiee etal., (2018). Janda, Trocchia & Gwinner (2002) state that a website can be used as an interaction medium to suffice customers' needs and also highlights an important functionality of mass customization. Hence the following part of the literature review will delve into the quintessence of IT used as an enabler for mass customization of electronic products. It will cover the importance of a software development programme in mass customization.

Kuo (2013) stated that MC stresses on using software products in accounts to make use of similarities and differences in satisfying customers' demands. This strategy is ingrained in the automotive industries where the major emphasis is to get both mass production and customization of products by creating only a single production line. This section investigates the importance of IT services like Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) in Mass Customization Capability (MCC).

Both the IT services mentioned affect supply chain management (SCM) which in turn affects the MC operations. Liu, Zhang & Guo (2018) empirically showed that precise MC technique depends on two important conditions: choosing the correct product configuration from a variety of operations and producing services or products with the help of a chosen configuration in a timely manner. Adoption of IT for MC has been manifested in several frontiers: supply chain management, enterprise resource planning and customer relationship management. Their relationship with MC can be described as follows: The supply chain management (SCM) is critical for any firm in order to gain maximum output from MC. Therefore, their paper further links supply chain integration in facilitating MC abilities in an enterprise. They elaborate on the information processing theory that is important in sharing of information within an organization and across boundaries in order to nullify the risks.

The empirical paper shows that a more defined relationship can be established between MC and supply chain integration when organizational information processing is used by the firm. Lai et al. (2012) defines supply chain integration (SC-integration) as the extent to which a firm collaborates with supply chain partners and manages organizational processes efficiently. Through cross-functional and inter-functional coordination, a systematic deployment of services and products is possible. These provisions of intermingling of stakeholders give opportunities to different departments to integrate their opinion to come out with best possible suggestions. Internal integration facilitates information sharing between supplier and customers, thus helping suppliers to gain an insight about the market demands, raw materials and available components. According to Lai et al., the suppliers can thus make use of this knowledge for efficient customization of the process. Liu et al., (2018) pointed out according to another paper earlier stated in the review of literature proved that supply chain planning has also a positive correlation with MC.

Enterprise Resource Planning (ERP) homogenizes data as per the business processes. ERP can substantially enhance an organization's design and decisions owing to the effective transfer of information says Akça et al., (2013); whereas Customer Relationship Management (CRM) helps in strengthening the ties between customers and manufactures. According to the research work by CRM conducted by Williams (2017), it was realized that CRM software are prominent in creating dual value between firms and customers either by obtaining information through customer segments or data available on individual customers. The most widely recognized model for SCM is the Software as Service (SaaS). The paper proves that, using an implementation of SaaS, CRM can improve SCM. In 1998, JP Morgan stated that CRM in the supply chain of businesses can expand the growth of the former in double digits year after year. According to Mandic & Vranesevic, (2012), this is possible with the quality of CRM applications that focus on customization and willingness to substitutes. Similarly, the prime purpose of ERP is to decrease supply chain expenses by effectively carrying out collaborations between various stakeholders. ERP can also reduce the production time, enhance the quality of products for all customers. Supplier selection and deciding of orders are important for a business. ERP satisfies both the criteria, thereby increasing the customer satisfaction and reducing cost as pointed out by Sekhar & Chalapathi, (2018).

2.4 Challenges of using IT in mass customization

As per Blecker and Abdelkafi (2006), there are several complexities that might still be faced even with the incorporation of IT with MC. Although customers respond well to customization of products, they can also get overwhelmed by the product selection process. The three important types of external complexity are: limited interpretation of information, limited knowledge regarding the products and ignorance pertaining to one's needs. There are also internal complexities due to the increase in the variety of products. Primarily, an expanded range of options as a result of customization leads to an increase in the cost of operations and a reduction in the speed of the supply chain states Blecker & Abdelkafi, (2006). Duchi et al. (2014) stated that the rigidity in the traditional Informations and Communications Technology (ICT) systems is the dawning challenge in manufacturing custom products and to bridge that gap it is important that there is flow of rich information via different processes.

Another important challenge that was perceived by Thomassen and Alfnes (2017) in their research was that the inconsistency in the delivery of products that require more production time. Any change in the order needs to be specifically defined in order for the delivery to take place. But the process of manufacturing of products that take a long time starts even before full instructions are given to facilitate on-time delivery. This inefficiency leads to a major drawback in customization of products as per the given guidelines. As per a paper by Heiskala, Paloheimo and Tiihonen (2005), some challenges are: the complexity of MC manufacturing, an increase in the amount of information shared or received, and the testing of the validity of the shared information . It is important that the IT based services notice any error in the production or inventory stage before the product is out for delivery. The ICT services are also posed with challenges such as satisfying both the product value and customization. The information received about a particular product can at times be tacit. Hence, it becomes difficult to tailor the products while ensuring customer satisfaction. Hence, ICT should most importantly solve the issues of information flow. Grafmüller and Habicht (2017) also attested that the major implications in MC manufacturing is to maintain a degree of individualization while making it a standard process. This can be achieved by IT applications via co-creation process.

Peter and Saidin (2000) stated that the cost of technology required for running customer-centric activities is a major facilitator of economic gaining through MC. The paper also affirms that small businesses with strategic expansion of business can also boost their valuable returns just like large IT companies, primarily through web services. However, the challenges and implications of web service-based MC as highlighted by Lim (2003) is that of scalability, performance issues along with security. It was also seen that an important issue of information sharing and handling via web services is associated with security threats. These threats can be neutralised by adopting cybersecurity service so that important information is not subjected to any malicious activities. Cybersecurity or cloud computing, both applications of industry 4.0, can be implemented to fetch better results of MC manufacturing. Therefore, it is crucial that such challenges can be overcome so that IT can function in full capacity when it comes to mass production and customization.

The paper also further points out the issue of trust between suppliers and manufacturers. The information sharing between both the stakeholders needs to happen in real time. The paper by Lim (2003) further states the role of trust between manufacturers and suppliers in automobile companies. The example states that the auto manufacturers understand the needs of their customers better. Therefore, they are able to provide them with customised cars in scheduled time with reasonable costs. The suppliers can also better adhere to the demands of the manufacturer, thus leading to less inventory loss. Besides that, the paper also manifests the importance of trained staff in proper handling of IT services in manufacturing. Hence, companies must hire staff who are proficient in that field or give training sessions in order to acquire IT skills.

3. FINDINGS AND DISCUSSION

Mass Customization (MC) is the process of customizing products closer to their individual needs. Earlier on, companies followed an approach of mass production. However, it was observed that, after a while, the products were inefficient to strike a chord with the customers. The companies then laid the foundation of MC. According to the paradigm of MC, customers can demand goods and services as per their individual requirements. This opportunity leads to a better connectivity between customers and their brands. Through research papers referred to in this review of literature, it was seen that an effective MC is responsive to demands of customers, can cater to a large volume of products and can manage both of the above criteria at minimum cost. MC can help in evoking a strong personal bond between products and customers thereby creating brand awareness. Hence, companies often use MC as a marketing strategy to increase online purchasing. Lean and agile manufacturing are the common manufacturing practices followed for MC. The basis of lean manufacturing is to reduce cost of process at any given stage. Lean manufacturing can be helpful in improving the speed of production and can create opportunities for innovation. Mass customizers are the people that are at forefront in MC manufacturing. Mass customizers have immense knowledge about customers' demands and hence they can be excellent supply chain leaders to efficiently carry out various production processes in an enterprise.

It was also expounded that ERP and CRM applications can be beneficial in MC manufacturing of products at a wide scale. The events in the supply chain can be instrumental in customization of a vast variety of products. Supply chain management (SCM) can be guided through both CRM and ERP services. The relationship between MC and ERP is not direct but a circuitous one. ERP and CRM helps in supply chain integration and supply chain planning which thereby leads to tailoring of products. Advancements in the supply chain of an industry is dependent on adoption of IT services as it can support supply performance and integration. The primary role of ERP based application is to improve the productivity of a business. There are two major benefits of ERP applications in context to SCM, they are operational and strategic effectiveness. The main function of ERP is to enable proper interaction between its diverse collaborators to make better decisions and facilitate the information without any inconvenience. Earlier, most of the work in the supply chain was outsourced, currently e-SCM and IT enabled SCM services are greatly used. The important aspect of supply chain planning is effective collaboration between the stakeholders within and outside of the company and ERP helps firms achieve that qualification seamlessly. Customer management is also widely used in relationship management to retain clients and develop strong relationships with clients over a period of time. CRM and its accompanying services are used to study huge sets of consumer data and to provide provisions such as personalization, creation of new products, increase purchasing demands of the products and subsequently improve customer share. CRM services can be divided into three major facets, they are operational CRM, analytical CRM and collaborative CRM. Each facet greatly supports the supply chain of businesses to achieve the functionality of MC manufacturing. Even if the applications of IT can provide huge benefits there are several limitations of ICT. Some Of the viable issues that are discussed in the prior sections convey that IT in mass customization has difficulty adapting itself to change in the markets.

As the competitive quotient of the company is high and each industry wants to outperform the other, it is important to study whether ICT can keep up with the frequent changes and is compatible in resolving issues. It is also important to note that there are huge advancements in the Industry 4.0 applications and its increasing incorporation in the prospects of mass customization is also slowly being perceived by researchers and business personnel. Hence, IT services should be competent in linking any Industry 4.0 applications in order to attain better results of MC manufacturing. It is important to note that the process of manufacturing has moved from standardized to customization however, there still lies a need to keep the basic functions standardized so as to incur less cost on production. This standardized process can further act in unison with other applications to garner maximum outcome. It has also been found that information flow is not in a correct manner. Besides the information flow, adequate amounts of information should also be shared via ICT services so that stakeholders can be in a better position to adequately understand the product information. Hence, IT applications should be often upgraded as per the required needs of the companies in delivering and manufacturing of mass customizable electronic products.

4. CONCLUSION

The review paper has acknowledged the benefits, implications and ways in which IT fuelled manufacturing can assist mass customization of products and services. IT applications in automotive manufacturing have proven to be a boon and its dynamics have also given rise to many innovations, specifically in terms of electronics products. Customers can connect to their products like they had never before, IT in the supply chain of a production company has also led to facilitation of customization on a larger scale. The advent of ERP and CRM has proven to be efficient in the phase of changing market scenarios. ERP has led to efficient conversation between different parties and CRM has helped in understanding the needs of the customers. Customization has been greatly influenced by both these applications of ICT and hence, it proves to be a major factor in automating all manufacturing firms to gain optimal outcomes. However, there are several challenges that arise when IT is employed for MC, such as the difference between efficient delivery time or maintaining the quality of products. These challenges must be mitigated if IT applications are to be used in full capacity in manufacturing. Future researchers can also study and explore the connectivity of IT with different Industry 4.0 applications to make the MC industries stronger and more efficient.

4.1 Limitations and future scope

The present research study has attempted to understand impact of Information Technology on Mass customisation, however, certain limitations of the study need to be mentioned. In this study, only manuscripts in English language only were considered book chapters and conference proceedings were also considered.

Based on the study a model will proposed to suggest changes in existing manufacturing set to suite Mass Customization approach of manufacturing. The use of emerging Information Technologies in various manufacturing phases will be suggested and the impact of the same on cost of production, customer satisfaction, quality and time to produce & delivery will be studied.

5. REFERENCES

[1] Akça, Y., Esen, Ş., & Özer, G. (2013). "The effects of education on enterprise resource planning implementation success and perceived organizational performance." International Business Research, 6(5), 168-179.

[2] Alexander Felfernig, Monica Mandi, Juha Tiihonen, Monika Schutbert, Gerhard Leitner. (2010). "Personalized user interfaces for product configuration", 15th International Conference on Intelligent User Interface

[3] B. Joseph Pine II, Bart Victor, and Andrew C Boynton (1993). "Making Mass Customization Work", Harvard Business Review, 93509 (108-116)

[4] Blecker, T., & Abdelkafi, N. (2006). "Mass customization: state-of-the-art and challenges. In Mass customization: challenges and solutions" (pp. 1-25). Springer, Boston, MA.

[5] Da Silveira, G., Borenstein, D., & Fogliatto, F. S. (2001). "Mass customization: Literature review and research directions". International journal of production economics, 72(1), 1-13

[6] DeVOR, R. I. C. H. A. R. D., Graves, R., & MILLS, J. J. (1997). "Agile manufacturing research: accomplishments and opportunities." IIE transactions, 29(10), 813-823.

[7] Duchi, A., Pourabdollahian , G., Sili, D., Cioffi, M., Taisch, M., & Schonsleben, P. (2014, September). "Motivations and Challenges for Engineer-to Order companies moving towards Mass Customization. IFIP International Conference on Advances in Production Management Systems (pp. 320 -327)." Springer, Berlin, Heidelberg

[8] Flynn, B. B., & Flynn, E. J. (2005). "Synergies between supply chain management and quality management: emerging implications." International Journal of Production Research, 43(16), 3421-3436.

[9] Grafmuller ,L.K.,bchit, H. (2017). "Current Challenges for Mass Customization on B2B Markets. Managing Complexity (pp 269-279)." Springer, Cham.

[10] Heiskala, M., Paloheimo, K. S., & Tiihonen, J. (2005). "Mass customization of services: benefits and challenges of configurable services." Frontiers of e-Business Research (FeBR 2005), Tampere, Finland, 206-221.

[11] Janda, S., Trocchia, P. J., & Gwinner, K. P. (2002). "Consumer perceptions of Internet retail service quality." International Journal of Service Industry Management.

[12] Jitpaiboon, T., Dobrzykowski, D. D., Ragu-Nathan, T. S., & Vonderembse, M. A. (2013). "Unpacking IT use and integration for mass customisation: a service-dominant logic view." International Journal of Production Research, 51(8), 2527-2547.

[13] Kuo, T. C. (2013), "Mass Customization and Personalization Software Development: A case study eco-design product service system. Journal of Intelligent Manufacturing ," 24(5), 1019-1031

[14] Lai, F., Zhang, M., Lee, D. M., & Zhao, X. (2012). "The impact of supply chain integration on mass customization capability: an extended resource-based view." IEEE Transactions on Engineering Management, 59(3), 443-456.

[15] Lim, J. M. (2003). "The Impact of Information Technology on Mass Customization". International Journal of Operations & Production Management 31(10)m 1022-1047

[16] Liu G. J., Zhang, W. & Guo, C. (2018). "Impacts of Supply Chain Planning and Integration on Mass Customization.", Journal of Manufacturing Technology Management

[17] Mandic, M., & Vranesevic, T. (2012, June). "Successful customer relationship management implementation." International Conference Proceedings (p. 1206). University of Zagreb, Faculty of Economics and Business.

[18] McCarthy, I. P. (2004). "Special issue editorial: the what, why and how of mass customization. Production Planning & Control", 15(4), 347-351.

[19] Park, C. W., MacInnis, D. J., & Priester, J. R. (2006). "Beyond attitudes: Attachment and Consumer behaviour". Seoul National Journal, 12(2), 3-36.

[20] Park, M. & Yoo, J. (2018). "Benefits of Mass Customized Products: Moderating Role of Product Involvement & Fashion Innovativeness", Helivon 4(2) e00537

[21] Peng, D. X., Liu, G. J., & Heim, G. R. (2011). "Impacts of information technology on mass customization capability of manufacturing plants." International Journal of Operations & Production Management.

[22] Peters, L., & Saidin, H. (2000). "IT and the mass customization of services: the challenge of implementation." International Journal of Information Management, 20(2), 103-119.

[23] Sekhar S., & Chelapathi P. V. (2018), "A Hybrid Statistical Data Preprocessing and Data Forecasting Model on ERP base Supply Chain Management (SCM) Databases." International Journal of Simulation – Systems, Science & Technology 19(6)

[24] Shafiee, S., Felfernig, A., Hvam, L., Piroozfar, P., & Forza, C. (2018). "Cost benefit analysis in product configuration systems." Configuration Workshop 2018 (ConfWS 2018) (pp. 37-40). CEUR-WS

[25] Shin, Y., An, S. H., Cho, H. H., Kim, G. H., & Kang, K. I. (2008). "Application of information technology for mass customization in the housing construction industry in Korea." Automation in Construction, 17(7), 831-838.

[26] Stroch R. L. & S. Lim. "Improving flow to achieve lean manufacturing in shipbuilding" Production Planning & Control, 2010, page no 127-137

[27] Thomassen, M. K., & Alfens E. (2017) "Mass Customization Challenges of Engineer- to- order manufacturing. Managing Complexity" (pp 27-39) Springer, Cham

[28] Tu, Q., Vonderembse, M. A., & Ragu-Nathan, T. S. (2001). "The impact of time-based manufacturing practices on mass customization and value to customer." Journal of Operations management, 19(2), 201-217.
[29] Wang, Y., Ma, H. S., Yang, J. H. & Wang K. S. (2017) "Industry 4.0: a way from mass customization to mass personalization production Advances in Manufacturing," 5(4) 311-320
[30] Williams, J. (2017). "Customer Relationship Management Systems Role in Supply Chain Management Strategiy References"
[31] Xiao, T. & Wu, A., (July 2017). "Flexible application of Lean Thinking in Mass Customization Technological Innovation System." 6th International Conference on Advanced Design & Manufacturing Engineering (ICADME 2016) Atlantis Press
[32[Zhang, M., Guo, H., Huo, B., Zhao, X., & Huang, J. (2019). "Linking supply chain quality integration with mass customization and product modularity." International Journal of Production Economics, 207, 227-235.
[33] Zhang, M., Qi, Y., Zaho, X., & Duray, R. (2015). "Mass Customization Systems: Complementarities and Performance Consequences." International Journal of Logistics Research & Applications, 18(6), 459-475
[34] Zipkin, P. (2001). "The limits of mass customization." MIT Sloan management review, 42(3), 81.

