Evolution Study Of Mass Customization And Its SWOT Analysis For Business Management Practices

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Abstract

This paper checks challenges and prospectus related to mass customization as a management tool for growth of business. The mass production and customize production are two opposite poles for style of production. So, when we going for mass customization that means both extremities are getting balanced and meeting in between somewhere.

The firms need some management tool which can enable them to achieve high productivity with lean losses and full customer delight. The managers also believe that along with external customers, the internal customership contains the same weightage of importance. And the challenge is, this management tool should support both external and internal customer delight. The mass customization has capability to cater this challenge of modern managers.
The study of literature about mass customization was carried out. And it's found that while implementing mass customization firms faced many challenges and ripped advantages too. The implementation is done either in all areas of management or for some localized department. For this research paper, based on the literature review Strength, Weakness, Opportunity and Threat (SWOT) analysis is carried out to check out how mass customization can enhance management results in growth of business. A successful implementation of mass customization is not as easy as it looks, but its implementation can be a game changer.

Many industries, mainly automobile industries, have already implemented mass customization for supply of parts as they must deliver a product in large numbers. Many other implementations of mass customization are operational today, such as software-based product configurations that make it

possible to add and/or change functionalities of a core product or to build fully customized assembled products start to end. These are not perfect mass customization examples in the original sense, but they achieved the point of balance between mass production and customized production.

As SWOT analysis reveals there are many strengthening examples and plenty of opportunities waiting to get explored for mass customizations in management domain. The company can create a great impact by developing customer-trusted brands. And this can be done with strategic implementation of mass customization in different domains of management like productivity, resource management, supply chain etc. In the era of industry 4.0, a win-win situation can be achieved by achieving economization of scale and customer delight by implementing mass customization.

Key Words: Mass customization, SWOT of mass customization, Growing with Mass customization, Customization and economization.

1. Introduction

The mass customization concept is around fifty years old. In 1970 Toffler coined it in 'Future Shock'(Toffler, 1970). Followed by Davis in 1987 in 'Future Perfect'(Davis, 1997). It is a production style where customized goods or services, produced at efficiency of mass production. In 1998 Pine and Devis narrated this concept as "any volume, any time, anybody, anywhere, and anything."

In 1993 Pine B. J said in his book that the competition has reached such a level that economization of scale by mass production is soon going to be ineffective. The fulfillment of customer's unique test while keeping cost low is the driving factor. The study on contrast between mass production and mass customization also shows that mass customizations can rip more growth for firm than the mass production only.

Total customer satisfaction starts with designing products specifically for the respective customer. Since when industrial revolutions started, manufacturing was usually evaluated by economization of scale. That is characterized by the highest level of mass production with extreme standardization to keep cost at lowest possible level. Now to take care of a customer's unique requirements mass customization can be applied in order to achieve both high volume and variety in the product. Here customers get individualized products at the same price as mass-produced items. But this is not less than a marathon challenge. Meeting this challenge requires strategic changes in the organization's modus of operandi and in manufacturing process

dynamics. Even though potential offered by mass customization for growth of firm is very high, but still firm has to decide strategically that mass customization is really optimum way for firm's annual targets and in line with firm's mission or vision before venturing into it. (Radder & Louw. 1999)

2. Objective

To study scholarly written research articles about implementation of mass customization in manufacturing units. Followed by categorization of same in strength, weakness, opportunity, or threat (SWOT) to know how the said tool Mass Customization (MC) is helping in growth of the business, especially in modern scenario of volatility, uncertainty, complexity, and ambiguity (VUCA).

3. Methodology

In our review, we primarily relied on Google Scholar to search for relevant publications. We examined a total of 767 publications, and through subject searches using keywords such as "Fabrication / digital fabrication, Optimization, Customization, economization, agile manufacturing, order to make, rapid production, design to order, capital goods, and mass manufacturing," we identified 300 publications that aligned with our research focus.

To maintain a narrow focus, our study specifically concentrated on publications that addressed the cost optimization with mass efficiencies in industrial sectors. This selection process resulted in a final collection of 80 papers for a thorough examination.

These 80 publications, spanning the years 1989 to 2023, were meticulously cited and examined in our study. Our objective was to explore how the tool of mass customization contributes to enhancing firm growth in the modern scenario. We carefully analysed the implementation facts and results presented in the respective articles, drawing specific conclusions regarding their impact on business growth.

Furthermore, the conclusions drawn from each paper underwent a SWOT analysis to gain further insights. The outcomes of the SWOT analysis were then converted into single-point indicators and organized in a tabular format, facilitating a comprehensive overview of the findings and their implications for the role of mass customization in driving business growth.

Table 1 provides a summary of publications related to the topic of Mass customization. It highlights key information about these publications.

Table 2 presents the number of articles published in different research fields concerning Mass customization. It showcases the distribution of publications across various areas of study.

Figure 1 visually represents the number of publications produced over different time periods, offering a clear depiction of the trends and patterns in research output on Mass customization.

Figure 2 Represents the process flow of SWOT analysis.

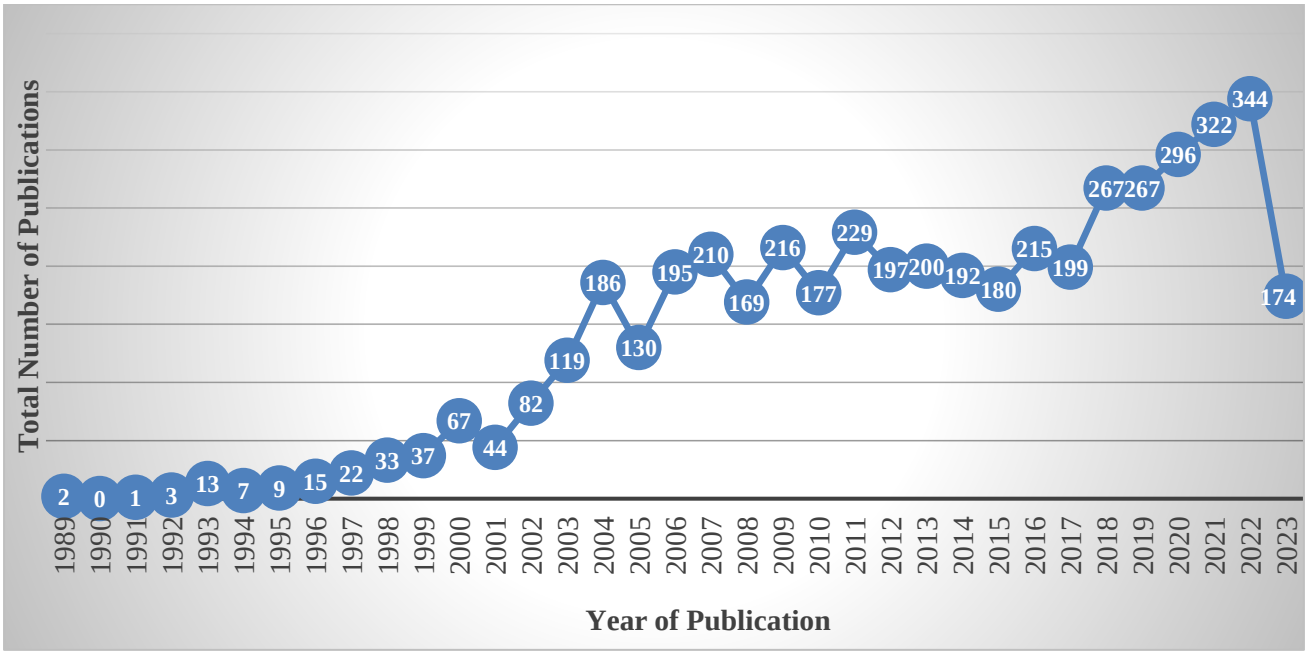
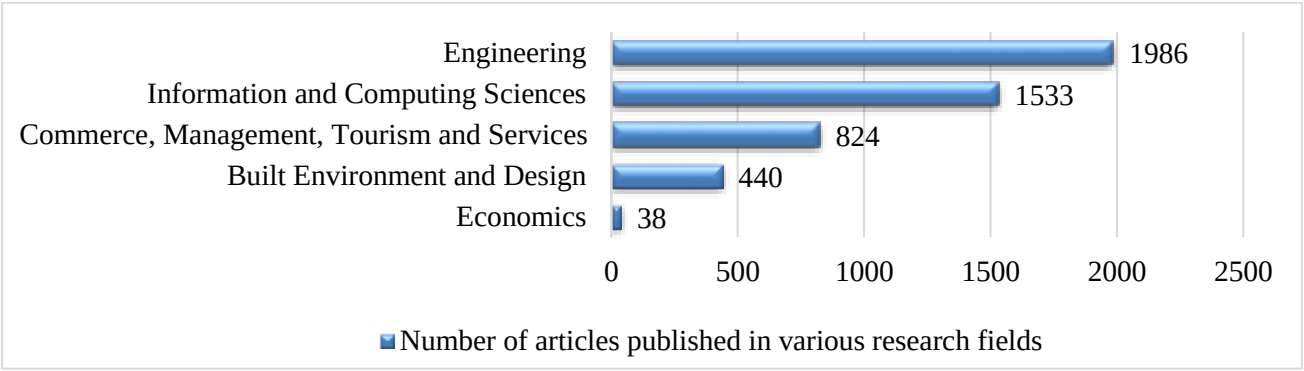


FIGURE 1 Number of articles in different time periods. (Source: app.dimesion.ai

TABLE 1 Summary of publications. (Source: app.dimesion.ai)

Type of Scholarly written Publication	Statistics
Article Published	4821
Data Sets	35
Grants	531
Patents	646

TABLE 2 Number of articles published in various research fields. (Source: app.dimesion.ai)



Review of Scholarly written articles about Mass customization	
Source: Peer reviewed journals	
↓	
Drawing of conclusions from each reviewed article	
Study of implementation of MC	Arrive to concussion based on results obtained in given papers
↓	
Further classification of conclusions with respect to modern world	
Analyze the conclusions under SWOT in respect to modern world	Review of SWOT analysis result

Figure 2 Process flow of SWOT analysis.

4. Literature review - Mass Customization as management tool

The mass customization is such a management tool which provides flexibility and quick response to production system to create variety and economical cost for customer. Unique products for each, produced in a mass way is the main appealing factor of mass customization. Mass customization can be the factor that defines the growing and leading organizations in the journey in the era of current industry 4.0. The difficulty lies in converting the choice of the customer into a tangible, customized product at profitably. The digital data transfer can be the key for growing in competitive business because of its rapidity. With which each customer's unique need can be transformed into the actual product. (Phelan, et al. 2017)

Each company is required to set different strategies to embark on mass customization based on their base product then only it results in standard yet customized product. In this process companies develop mass customization in different departments which emerged from their current capability, achieved as a result of their learning curve, and will lead to financial success. Both standard and mass produced, and customized producers can go for their operation line modification for production of mass customized items. To get highest growth of firm its most required that firm's mass customization strategy forms such production line that is very closely resemble to mass production line but yet can produce unique product for different needs or different specifications of customer. (Çil & Pangburn. 2017)

Many researchers have described mass customization as a firm's ability to produce customized products at large capacity with cost efficiency meeting to mass production. The technological and managerial improvements achieved in the process of creating mass customization are the key to addressing challenges of industrial growth. (Tseng & Piller. 2003).

O'Grady & Liang (1998) has explained three powerful forces which are responsible for successful mass customization. First is the accelerating rate of technological advancement. Second is complexity in product or need. Third is customer awareness and employment. Increase in disposable income globally also boosting demand for more customized products.

In any production system, each stage of the production line adding some value to the product. To minimize cost this value addition to product to be done by standardization. Standardization brings efficiency losses to minimum and capacity of producing increases with keeping input resources as same. Now if value addition activity by means of producer -customer interaction happens at the manufacturing stages or at the operations level then it creates customized products with production cost matching to mass production system. (Tseng, et al. 1996)

Mass customization involves the development of the process which provides a high volume of product options for a niche customer group. At the same time not compromising in quality, delivery and cost. (McCarthy. 2004)

To introduce mass customization as a management tool, it's important that both internal and external learning from supply chain, operations and delivery systems contribute to build up the capabilities of mass production and customization development. And thus, their effects can result as effective mass customized process implementation.

5. Strength, Weakness, Opportunity, and Threat (SWOT) analysis of mass customization - Management Tool for Business Growth

Strength

Flexible manufacturing systems (FMS) achieving mass customisation via automated flexible fixture system for mass customization. And thus mass-produced, customised parts making becomes possible mostly due to the supply fixtures that are rapidly made available in management function (Illidge, A., & Bright, G. 2018).

Module based production and followed by process development in which modules are assembled to get final product. This is called process modularity. This is one of the ways to implement mass customized production. In design process architecting, the module-based process considered as vital resource. This type of module assembly lines achieves efficiencies of mass production lines and also enhancing product value with uniqueness. It increases the effectiveness of mass customization because, module-based production system is very accurately predictable. The modules are based on past experience of conventional mass production line and hence prediction accuracy usually high. (Modrak, V., & Soltysova, Z. 2018).

A modular-based approach is already implemented in management of capital good making industries. They are the industries like power plant's equipment, transportation equipment, Petro-chemical plant's equipment, chemical plant's equipment, food and dairy machinery equipment, etc. These equipment making firms are demanding flexibility in product range and with highly customized capital goods. The demand is rising sky high and predicated that growing exponentially. (Buergin, et al. 2018). The same going to be scenario for India too while going for $5 Trillion economy by 2024.

The option for customers to give specification or need just in time for production line. Which can be integrated to Enterprise Resource planning (ERP) is game changer step. The implementation of mass customization in various steps of management via ERP is applied to the aircraft and likewise other capital goods manufacturing industry widely.

In the automotive sector often configuration of management tools and associated requirements are defined by firms which could be used to assist companies to define point of input for customer and its conversion in product. That leads firms towards mass customization of products (Phelan, et al. 2017).

In this industry 4.0 era state-of-the-art production is in trend. Workshops are not less than a showroom for firms. In such management paradigm firms are aiming to deliver service or product which is highly customized and unique with cost efficiency that of mass production (Tiihonen, J., & Felfernig, A. 2017).

Time & cost benefits with uniqueness in product using decision support systems also leads to mass customization. The decision support systems usually based on strategies that compiles lean improvements for product which create uniqueness without deviating from existing time and cost boundaries. The decision

support system also comes with a simulation model. Such system also does extensive calculations and checks results for real time data with model before implementing physically (Ramadan, et al. 2017). Thus, proven mass customization systems already exist in many firms which embedded in management of those firms.

Weakness

Mass customized production is usually complex and has high variability. Mass customization gives edge in competition but that at a cost of change in each segment like product design, product development, processing operation, inbound and outbound logistics of firm's management. Thus, mass customization creates overall complex management system for organization (Behunova, et al. 2018).

It's a hybrid design era for combining craft and internet of things with digital practices. Digital technology for fabrication is transforming businesses and their practices. It is now the normal for a designer to consider or reconsider almost the entire design process, from idea creation to fabrication, using digital means (Bernabei, R., & Power, J. 2018). Thus, consumes more and repetitive efforts for design and redesign.

The extensively used technology in product family design is product family configuration. It gives effective way of combining mass production technologies with customization strategies. The weakening factor is whole product cycle need to go under revision. Hence mass customization actually calls all sections of management to make changes (Wang, et al. 2017).

Mass customization is projected as alternative to mass production by many management stream researchers. This is an ambitious target and no example yet available where its achieved. That is because mass customization cannot achieve time and cost efficiencies of mass production (Buffington, J. 2011).

Opportunity

A multistage optimization method for the management of an in-situ feature addition during manufacturing, for mass customization can be developed to accommodate in-process design change demands. The paradigm of growing has caused an increase in researchers' interest in mass customisation in industries. These manufacturing methods are expected to be facilitated by reconfigurable fixtures / models. These models have to be treated as tool of the manufacturing system that enhances the production performance (Naidoo, et al. 2018).

Awareness of mass customization concept in small and medium scale Entities (SMEs) is substantially low. The implementation of

flexible manufacturing system in SMEs is still at incubation stage. Both SMEs and large or capital goods industry implements flexible manufacturing system, the difference between them is their stage of input espousal form customer in entire value addition chain of product (Safar, et al. 2018).

As product gets feature which is personalised for each customer it calls for change in production line management. While managing this change by means of module-based personalisation. Then, how to perform module differentiation with same rapidness in production line is becomes the key for success in module-based mass customization (Ren, et al. 2018). This mass customization brings tangible personalized feature in product which earns growth and brand value for an organization.

Development of analysis method for implementation of mass customization in electronic devices production is possible. For such industries the process time estimation is essential stage in both mass production and mass customization. When cyber physical system is employed for this estimation then it gives more benefits to mass customization as each unique value addition for each product also gets estimated and accommodated within same time and cost of production. (Nagahara, S., & Nonaka, Y. 2018). This can embark a firm in successful implementation of mass customisation as management tool for firms' growth.

A development of decision support model in mass customization is implemented in many firms to obtain the optimized production solution (Xu, Y, et al. 2017). And hence a decision support model is key feature for implementation of mass customization in management function.

The strategical implementation of mass customization enables organization to design and produce product or services as per unique consumer taste with market competitive cost. This is along with option available for customer to ask for in-process design change at certain defined levels of product or service process line (Çil, E. B., & Pangburn, M. S. 2017).

Realization of manufacturing flexibility and such concept in small and medium scale industries is very low. The application of manufacturing flexibility is still at primary stage. Both large and small industries can add flexibility in their manufacturing. They differ with respect to intervention or input point for customer in production line and rapidity of implementation of change in system (Mishra, R. 2016).

Threat

In the pursuit of mass customization, the most popular approaches have been based on Delayed Product Differentiation (DPD), also known as process postponement (Butler, L., & Bright, G. 2018). Because of this characteristic, the management gets information with delays and thus they have to perform within shorter delivery lead times.

For implementation of economically feasible mass customization of products, product & process modification need to be performed often. This to be done in such a way that earlier produced product or any product feature does not go obsolete. This requires deep understanding of customers' purchasing behaviours (Sha, et al. 2017).

6. Implications on Management practices

Mass customization, a business strategy that seeks to combine the benefits of mass production and customization, has profound implications for management practices in various industries. This approach revolutionizes how companies operate and interact with their customers, challenging traditional management paradigms. Here are some unique implications:

Shift from Push to Pull Models: Mass customization necessitates a shift from a push production model to a pull model. Instead of predicting demand and producing goods in advance, companies respond to specific customer orders. This requires a more agile and demand-driven supply chain, redefining inventory management and production scheduling.

Data-Driven Decision-Making: Mass customization relies heavily on data analysis. Managers need to harness vast amounts of customer data to understand preferences, buying habits, and market trends. This shift toward data-driven decision-making requires investments in analytics tools and expertise.

Flexible Manufacturing: Traditional manufacturing setups often focus on economies of scale, leading to rigid production processes. Mass customization requires flexible manufacturing systems that can quickly adapt to changing product configurations. Managers must invest in technology and employee training to support this adaptability.

Talent and Skill Diversity: Managing a mass customization operation demands a diverse set of skills. Engineers, designers, data scientists, and marketing experts must collaborate effectively. Managers need to create cross-functional teams and foster a culture of interdisciplinary cooperation.

Customization of Operations: Traditional management practices often follow a one-size-fits-all approach. In mass customization, operations themselves may need customization. Companies must develop adaptable processes and systems that can be fine-tuned to meet individual customer needs while maintaining efficiency.

Customer-Centric Approach: Mass customization is inherently customer-centric. Managers must prioritize understanding customer needs, preferences, and feedback. This requires a cultural shift toward customer-centricity and the development of customer-focused metrics.

Supply Chain Complexity: Managing a mass customization supply chain is considerably more complex than traditional supply chains. Companies must source a diverse range of materials and components to accommodate customization options. This complexity requires innovative supply chain management strategies.

Digital Transformation: To implement mass customization successfully, companies must undergo a digital transformation. This involves integrating digital technologies throughout the organization, from production processes to customer interfaces. Managers must lead and navigate this transformation effectively.

Marketing and Communication Challenges: Mass customization introduces challenges in marketing and communication. Companies must develop targeted marketing strategies for each customer segment, often relying on advanced personalization techniques. Managers must oversee these efforts and ensure consistency across all touchpoints.

Quality Control and Assurance: Customized products increase the complexity of quality control and assurance. Managers need to establish rigorous quality standards and implement real-time monitoring and feedback systems to ensure that each customized product meets the desired quality level.

7. Conclusion

In conclusion, mass customization disrupts traditional management practices by necessitating a customer-centric, data-driven, and flexible approach to operations. Successfully implementing mass customization requires a rethinking of supply chain management, talent acquisition, and digital transformation. It challenges managers to adapt to a dynamic and rapidly changing business landscape while delivering highly personalized products and experiences to customers.

The modern world challenges you to find new normal. When business encounters volatility, uncertainty, complexity, and ambiguity then its call for new directions with renewed approach to management. And when these new directions aligned to customer's need then it guarantees positive results in modern circumstances. Mass customization has desired potential to make firm enable to achieve fast growth along with becoming customer trusted brand. Also gives an opportunity to maintain economization of scale and resulting competitive pricing benefits. As SWOT analysis reveals there are examples of firms where mass customization has already been implemented. This strategy strengthens the growth of firms. Also, plenty of opportunities waiting to get explored for mass customizations in management domain. The company can create a great impact by developing customer-trusted brands. And this can be done with strategic implementation of mass customization in management domain. In the era of industry 4.0 with modern circumstances, a win-win situation can be achieved by achieving economization of scale and customer delight by implementing mass customization in the domains of management. The opportunities revealed in SWOT analysis need to be explored by firms to grow rapidly and become a global giant. Table 3 shows the crux of SWOT analysis carried out.

Table 3 Crux of SWOT analysis –Mass Customization

Strength	**Weakness**
Rapidity in supply.	Higher in complexity.
Gives modularity to processes.	Rapid re-design and re-structuring.
Boost just in time concept.	Difficult to achieve mass market efficiency.
A set configured management tools already available in firms for mass customization.	Calls for changes in all function of management.
Enables state of art production.	
Gives time and cost benefits.	
Opportunity	**Threat**
Gives option to perform multistage management.	Gives shorten lead time to supporting functions of management.
Achieves balance between unique needs and economization of scale.	Requires deep understanding from customer including behavioural.
SMEs can also implement this concept.	
Fulfils personalised requirements.	
Enables cyber - physical production.	
Strengthens decision support matrix.	
Accommodate in-process design changes.	

Gives flexibility to manufacturing and management.	

In conclusion, the modern business landscape demands adaptability and innovation. Mass customization stands as a powerful tool to address these challenges, empowering firms to achieve sustainable growth while delivering customized solutions that cater to customer needs effectively. Exploring the opportunities presented by mass customization and capitalizing on its potential can elevate a company to new heights in today's dynamic and competitive world

8. Future scope for research

The future scope for research in mass customization with a focus on capital goods is both exciting and promising, as it combines the principles of mass customization with the unique challenges and opportunities presented by the capital goods industry. Here are some potential areas for research in this field:

Sustainability in Mass Customization: Investigate how mass customization can be leveraged to make capital goods production more sustainable. This includes studying eco-friendly materials, energy-efficient manufacturing processes, and the impact of customization on resource consumption.

Digital Twin Technology: Explore the use of digital twin technology in capital goods manufacturing. How can digital twins be customized for different equipment or machinery, and how do they enhance design, testing, and maintenance processes?

Supply Chain Optimization: Research how mass customization affects the supply chain of capital goods, including the role of suppliers, logistics, and inventory management. Develop models and strategies for optimizing the supply chain while meeting customized product demands.

Cost Management: Analyze cost implications in capital goods manufacturing with mass customization. Investigate how to maintain cost competitiveness while offering customized solutions. This may involve cost modeling, value engineering, and cost-effective customization strategies.

Design for Customization: Study advanced design techniques that facilitate easier customization of capital goods. This may include modular design, 3D printing, and other emerging technologies that enable more flexible product configurations.

Digital Manufacturing and Industry 4.0: Explore the integration of Industry 4.0 technologies, such as IoT, AI, and automation, in capital goods manufacturing. Investigate how these technologies can enhance customization capabilities, improve production efficiency, and reduce lead times.

Customer-Centric Customization: Examine the role of customer feedback and collaboration in capital goods customization. How can manufacturers engage customers in the design and configuration process to create products that truly meet their unique needs?

Lifecycle Management: Research the implications of mass customization on the entire lifecycle of capital goods, from design and manufacturing to operation and maintenance. Develop strategies for extending product lifecycles and enhancing service offerings.

Risk Management: Investigate the risks associated with mass customization in the capital goods industry, including supply chain disruptions, quality control challenges, and intellectual property concerns. Develop risk mitigation strategies tailored to customized manufacturing.

Case Studies and Best Practices: Conduct in-depth case studies of companies that have successfully implemented mass customization in the capital goods sector. Identify best practices, lessons learned, and key success factors that can serve as benchmarks for other manufacturers.

Regulatory and Compliance Issues: Examine how customized capital goods may pose unique regulatory and compliance challenges. Research strategies for ensuring that customized products meet industry standards and safety regulations.

Market Trends and Customer Preferences: Stay attuned to evolving market trends and changing customer preferences in the capital goods industry. Research how these trends influence the demand for customization and shape product development strategies.

Research in mass customization with a focus on capital goods is not only academically valuable but also highly relevant to industry practitioners. It has the potential to drive innovation, improve competitiveness, and create more sustainable and customer-centric solutions in the capital goods sector.

The mass customization targets satisfying customer through fulfilling personalized needs. To full fill personalized need along

with design and process changes the performing human resource also becomes vital contributing factor. Analysis to check impact of various human resource management practices like training, partnering, job rotation, and group / individual incentives and rewards, to mass customization capability in management domain can be the scope of future research.

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