STUDY OF PLANNING AND CONTROL ASPECTS IN MANUFACTURING

A Thesis submitted to the Delhi Technological University, Delhi in fulfilment of the requirements for the award of the degree of

DOCTOR OF PHILOSOPHY

In

Mechanical Engineering

By

SURBHI UPADHYAY

(2K18/Ph.D/ME/38)

Under the Supervision of

Prof Suresh Kumar Garg
Professor,
Department of Mechanical Engineering
DTU, Delhi

Dr. Rishu Sharma
Assistant Professor
Department of Mechanical Engineering
GBPEC, Delhi

Department of Mechanical Engineering
Delhi Technological University
Bawana Road, Shahbad Daulatpur, Delhi-110042, India

June 2025

DECLARATION

I hereby declare that the thesis work entitled **"**STUDY OF PLANNING AND CONTROL ASPECTS IN MANUFACTURING**"** is an original work carried out by me under the supervision of Prof. S. K. Garg, Department of Mechanical Engineering, Delhi Technological University and Dr. Rishu Sharma. This thesis has been prepared in conformity with the rules and regulations of the Delhi Technological University, Delhi. The research work presented and reported in the thesis has not been submitted either in part or full to any other university or institute for the award of any other degree or diploma.

SURBHI UPADHYAY
(Regd. No: 2K18/Ph.D/ME/38)
Department of Mechanical Engineering
Delhi Technological University

Date:
Place: Delhi

CERTIFICATE

This is to certify that the Ph.D. thesis entitled "STUDY OF PLANNING AND CONTROL ASPECTS IN MANUFACTURING" being submitted by Ms. Surbhi Upadhyay to Delhi Technological University, Delhi, India, for the award of the degree of Doctor of Philosophy in Mechanical Engineering, is a bonafide record of original research work carried out by her under our supervision in accordance with the rules and regulations of the institute. The work presented in this thesis has not been submitted to any other university or institution for the award of any degree or diploma.

Prof Suresh Kumar Garg
Professor,
Department of Mechanical Engineering
DTU, Delhi

Dr. Rishu Sharma
Assistant Professor
Department of Mechanical Engineering
GBPEC, Delhi

Dedicated

to

my loving parents and parent-in-laws,

my beloved husband Vipin,

my son Rijul, and daughter Rhythm

ACKNOWLEDGMENT

I would like to express my deep gratitude, sincere thanks, and appreciation to my supervisor Prof. Suresh Kumar Garg and Dr. Rishu Sharma for their valuable guidance during my Ph.D. work. I am thankful from the bottom of my heart for all the help, encouragement, and support generously extended to me. I am grateful to them for their thoughtful guidance and generosity which made a huge difference to me, and for their scholarly suggestions, their compassionate disposition, and their advice throughout the work. I enjoyed working in a research environment that inspired great thought and skillful guidance by them.

I wish to express my warm and sincere thanks to Prof. Prateek Sharma, Vice Chancellor, Delhi Technological University, Delhi for providing me with the infrastructure and other necessary facilities to execute the present study in the University. I wish to express my sincere thanks to the Dean (PG), Prof. Rinku Sharma for her kind support during the entire academic and administrative work related to the thesis. I also sincerely thank the HOD of the Mechanical Department of DTU, Prof B B Arora for his cooperation. I am thankful to Prof. Pravin Kumar, Mechanical Department, DTU, for his motivation and support.

I am extremely thankful to the Management of Maharaja Agrasen Institute of Technology, Rohini, Delhi, for permitting me to carry out my doctoral research work. I am also thankful to Dr. Nand Kishore Garg, Founder & Chief Advisor-MATES, Prof. M. L. Goyal, Vice Chairman (Academics), Prof. Neelam Sharma, Director-MAIT, Prof. S.S. Deswal, Dean Academics, Prof. V. N. Mathur, HOD-MAE, and Dr. Vaibhav Jain, HOD-ME for all the support and encouragement. I would also like to express my sincere thanks to my dear friends and colleagues Dr. Piu Jain, Dr. Garima Sharma, Ms. Ruchi Goel, Ms. Rachna Chawla, Dr Anil Dahiya and Mr. Vikas Sharma of Maharaja Agrasen Institute of Technology, for their support and encouragement throughout this period. I am also thankful to the industry experts whose opinions have been valuable to me during the research process.

I would like to express my heartfelt thanks to my special and eternal friends, Ms. Shweta Kumar and Ms. Geetika Jain for their cheerfulness and joyful spirit, which has always held my morale high.

I am and always be forever grateful to my parents, Mr. S K Vashisht, and Mrs. Lata Vashisht, my in-laws, Mr. J P Sharma, and Mrs. Sheela Sharma, for their boundless love and utmost affection. My parents and in- laws have always stayed with me through all the bumps and challenges in the course of my research work. I can't imagine myself on this stage without their unceasing and fervent love. I would extend my gratitude and indebtedness towards my always supporting husband, Mr. Vipin Upadhyay, and my adorable son Rijul and my loving daughter Rhythm for their continuous love and support throughout the years, without which I can’t even imagine my life. The unwavering confidence of my children in me through undeterred, unconquerable, and sedulous encouragement and love has helped me reach this milestone.

A sincere thanks to my brother, Mr. Saurabh Vashisht, and bhabhi Mrs. Geetanjali Vashisht, for their moral support in my work. They strengthened and made it easier for me to cross the hurdles during the research. I sincerely thank all who are not listed here but have been instrumental in making my journey a fulfilling experience.

Surbhi Upadhyay

ABSTRACT

Production Planning and Control (PPC) is a critical component of a Make-to-Order (MTO) system that ensures production processes are coordinated to fulfil specific client demands while optimising resources and adhering to delivery deadlines. PPC in MTO settings is different from traditional mass production systems since each order is distinct and frequently customised. Make to Order (MTO) is increasingly important in order to satisfy constantly evolving client needs. The percentage of MTO enterprises has increased in tandem with the growing demand for customised goods. The MTO idea has been applied by numerous industries and product categories, giving them a competitive advantage in sustainable production. Make To Order (MTO) is a manufacturing management strategy that helps decrease overproduction and item waste, promotes sustainable manufacturing, and boosts overall organisational competitiveness. Manufacturing companies are facing increased competition in which customer requirements are more demanding in terms of flexibility, quality, cost, and response time. In light of these conditions, MTOs have drawn the attention of researchers and practitioners who see the benefits of reduced finished product inventory levels, high levels of customisation, and the ability to quickly adapt to changing customer behaviour. These systems not only meet the needs for a wide range of products but also make it possible to deliver products on time. Given this need for research, the current study focuses on the critical success factors, and implementation strategies for make to order manufacturing systems.

The literature review reveals that businesses are reluctant to embrace new technologies and aren't stepping up to switch from make-to-stock to make-to-order production processes in response to the demands of expanding markets. In order to address this study gap, a thorough evaluation of the literature is done on the critical success factors of MTO. The identification of

critical success factors and implementation strategies for Make to order manufacturing systems has been the subject of research; nevertheless, conceptual papers have received a greater amount of attention than theory-building articles. Furthermore, the Indian market scenario has received less research.

Make to Order as a manufacturing strategy is a rapidly developing idea in India, and the critical success factors of Make to Order that propel the present market were thoroughly investigated. This study aims to rank the various approaches to implementing make-to-order manufacturing systems and identify and prioritize the critical success factors (CSF) that can impact its adoption. Eighteen critical success factors were grouped into six categories and three implementation strategies ranked based on inputs from industry experts. The present research suggests an integrated methodology that employs the Analytic Hierarchy Process (AHP) to prioritise Critical Success Factors and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to rank the implementation strategies. The research indicates that the most effective way to execute MTO would be through a customer-centric approach.

Building a sustainability model using an MTO production system is the aim of this research. Sustainable manufacturing has piqued the interest of policymakers, producers, and society at large in an effort to reduce harmful environmental effects. Through this method, the researchers are looking into a number of elements related to Configurable Product, Customer Need, Emerging Technology, Information Technology, Market Performance, and Organisation Readiness. PLS-SEM (SMART PLS 4), or the Partial Least Squares technique to structural equation modelling, has been used to create the model and ascertain the degree of relationship between items based on the replies to structured questionnaires. The empirical results show that each strategy significantly affects the MTO production system. Competitive Advantage acts as a mediator for the relationship between MTO and Sustainable manufacturing. The current literature on sustainable manufacturing initiatives has been extended and improved by these findings, and give researchers a fresh angle from which to further explore this idea.

The manufacturing approach chosen for the deployment of Make To Order was verified by the research using the multiple case study method. With the aid of several case studies, this study sought to validate the earlier critical success factors. PPC expert, Sales and Marketing expert, IT expert, Head of operations, Product expert, Design Expert, and Business strategy expert from two Indian manufacturing companies were interviewed in depth. The case companies vary widely in terms of their ownership, size, and target markets. Identifying challenges and suggesting strategies to improve make to order implementation for competitive advantage are presented in industries attempting to apply it.

This study will help managers better understand the critical areas where greater emphasis is needed when considering a shift from make to stock to make to order. Identifying and prioritization of critical success factors and implementation strategies for MTO will assist managers and decision-makers in focusing on a few key drivers that will support in the transition from make to stock to make to order. The case studies will help practitioners to understand the critical success factors were practically used by certain companies for MTO implementation. A clear image of MTO as a business strategy is provided by the difficulties encountered by the case firms and the organisational lessons learned as well as the conclusion. This approach will assist managers in determining the necessary elements for the transition from make to stock to make to order.

TABLE OF CONTENTS

Chapter 5 Implementation of Make To Order Manufacturing system: PLS SEM modelling

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AHP	Analytic Hierarchy Process
ATO	Assemble to Order
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CI	Consistency Index
CR	Consistency Ratio
CSF	Critical Success Factors
EFA	Exploratory Factor Analysis
ETO	Engineer to Order
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
MTO	Make to Order
MTS	Make to Stock
OPP	Order Penetration Point
PPC	Production Planning and Control
PLS SEM	Partial Least Square - Structural Equation Modelling
RBC	Repeat Business Customizers
SFTT	Shop Floor Throughput Times
SME	Small and Medium-sized enterprises
WIP	Work in Progress
VMC	Versatile Manufacturing Companies

CHAPTER 1

INTRODUCTION

1.1 Introduction

In order to fulfil the ever-increasing customer expectations, manufacturers are under intense competitiveness and in these circumstances make to order (MTO) strategy is of great importance. Generally, manufacturing systems are of a combination of two extremes, MTS (Make to Stock) and MTO (Make to Order). The primary difference between the two types is the timings to receive a customer order. When an order arrives in the MTS system, all of the production is completed, and the customer's requirements are met from stock. Some or all of the production in the MTO sector occurs after the customer order has been received. As a result, there is more freedom in customizing items to satisfy the special needs of individual clients in the latter industry. This chapter thoroughly explains the background of Make To Order production system. Next, it discusses different aspects of MTO’s Planning and Control in detail. After that, it provides an explanation of the research's motive and the necessity of studying this subject. The research gap and the research objectives follow, reflecting the lack of prior research in that area. Next, the organization of the thesis is discussed followed by conclusion of the chapter.The flow of this chapter is shown in figure 1.1.

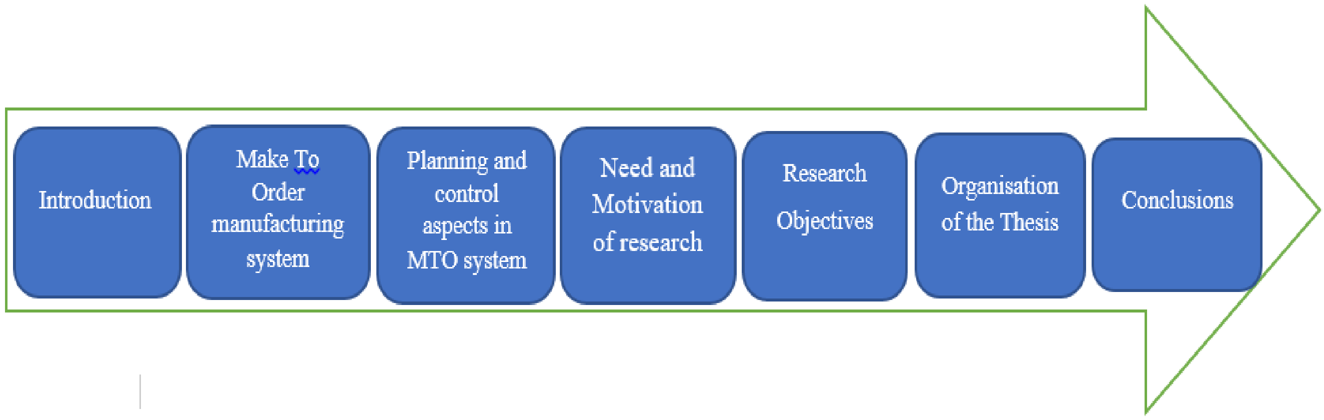
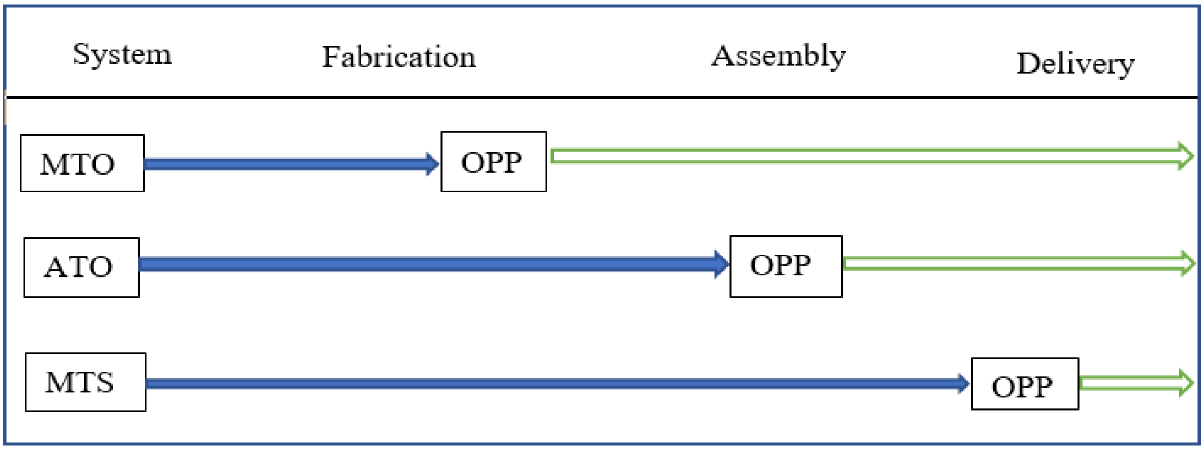


Figure1.1: Flow of chapter 1

Make to Stock (MTS), Make to Order (MTO), Assemble to Order (ATO), and Engineer to order (ETO) are some of the common classifications for manufacturing systems. The decoupling point between client and supplier influences the type of production chosen (Figure 1.2) . In some supply chains, such as the aerospace industry, a customer may follow an MTO process (because to the extremely particular nature of his product) while his supplier follows an MTS process (since variants of standards components are delivered). . Make to order (MTO) is defined as the system where the customized products are manufactured, in accordance with a customer order, especially useful when the variety of SKU are large. It implies a situation where a manufacturer is producing a standard product after the customer order, considering the conditions of built in inventories and infrequency of demand. These types of systems intents to produce high variety of components, meet delivery time, reduce lead time, and has high level of technical skills and flexibility to change product design and production quantity to meet customer requirements.



OPP – Order Penetration Point

Figure 1.2: Classification of Production systems.(Rafiei & Rabbani, 2012)

For MTO businesses, improving delivery reliability is becoming increasingly critical. These systems have enabled business processes to improve flexibility and produce customized products. Manufacturers must continue to be adaptable and flexible in light of the shorter product development life cycles and increased customised products brought about by the emphasis on innovation and customer happiness. The popularity of the MTO operational philosophy has increased as a result of these considerations (Chin-sheng Chen et al., 2009). MTO businesses are process-focused since the goods they produce have similar operations but different designs, which makes them effective at creating a wider range of items at a reduced cost as well as unique product manufacturing (Gallien et al., 2004). The products produced are unique or made in small batches, and this philosophy permits a great degree of operational flexibility. An order placed by a customer is the first thing an MTO company works on. Chin-sheng Chen (2006), has mentioned few examples of MTO operations like, Construction, industrial boilers and engineering tooling. To successfully implement MTO system, several aspects of PPC needs to be considered starting with identifying products which can be put to MTO system be followed by suitability of technology, manpower, organisation structure. The present research focusses on planning and control aspects of Make To Order manufacturing system.

1.2 Make To Order Manufacturing System

The modern industries are growing more complicated, and new technology must be introduced to keep up with the shifting trends. Industries these days require to improve business performance in terms of quality, cost and on time delivery. Considering these factors strategically helps them to compete globally. The manufacturing companies need to meet the increased competition where the factors like quality and cost are important to meet the dynamic customer needs. Due to these circumstances, MTOs have drawn the interest of researchers and practitioners. Their main benefits are lower inventory levels, a noticeable degree of customisation, and flexibility to adapt quickly to changing client needs.

In order to meet customer's expectations and cope up with the worldwide competition, MTO systems are gaining attention in manufacturing industries. With such systems, not only high product variety is met, but it also enables to provide on time delivery. This has also been highlighted that increase in the variety of SKU in the market, is the critical reason for rapid growth of MTO systems (Gharehgozli et al., 2008). Companies are searching for a way to manage products and associated processes, such as inventory, with these types of production paradigms available, where product customization is more and more of a requirement by customers. Production is started when a real customer order is received in an MTO production system. Delivery lead-time, average order delay, average response time, due dates, and other criteria are used in MTO systems (Soman et al., 2004). Make to order businesses compete with other businesses by providing items in response to a client order, based on pricing, technical skill, delivery time, and reliability in fulfilling deadlines. The biggest issue that MTO organizations encounter is correctly handling inquiries. Real customer orders drive MTO systems, whereas a pure (MTS) system is based on projections of future orders (Rafiei & Rabbani, 2012). Forecasting is taken into account at the highest levels of decision-making, with the goal of balancing capacity requirements and output volumes over the medium term. In order to meet the competitive requirement of markets, the issues related to MTO systems need to be studied in detail.

1.3 Planning and Control aspects in MTO system

Production Planning and Control (PPC) systems are essential instruments in the current highly competitive industrial environment to fulfil the ever-higher demands and expectations of customers. A PPC system's typical features include capacity planning, demand management, material requirements planning, task scheduling, and job sequencing. In order to generate long-term, sustainable revenues, MTO enterprises must efficiently manage planning and control processes. Selectively accepting available customer orders and concurrently planning for capacity are two ways to achieve this goal. The production planning and control process is essential in MTO enterprises due to the different sources of uncertainty that set them apart from MTS configurations (Corti et al., 2006). The study conducted by (M. Stevenson et al., 2005) took into account many elements, including the level of customisation, the significance of the customer inquiry phase, layout of the shop floor, the size of the organisation, and demonstrates how these factors affect the applicability of concepts related to planning and control. Reduced Work in Progress (WIP), reduced Shop Floor Throughput Times (SFTT) and lead times, decreased stockholding costs, enhanced demand responsiveness, and improved Delivery Date (DD) adherence are some of the main goals of these elements. These are significant goals, making the selection of the best PPC system an essential strategic choice. The recent study literature has increasingly emphasised the need to address the unique requirements of the MTO industry. Thus, a range of concepts in contemporary literature aim to tackle intricate manufacturing scenarios, such as the jobshop, which is commonly employed in this sector. Hence, to support practitioners in their system selection process, a critical evaluation of PPC approaches from an MTO perspective is required.

The goal of the planning and control process is to determine, given all the constraints listed in the problem description, which orders to accept at the current decision time, how many hours each resource must be assigned in each time period, and which sources to assign to each of the accepted jobs. Chin-sheng Chen et al. (2009), discussed the model in which the planning horizon is divided into discrete time intervals, or time buckets, of uniform length. Every time interval is taken to be one day without losing generality. Back orders with zero percent inventories are a hallmark of MTO since every customer order is distinct and cannot be produced in advance. Customer orders serve as the primary engine for MTO operations, thus it's critical to coordinate sales and operations to make the best use of the resources at hand by controlling system demand (Barut & Sridharan, 2005). Decisions regarding order acceptance are frequently made without consulting the production department or with insufficient knowledge of the available capacity due to a lack of efficient coordination and look-forward processes (Slotnick & Morton, 2007). Renna (2016), proposed a model to cope up with the production, planning and control policies in MTS – MTO production system. Their study suggested a policy to regulate the buffer levels to minimize the average tardiness of orders. The buffers' stock level must correspond with the manufacturing stages' capacity. In certain instances, the tardy performance deteriorates due to increased congestion or decreased production reliability if the implemented policy results in a larger level of stock than the stages of production can sustain. One important issue that determines the application of PPC is shop floor configuration (M. Stevenson et al., 2005). Because customised sectors have a significant percentage of Small and Medium-sized enterprises (SMEs), PPC tactics can be applied to a large number of MTO companies by being accessible to businesses with reduced resources. High levels of customisation, which include multiple end products, changeable routing, and multiple set ups, must be accommodated by a method for MTO applicability. Thus, to sum up, the following standards are suggested as the primary prerequisites for a PPC system in the MTO industry:

1. Considering Customer enquiry stage for determining capacity planning and delivery date.
2. Considering Job Entry and Job Release stages, with an emphasis on due date adherence.
3. Capacity to handle highly customised items, or non-repeat manufacturing.
4. Capacity to offer planning and control in situations where shop floor routings—such as general flow and task shops are unpredictable.
5. Relevance for Small and Medium-Sized Businesses

According to (Aslan et al., 2012), in order for MTO businesses to execute orders, the following PPC phases are essential:

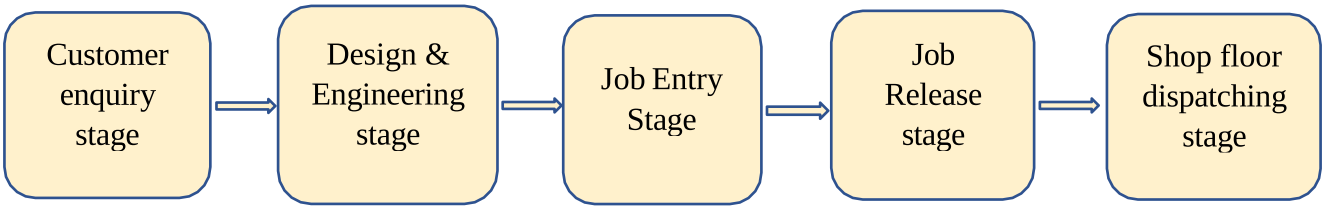


Figure 1.3: PPC phases for MTO business (Aslan et al., 2012)

1. Customer Enquiry stage: At this stage client asks potential suppliers for a quote on a certain product, asking them to determine a price and a deadline. PPC must start here for MTO organisations since every order is unique and actions made here have an impact on later phases (B. Kingsman & Hendry, 2002). Estimating lead times, evaluating the facilities and skills available for design and production, archiving and retrieving product data, estimating costs and profit margins, and effectively coordinating and communicating with all departments involved in the aforementioned activities are all necessary for making these decisions (L. C. Hendry & Kingsman, 1993) (B. Kingsman et al., 1996) (Moodie, 1999) (Cakravastia & Nakamura, 2010) (Calosso et al., 2004) (Mark Stevenson, 2006)

2. Design and Engineering stage: During this phase, accepted orders undergo more thorough engineering and design planning. In their framework for the MTO order-promise process, Rudberg & Wikner (2004) pointed out that order fulfilment and forecasting are necessary for both the production and design roles.

3. Job Entry stage: Purchasing, shop floor routing, and material requirements are all planned at this point in the manufacture of a confirmed order. The literature identifies four MTO planning requirements that are very crucial. First and foremost, the IT solution must permit specification modification (M. Stevenson et al., 2005) (Bertrand & Muntslag, 1993) (Amandeep et al., 2008) (Bertrand & Muntslag, 1993). Secondly, as many MTO businesses handle a combination of recurring and one-time orders, the capacity to expertly integrate the impact of forecasts on real plans is crucial (Amandeep et al., 2008) (B G Kingsman & Hendry, 1989). Thirdly, capacity planning is crucial, with any capacity limitations taken into consideration. This is crucial to make sure that deadlines are realistic and helps determine whether it's required to renegotiate deadlines with clients. It may be especially crucial in cases where there has been a significant lag between submitting a bid and receiving confirmation of an enquiry (M. Stevenson et al., 2005). Finally, since most orders are for large projects, MTO enterprises may need project management strategies and pertinent IT support (Bertrand & Muntslag, 1993).

4. Job Release stage: The Company determines when to begin producing a certain task by managing its release onto the shop floor during this decoupling period. Additional PPC may be required during this phase to guarantee that there is enough capacity available to release work in time for their deadlines. Consequently, as a component of a hierarchical structure, MTO organisations want this planning phase (Ã & Hendry, 2006).

5. Shop floor dispatching stage: During this phase, a scheduled shop floor is determined and sequencing of jobs handling control if the earlier hierarchical planning steps are properly managed (Brian G Kingsman, 2000).

1.4 Need and Motivation of Research

The MTO sector, which has got relatively little research attention, is becoming increasingly significant as a result of the enterprises' need to customise their output (Corti et al., 2006). It is argued that there is a higher market need than ever before for customised items. Due to the short product life cycles brought about by this expanding market, a corporation must offer a broad choice of products (Brown & Bessant, 2003) (Aslan et al., 2012). Demand can be erratic and product specifications are frequently unclear. MTO businesses have to simultaneously satisfy current clients and conduct a constant search for new business. The strike rate—the proportion of tenders that result in firm orders—shows how volatile the MTO market is. For MTO enterprises, this strike rate might be extremely low. Production planning in MTO systems is more complex than in MTS systems because of the large range of products, small number of standard items, and impossibility of accurate forecasts (S. Hemmati et al., 2012).

The application of MTO as a manufacturing strategy and the creation of a roadmap for MTO adaption has received very little attention. There are drifting bottlenecks in the make-to-order industry due to the wide variation in the mix of incoming orders. Also, the orders in the MTO industry can spend up to 90% of their entire production time sitting in front of or between work centres, with just 10% of that time actually being spent on machine. This results from the fluctuations in order quantities, the quantity of transformation operations required for each order, and the random intervals between inquiries and orders (B. Kingsman & Hendry, 2002) The main characteristics of the MTO systems are their long delivery times, more flexibility, and less storage costs because they are operated based on customer orders (Olhager, 2003). Delivery times typically increase when high-quality orders are produced (Ebadian et al., 2008). The MTO system's goal is to generate the best possible collection of arriving orders in order to maximise profit and ensure consistent due dates. Due to the stochastic nature of order arrival timings and the limited capacity of the system, MTO enterprises must give priority to incoming orders in order to enhance customer service. The system can only process a portion of the incoming orders before rejecting the remaining ones because of various limitations. MTO companies must, therefore, accept the best combination of incoming orders in order to grow their profits and market share. As a result, MTO systems require a decision-making framework to assist them in managing the arriving orders in order to satisfy these primary requirements because they are unable to foresee the arrival time of their orders and must fulfil the arriving orders promptly (S. Hemmati et al., 2012). A survey of the literature on MTO systems' production planning reveals that there aren't many studies on the order entry stage. Pinar Keskinocak, R. Ravi (2001), examines a model where the company has the discretion to accept or reject an order. They prioritised lead time quotation and scheduling. The lead time affects a job's revenue even though price isn't a decision made explicitly. Within a multi-tiered value chain that operates on an MTO basis, Calosso et al. (2003), went into great length on a negotiation process model and three decision-making challenges that are typical of the negotiation rounds that may occur. The issue of order negotiation regarding pricing and due date between suppliers and customers who operate on an MTO basis was also covered by (Calosso et al., 2004). An order entry stage decision-making framework for MTO environments was proposed by (Ebadian et al., 2008). Their suggested approach consists of five primary processes for handling incoming orders while taking delivery time and price into account.

Product specifications can change during the processing stage even after the order has been confirmed, and they are not known until a customer makes a request. There might be a significant delay between a request and an order being accepted, and very few requests actually result in orders. Because of this, lead times cannot be accurately forecast, and throughout the tendering process, during which the MTO Company must provide the customer with a certain due date, probabilistic assumptions on the workload of resources must be made. Practitioners could get advantages for the entire company by increasing the tendering phase's efficiency (Corti et al., 2006). Specifically, the following three essential components make it challenging to regulate MTO realities: complex nature of product flow, ambiguity surrounding the product specification and the dynamics brought on by fluctuations in mix and volume. Based on an analysis of each resource's rate of utilisation within the relevant time frame, capacity checks are performed. It is not always easy to predict with precision how much capacity will be needed in a given time frame given the high degree of uncertainty that permeates the MTO environment.

Following research gaps have been identified on the basis of the study:

Research Gap 1: Very limited work was found to study the planning and control aspects of Make To Order system.

Research Gap 2: To best of the review conducted, very less work was done to study the performance of Make To Order environment under different manufacturing systems and various customer Requirements.

Research Gap 3: Limited work to develop a strategic model for Make To Order system

The following research questions have been investigated in order to implement MTO in the Indian manufacturing sector, taking into account the research gap:

Research Question 1: What are the challenges faced while adopting MTO? What types of industries can be benefitted by MTO?

Research Question 2: What are the critical success factors and appropriate implementation strategies to be considered while transferring system from MTS to MTO.

Research Question 3: What is the impact of Make To Order approach over Competitive Advantage and sustainable manufacturing?

The research objectives were formulated in an attempt to address these research questions. The next part provides an explanation of the research objectives.

1.5 Research Objectives

This study attempts to fill in the empirical gaps in MTO adaptation, focusing on the ways in which manufacturing and design challenges impact MTO capacities for sustainability and competitive advantage in India's manufacturing sector. Literature review was undertaken to search literature from reputed databases with objective to find the planning and control aspects of make to order system. Experts from case studies who are familiar with the application, improvisation, and adaption of MTO in the contemporary business environment in India are required to validate the findings. It is required to identify Critical success factors and implementation strategies for Make To Order manufacturing. Identifying and prioritising these factors and strategies will help decision makers and managers to focus on this transition from MTS to MTO. Based on research gaps identified, following objectives are formulated:

Objective 1: To study the various planning and control aspects of Make to order manufacturing system.

Objective 2: To study performance of Make To Order environment under different manufacturing system and various customer Requirements.

Objective 3: To develop strategic model of Make To Order system.

1.6 Organisation of Thesis

Chapter 1 - Introduction: The introduction to the research topic is the main emphasis of this chapter. Background information on the study clarifies the necessity for a change from make to stock to make to order as well as the aspects of planning and control for MTO manufacturing systems, particularly in Indian manufacturing facilities. It provides an explanation of the research's motive and the necessity of studying this subject. The research gap and the research objectives are highlighted to reflect the lack of prior research in that area. Next, the organization of the thesis is discussed to provide the basic understanding of the discussions in each chapter.

Chapter 2 - Literature Review: The section includes Systematic Literarture Review, which consists of the contribution of make to order for competitive advantage. The major research areas concerning planning and control issues, critical success factors and implementation strategies for MTO is discussed in detail. A discussion of the Key MTO implementation issues is followed by its benefits and challenges. The chapter also includes the literature of Analytic Hierarchy Process (AHP), Technique for order preference by similarity to ideal solution (TOPSIS), Partial Least Square-Structural Equation Modelling for Hypothesis Testing (PLS SEM) and Case Study method. There is a conclusion at the end of the chapter.

Chapter 3 - Research Methodology: The philosophical presuppositions that underpin every research are covered in this chapter. The research technique, strategy, and approach are all discussed. This chapter first presents the chosen research study before going over the instruments and methods used in the investigation.

Chapter 4 - Prioritisation of Critical Success Factors and strategy selection of Make To Order Manufacturing system: AHP and TOPSIS approach: This chapter identifies Critical success factors for implementing MTO manufacturing system. The critical success factors are grouped into six categories and prioritised based on inputs from industry experts using Analytic Herirarchy Planning (AHP) technique. The Implementation strategies for a MTO system are identified and they are Ranked using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The result and discussions are mentioned at the end of the chapter.

Chapter 5 - Implementation of Make To Order Manufacturing system: PLS SEM modelling: In this chapter, the set of constructs for building a manufacturing model for the application of MTO is established. Through competitive advantage, the model is connected to sustainable manufacturing, and hypotheses are developed.

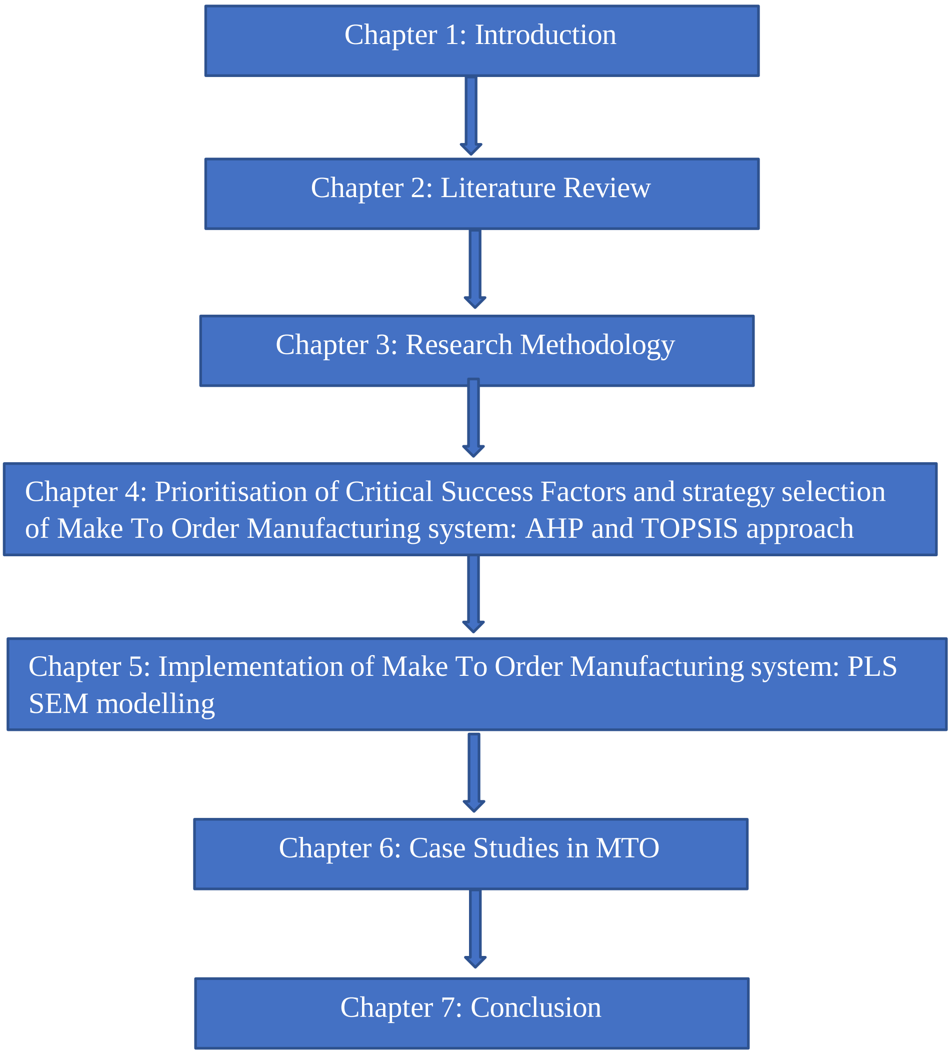


Figure1.4: Structure of the thesis.

Chapter 6 - Challenges in implementation of Make To Order: Case Studies: The suggested model for MTO implementation given in chapter four was verified in this chapter using the case study methodology. The two manufacturing sectors under study are the automotive component and apparel industries. Strategies that were identified by case companies during the implementation of MTO are highlighted, along with critical success factors role during the implementation process.

Chapter 7 - Conclusions: The final chapter provides a summary of the research, with an emphasis on the contribution this thesis has made to the body of knowledge regarding MTO acceptance in the context of developing nations like India. Furthemore addressed are limitations and research directions. The thesis is organized as shown in Figure 1.4.

1.7 Conclusions

This chapter presents an overview of the research conducted for this thesis and gives background information to help readers understand why the manufacturing industry must adopt Make To Order in order to maintain sustainability and gain a competitive edge. Planning and control concerns in MTO manufacturing are identified as the research motivation, and the identification of the research gap results in the formulation of research questions that serve as the study's objective. A summary of the literature that has served as the foundation for the research is provided in the next chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature on MTO in order to determine study areas based on the gap in the material, as was previously covered in Chapter 1. Although there has been much research on the subject of what makes MTO possible, there are still a number of issues for both conceptual and implementation that require research. By giving an overview of recent MTO literature, this chapter can be considered the basis for future research. The major research areas concerning planning and control issues, critical success factors and implementation strategies for MTO will be discussed in detail for obtaining Competitive advantage. In order to understand the selection of proper methodology for the analysis of the findings, a literature study on methodology will be discussed. The overview of MTO, Key MTO implementation issues, MTO benefits and challenges will be discussed to comprehend the potential of different factors to its implementation. There is a conclusion at the end of the chapter. The flow of this chapter is shown in figure 2.1.

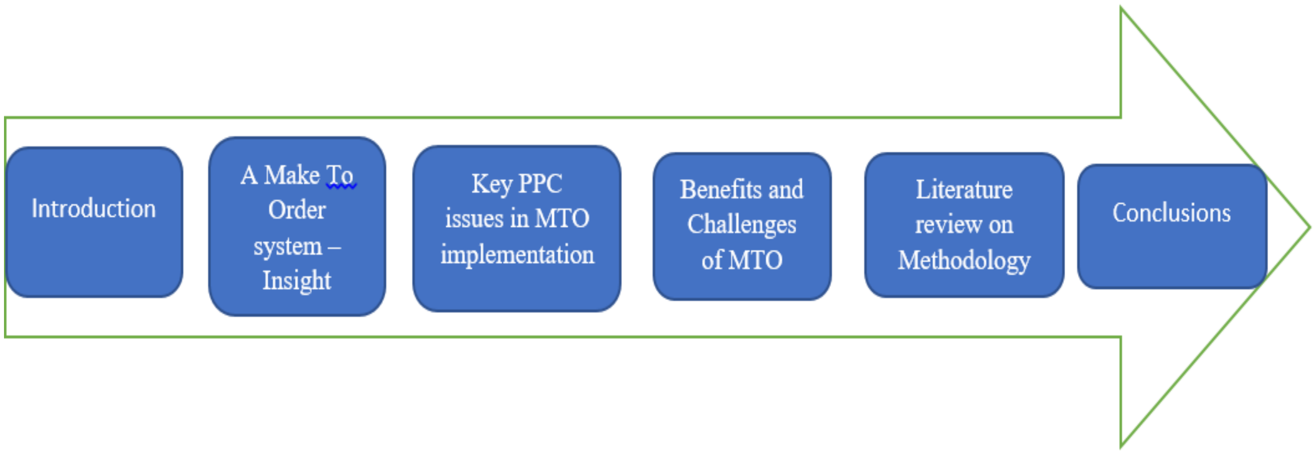


Figure 2.1: Flow of chapter 2

Make to order (MTO) is becoming more and more interesting to both industry for implementation and academia for research. It is well known fact that achieving long-term profitability is every manufacturing company's primary goal. The global business landscape has evolved in recent years due to factors like rising market complexity and demand, as well as increased rivalry brought about by globalisation and digitalization. Consequently, businesses face pressure to maintain competitiveness, which necessitates a strong and ongoing effort to identify opportunities for improvement. Businesses now operate in a more dynamic and unpredictable world where providing an ever-higher degree of customisation is essential due to the growth of the competitive backdrop in recent decades (Corti et al., 2006). Production planning is more difficult in MTO systems than in MTS systems because of the large range of products, lack of standard items, and impossibility of suitable forecasts. Product requirements are not known until a customer makes a request, and they may change during the processing stage even after the purchase has been confirmed (S. Hemmati et al., 2012). Work releases in an MTO system are only permitted in compliance with the arrival of external demand (Gharehgozli et al., 2008).

2.2 A Make To Order system – Insight

As one of the classifications, manufacturing systems are classified as Make to Order and Make to Stock (S. Hemmati et al., 2012), (S. Hemmati et al., 2009), (Günalay, 2011), (Rafiei & Rabbani, 2009) (Peeters & van Ooijen, 2020). Make to stock manufacturing systems respond to customer demand swiftly through the available stocks. However, this system is ineffective in markets that have enormous product variety according to needs of customer, and inventory holding costs are significant. MTO systems, on the other hand, can create highly tailored items, but buyers must wait for them to be filled (Almehdawe & Jewkes, 2013). MTO is a manufacturing system in which the receipt of a customer order triggers all processes within the company, from sales to procurement to product delivery (H. Li & Womer, 2012). Many organizations are shifting their manufacturing approach from MTS to MTO as customer expectations for large variety is increasing along with greater modification of the items (S. Hemmati et al., 2009), (Günalay, 2011)(Rafiei & Rabbani, 2009)(Peeters & van Ooijen, 2020) (Fakhrzad & Mohagheghian, 2019) (Kalantari et al., 2011). Short delivery times and the potential to create guaranteed delivery dates with significantly less inventory are the major competitive advantages in MTO situations (Ebadian et al., 2008). MTO describes scenarios in which a product is produced (Amaro et al., 1999) through a variety of services or engineering designs and cannot be manufactured without a customer order. MTO companies are usually pressured to maintain reduced delivery lead time, a wider range of parts of components, improved OTD (on-time delivery), achieve a high degree of technical expertise, and update product designs on a regular basis in order to fulfil customers' needs (Raturi et al., 1990).

Amaro et al. (1999), defines two categories of MTO firms based on contract type, which directly affects market strategy: Versatile Manufacturing Companies (VMC) and Repeat Business Customizers (RBC). While a VMC makes a wide range of items and competes for each order individually, an RBC continuously provides tailored products over the term of a contract. Thus, by persuading clients into a more dependable and committed relationship, the RBC is able to create greater stability (Stevenson & Hendry, 2007). RBCs often occupy an upstream position within supply networks, whereas VMCs are present at all supply chain levels. While it can be vital for VMCs to explore new markets, it is extremely important for RBCs to hold onto their present customers. In order to manage data and boost sales while dealing with a large number of both current and potential clients, software support may be necessary (Aslan et al., 2012). With MTO systems, the highly custiomized prioducts can be delivered but with delay in delivery. The product to be manufactured already prevails in MTO at the time of order entry. Six determinants of product design and development that can be used to evaluate consumer orders (Barbosa & Azevedo, 2018).

1. Design/Engineering workload
2. Project Type
3. Design reuse
4. Outsourcing
5. Complexity
6. Experience/knowledge of technology

Out of the manufacturing strategies available in literature, Make to order is one of the oldest strategy and is defined to be a pull-type supply strategy. With the rapid increase in the application technology and introduction of computerized machines, materials, purchasing and inventory management; the MTO strategies can be developed for mass produced items. Today’s market requirement is to deliver finished products to customers as soon as possible. In these kind of scenarios, system like MTO have gained large importance due to its benefits like reduction in inventory levels, high rate of customization and flexibility to adapt the changing environments to meet market fluctuations. It is critical for an MTO system to deliver products to customers on time and to accommodate a wide range of customized products. In addition to this, high price of the product will be make it of lesser advantage in market even if high customization rate is maintained. It thus becomes important, to develop a scheme that can prove to be helpful in various decisions like production, distribution, design and so on. It's difficult to match the demands for high personalization while delivering on time and at a low total cost in MTO (Mohammadi et al., 2020). It is highly important for MTO adopting firms to choose a strategy that can anticipate the demand patterns and customer’s needs for offering superior products at economical scale. For fulfilling this purpose, the firms requires to transmit the demand pattern of their customer to suppliers. In general, these firms follow existing product design but during manufacturing, they follow the user defined customization. Furthermore, production does not begin until the customer placed an order.

Many authors have discussed the supply chain aspect in MTO environment. MTO businesses are frequently found in the upstream and midstream ends of supply chains, for big and powerful customers. (Prasad et al., 2005) (A. Gunasekaran & Ngai, 2005). M. Stevenson et al. (2005), emphasised the value of web-based procedures that encourage information and knowledge sharing across supply chains and clarified how the existence of urgent orders is likely to influence the kind of PPC solution suitable for MTO businesses. In MTO supply chains, Sahin & Robinson (2005), emphasised the importance of cooperation and information exchange; Jr et al. (2005), report comparable results that support the usefulness of web-based methods. MTO companies gain few benefits due to sharing of information within supply chains. According to Sahin & Robinson (2005), increased due date adherence and cost reduction in MTO supply chains can be achieved by information exchange and collaboration along the supply chain. Therefore, a company's capacity to service its customers can be impacted by the relationships and information exchange that MTO enterprises have with their suppliers. In summary, information sharing plays a critical role in facilitating coordination in supply chains that include MTO suppliers. A summary (as given in Table 2.1) gives us a broader perspective of a MTO system.

Some recent work related to MTO has been discussed hereafter. An Indian MTO handloom saree sector performed a study to determine the supply chain risks which were generated during the pandemic and how to minimize its impact on the MTO handloom industry (Dohale et al., 2022). Another study reviewed and examined the strategies employed to fix and validate sequencing issues in make-to-order production on a single machine setting (Martinelli et al., 2022). To determine how PTH (production time hedging) impacts the retailer’s QDLT (quoted delivery lead time) choice and the supply chain’s effectiveness, an analytical model is

Table 2.1: Overview on Make To Order

Author	Methodology	Findings
M. Stevenson et al., 2005	Literature Review	Review of PPC in MTO companies. Paper highlights the key areas for future research in small and medium MTO companies
Oğuz et al., 2010	Case study – mathematical modelling - Mixed Integer Linear Programming (MLIP)	Paper Examined the Order acceptance and scheduling decisions in Make to Order System, to increase the revenues.
Sahin & Robinson, 2005	Mathematical modelling and simulation	The importance of information sharing and physical flow coordination in a make-to-order supply chain was explored in this paper..
Ebadian et al., 2008	Mathematical modelling - Mixed Integer Linear Programming (MLIP)	To improve the production planning framework in MTO environments, a more comprehensive decision structure for the order entry step was suggested.
H. Li & Womer, 2012	Hybrid Benders Decomposition	This research presented a decision framework for establishing MTO manufacturing supply chains.
Ebadian et al., 2009	Developed Hierarchical Production Planning Structure (HPP) and Simulation (ARENA 7.0)	To increase the performance of MTO systems in terms of delivery dates.
Zhen Wang et al., 2019	Game theory	Considered lead time quotation and hedging problem for MTO supply chain with retailer and supplier
Bagheri et al., 2022	Mathematical Programming	Studied the aspects of Rough cut capacity planning and considered capacity fluctuation in order to schedule customer order with minimum cost.
E. Kim & Van Oyen, 2021	Markov decision process framework	MTO manufacturing facility with two customer classes is examined together with a combined admission control, production sequencing, and production rate control problem
Lödding & Koch, 2020	New value stream method	Focussed on on-time delivery and factors influencing it in MTO companies.
Garmdare et al., 2018	mixed-integer non-linear model was	Proposed an integrated model for delivery time, price and scheduling for Make To Order manufacturing.
Chua et al., 2018	game theoretic approach	Analysed the MTO supply chain considering the multiple suppliers and manufacturers.

developed (Zhai & Cheng, 2022). For MTO manufacturing systems, a step-by-step model was created for combined optimization of production- and condition-based maintenance scheduling (Qiu et al., 2021). Another study presented a multi-objective discrete firefly algorithm as a solution for a scheduling problem encountered by flexible job shops in make-to-order production (Álvarez-Gil et al., 2021). One of the most important success factors for MTO producers is their capacity to establish and uphold short due dates in response to customer inquiries (Mezzogori et al., 2020). Numerous studies on the automotive sector have been carried out but very few have discussed the importance of attainment of sustainable manufacturing through MTO. Ha & Woo (2022), mentioned that operations or processes involved in car manufacture need massive investments into equipment, facilities, employees, and others. To implement digital transformation, increase digital technology innovation capacity, and enhance product research and development performance, automotive businesses should manage resources and the environment responsibly (Men et al., 2023). Dou et al. (2021), mentioned that the number of nations beginning to prioritize the sustainable growth of manufacturing is growing.

2.3 Key PPC issues in Make To Order Implementation

MTO businesses need to effectively manage their planning and control processes in order to provide long-term, sustainable revenue. The complexity of MTO models and variants is on the increase and hence requires close study related to production planning issues of a MTO system. A careful design and implementation of these issues helps the manufacturer to meet the market competitiveness. Indeed, an intensive literature review reveals that the MTO system’s production planning encounters various issues . This section attempts to look into some key issues of a MTO system.

2.3.1 Production Scheduling – Production scheduling, which is stated as the distribution of resources over time to fulfil a set of activities, has recently gotten a lot more attention in the literature recently. This area is clearly a sector which cannot be neglected. In order to cope up with MTO business optimization strategy, mass customization, timely delivery of products in market; it is important to design and implement efficient production schedule. MTO system was analyzed using hybrid swarm optimization method and tackled a significant variant of a combined production-distribution scheduling (IPDS) problem and offered a professional scheduling plan, as well as an appropriate production and delivery configuration, to meet MTO business optimization requirements (Mohammadi et al., 2020). Cheng et al. (2010), studies scheduling issues with declining jobs and learning effects, including proportional setup times. The goal of Wu et al. (2011), is to determine a timetable that will reduce the overall completion times. Although MTO reduces inventory, it also introduces issues such as production scheduling issues in the event of demand congestion or the inability to specify correct due dates, among others (Günalay, 2011). Reduced pool time and total lead time demonstrates the production management and scheduling model's ability to release and dispatch MTO items quickly. On-time delivery is the crucial criterion for assessing the satisfaction of customer. This indicates other significant performance indicators such as tardiness on its own. The major competitive factor in MTO systems is the lowering of lead times, which improves customer service (Renna, 2016).

2.3.2 Risk Pooling- . In inventory management, risk pooling (inventory pooling) pertains to the unification of inventory across several locations into a single (physical or virtual) location from which individual location requests are met (Berman et al., 2011). This approach is useful when structuring a supply chain so that demand aggregation at a single location can mitigate the effects of demand uncertainty (Edirisinghe et al., 2017). When demand is deterministic and supply is uncertain, the risk diversification effect of a decentralized inventory system reduces cost variance, making it the optimal alternative. This is in contradiction to the widely held belief that, due to the risk-pooling effect, centralization is best when supply is deterministic and demand is stochastic. Demand pooling is a well-known concept in operations management, and it is a key tool for managing demand volatility.(Schmitt et al., 2015).

2.3.3 Order Acceptance and Scheduling: The capacity to evaluate incoming orders based on performance and select the best orders to accept is a critical need for make-to-order (MTO) manufacturing companies to stay competitive (Ghelase et al., 2013). To handle the incoming orders, Gharehgozli et al. (2008), presents a two-phase, complete decision-making system. The first step involves reviewing the incoming orders to determine whether to accept them based on the due dates. They compute the completion date, the earliest release date, and the latest release date of the orders using the backward technique suggested by B. Kingsman & Hendry (2002). The approved orders are ranked in the second step using a multiple criterion decision-making methodology that combines two approaches, Analytical Heirarchy Process (AHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS). In order to improve the production planning framework in MTO environments, Ebadian et al. (2008), proposes a new comprehensive decision structure for the order entry stage that takes into account all stakeholders affected by the supply chain, including MTO company, subcontractors, suppliers, and customers. In order to maximise project profitability within a confined planning horizon, Herbots et al. (2010), look at capacity planning and dynamic order acceptance under limited regular and non-regular resources. Few research papers consider the order entry stage in MTO systems, an issue that was first presented by B G Kingsman & Hendry (1989); the authors emphasize hierarchical production planning as a critical component of MTO manufacturing system modelling. L. C. Hendry & Kingsman (1993), considered input–output control systems as a method to reject or accept new order arrivals. Ebadian et al. (2008), presented an entirely new comprehensive decision structure for the order entry stage that takes into account all supply chain stakeholders, including the MTO organization, customers, subcontractors, and suppliers, in an attempt to strengthen the framework for production planning for MTO scenarios.

2.3.4 Manufacturing Process planning: In an integrated manufacturing environment, Khoshnevis (2003), finds a solution to the challenge of generating alternative process plans by choosing different machining processes, grouping and ordering those processes, and creating a hierarchical process plan network. Only a portion of the floor is available with a job release, which is an intriguing concept put out by Chang & Chen (2002), in their discussion of process planning and scheduling. An intriguing concept for process plan representation was put out by Marefat (2004). Kafashi (2011), created an additional process plan presentation, where the generators of the process plans are the setups (specified by machine, tool, and tool approach direction), operations, and operation sequencing. MTO manufacturing organizations must be able to assess incoming orders with respect to productivity and choose the appropriate orders to remain competitive. For an MTO production system manager, the most pressing issues are order acceptance and machine control. Furthermore, MTO production must be a job shop, with process-specific workstations (Ghelase et al., 2013). Due to the need to satisfy new client order criteria, MTO extends production lead times. Using MTO, one of the challenges of modern operations management is to reconcile lead time and inventory risk conflicts (Tomino et al., 2009). MTO would initially be unable to match demand, which would result in lost sales (Peeters & van Ooijen, 2020).

2.3.5 Due Date Quotation and Pricing: Most of the time, due date quotation is capacity driven and oriented towards the combination of capacity planning and due date setting. However, the examination of the system burden is done from a temporal perspective at the aggregate level (Ghelase et al., 2013). Corti et al. (2006), put forth a methodology designed to assist decision-makers in determining whether the due date (DD) requested by a potential client is feasible or not. Zorzini et al. (2008), provides an empirical review of the capital goods industry's managerial methods for managing delivery times and supporting capacity. A sample of fifteen Italian firms forms the basis of the analysis. According to its findings, certain approaches to capacity and delivery time management appear to be more suited for particular industrial environments. Decision models that combine pricing and production choices are presented by Charnsirisakskul et al. (2006). Through numerical simulations, they demonstrated that price flexibility is helpful in all situations and that lead times and price flexibility are generally complementary. Samira Hemmati & Rabbani (2010) discussed that in MTO environments, the main purpose is to keep track of arriving orders' delivery dates for accomplishing timely and consistent delivery. Firms should use appropriate production planning to attain this goal.

2.3.6 Performance Measurement: Manufacturing organisations often base their performance measuring systems on cost analysis. These solutions miss the important performance concerns in the current production environment (Ghelase et al., 2013). Manufacturing operations are monitored, controlled, and improved with the use of assessment outcomes. Thus, in an effort to give managers and operators pertinent data to assist their everyday operations, numerous researchers proposed innovative techniques to performance monitoring. A novel methodology for measuring performance is provided by Chee-cheng Chen & Cheng (2007). There are four indications in total, and each has a certain weight. The following performance measures— manufacturing lead time, work in progress and workstation utilization—are considered consistent for a make-to-order environment (Haskose et al., 2004). Total productivity is taken into consideration as a significant performance indicator (Mohanty & Barlow, 2005). B. Kingsman & Hendry (2002), exhibited that input–output control improves performance measures such as capacity utilization, waiting time, and lead time. MTO systems are characterized by extended lead times, despite the fact that they provide high levels of product customization and retain constant client participation (Ioannou & Dimitriou, 2012).

MTO companies can offer a wider range of items and customer orders while reducing inventory concerns, while customer lead times are usually higher (Teimoury et al., 2012). To exist in an uncertain and complex environment, MTO production systems should react quickly in terms of beneficial market position. Total lead time, cycle time and OTD (on-time delivery) are the major performance measures for products manufactured by the MTO approach (Eivazy et al., 2009). The lower the cycle time standard deviation, the more negotiating leverage each MTO product has in deciding its delivery date and price. In a competitive climate, total lead time is another important component for high income, rapid growth, and increased margins for businesses. Total lead time is the amount of time it takes for an MTO product to arrive in the job pool and leave the production floor. Eivazy et al. (2009), mentioned that this performance metric depicts workload flow and a balanced workload on the production floor, which is a key aspect in maintaining shop floor production management. Pool time, in addition to workload balancing, is also indicated by this performance measure

2.4 Literature review on Research Tools used

To address the study objectives, a systematic technique should be applied. In addition to understanding the how and why of specific research procedures, the researcher also needs to understand which approaches or methods are appropriate and which are not. A literature review was conducted in order to comprehend the different research methodologies used by authors to solve comparable challenges in the already accessible literature. For first objective, AHP was selected for prioritizing critical success factors and TOPSIS was chosen for ranking implementation startegies or alternates. For second objective, PLS SEM was selected to construct and evaluate the hypotheses. For third objective, case study approach was selected.

2.4.1 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making tool used where the decision is influenced by subjective and objective criteria. It is a simple technique for decision-making designed by Saaty (1980) to tackle complicated, multi-attribute, and unstructured problems. When both tangible and intangible components of a decision need to be examined, AHP is a strong and adaptive decision-making technique that may help people define priorities and choose the optimal option (Rao & Davim, 2008). According to Fountzoula & Aravossis (2021), “Since its inception, AHP has long been a tool in the hands of decision-makers and researchers, and it is one of the most widely used multiple-criterion decision-making tools on the market”. The ability of AHP to integrate with a number of techniques, such as quality function deployment, TOPSIS, linear programming, and fuzzy logic, is one of its distinguishing features. As a result, the user may get far more out of all of the integrated methods and achieve the desired outcome faster. An extensive literature review demonstrates that in the past, several researchers have used AHP both in manufacturing and service sectors. The AHP technique is based on three guiding principles: the model's structure; evaluating options and criteria; and synthesizing priorities. Tables 2.2 highlight different areas of application for AHP.

2.4.2 Technique for order preference by similarity to ideal solution (TOPSIS)

Technique for order preference by similarity to ideal solution (TOPSIS) is a ranking algorithm established by Hwang and Yoon in 1981 (Hosseini et al., 2019), and it is still in use today for conception and implementation. As a multi-criteria decision-making tool, TOPSIS is a straightforward but effective strategy for prioritization. An in-depth literature review has been performed to comprehend the importance of TOPSIS and its application in different fields. Tables 2.3 highlight different areas of application for TOPSIS.

2.4.3 Partial Least Square-Structural Equation Modelling (PLS SEM)

PLS-SEM is a causal-predictive method for SEM that emphasises forecasting in the assessment of quantifiable models with constructs intended to provide causal explanation. Many analysts find the PLS-SEM approach appealing because it enables them to evaluate intricate models with several builds, pointer factors, and structural approaches without forcing distributional assumptions on the data. There are two types of SEM methods: covariance-based and partial least squares (PLS-SEM) (Joe F. Hair et al., 2014). Maximising the explained variance of the dependent latent components is the goal of the PLS-SEM causal modelling method. In many theoretical models and empirical data scenarios, PLS-SEM path modelling provides a "silver bullet" for estimating causal models when used effectively (Joe F. Hair et al., 2011).

Table 2.2. Research areas of application AHP

References	Areas of application	Findings
Zhichao Wang et al., 2020	Precision analysis of five-axis CNC milling machine (9 main criteria , 53 sub criteria)	Life prediction and precision evaluation of five-axis CNC milling machine.
Younas et al., 2019	Sustainable machining of Ti6Al4 alloy (4 criteria)	Achieved advantages of high speed machining Ti6Al4V.
Oliveira et al., 2018	New Product Development focused on SME's (6 criteria)	To define relative importance of SME's characteristics.
Durão et al., 2018	Selection of Internet of Things process (5 criteria)	Selected suitable process for improvement by IOT technology.
Fortunet et al., 2018	Optimization of dimensions of an I Beam Profile for obtaining optimal performances (3 main criteria)	Optimized geometry of an aircraft's I beam, considering use and manufacturing process of the same.
Rajesh & Malliga, 2013, Özkan et al., 2011 and Yücenur et al., 2011	Supplier Selection (3 main criteria), Supplier Selection (4 main criteria , 16 sub criteria) and Selection of global supplier (4 main criteria , 28 sub criteria) respectively	Selection of supplier for a medium scale industry manufacturing die cast components of precision machined aluminum alloy and for computer and printer purchasing. Also, it's used supplier selection in global supply chain.
Amiri, 2010	Selecting project for oil-fields development (6 criteria)	AHP analyzed the structure of the problem for selection of project, and the weights of the criteria are determined.
Şahin et al., 2019	Site selection for establishing a new hospital (6 criteria and 19 sub-criteria)	AHP has been used to investigate a decision model for selection of site for establishing a new hospital (Turkey)
Y. Li et al., 2019	Assessment of risk in the life cycle of distributed wind farm (4 main criteria , 21 sub criteria)	Risk factors have been identified for distributed wind power and ranked using AHP.
Canco & Kruja, 2021	Decsion Making by Business managers	provided managers with a valuable manual for enhancing performance and decision-making in marketplaces with intense competition.
Das et al., 2022	Building supply chain resilience	assisted policymakers in creating a risk-resilient architecture that can improvethe supply chain's operational capacity and performance.
Chiclana et al., 2024	Decision support techniques for cost-benefit analysis	AHP with consistency outperforms the other methods for competence levels greater than or equal to 0.25

Table 2.3. Research areas of application of TOPSIS

References	Areas of application	Indicators/Alternatives
Ocampo, 2019	Large Food production firms (7 alternatives)	In food production system, the content strategy to make it sustainable is determined using TOPSIS.
Vavrek & Chovancová, 2019	Environmental energy performance of the EU countries (7 indicators)	quantitative analysis of EU country's energy, environmental and economic performance
Abdel-Basset et al., 2019 and Arabzad et al., 2015	Selection of suppliers (5 alternatives), Supplier selection and order allocation problem (5 alternatives) respectively	To select supplier with group decision making under type-2 neutrosophic number. Also, it's used for calculating weights of criteria for supplier selection and order allocation.
Alao et al., 2020	Select the technology for waste -to -energy plant (4 alternatives)	Using the waste stream from Lagos, Nigeria, to choose the best technology from the available waste-to-energy possibilities.
Hosseini et al., 2019	Ranking Western Iranian Hospitals based on Disaster Preparedness (8 alternatives)	TOPSIS method is used to rate hospitals according to how well-prepared they are for disasters.
Umer et al., 2021	Selection of solar tracking system (3 Alternatives)	For making multiple subjective decisions, TOPSIS is employed by decision-makers having distinct decision-making perspectives
Swain et al., 2021	To establish the plasma spray process's optimal parametric settings (3 alternatives)	TOPSIS revealed the gas flow rate and current's optimized parametric setting
Sirisawat & Kiatcharoenpol, 2018	Green supply chain management (14 alternatives)	TOPSIS is used to prioritize solutions for reverse logistics barriers
Sharma & Singhal, 2017	Facility Layout Planning (5 alternatives)	TOPSIS is applied to select procedural approach for facility layout planning
(Deveci et al., 2023)	Urban transportation and safety (4 alternatives)	TOPSIS found that the best area for Metaverse to improve traffic safety is public transport.
(Dinh et al., 2024)	The design of a two-stage helical gearbox with second stage double gear-sets multi-objective optimisation problem (MOOP) (3 design alternatives)	To determine the optimal basic elements for raising gearbox efficiency and lowering gearbox cross-section size.

In recent years, PLS-SEM has become more widely used in a range of sectors; the main reasons for this include the usage of formative markers, small sample sizes, and nonnormal data. In order to overcome data deficiencies like heterogeneity or accommodate more complicated model structures, recent methodological research has expanded PLS-SEM's methodological toolkit. Table 2.4 highlights some review and research work of PLS SEM.

Table 2.4: Research areas of applications of PLS SEM

References	Areas of Application	Findings
Tian et al., 2020	Employee retention in SMEs	PLS SEM was used to model the impact of transformational leadership on retention of employees. Moderating role of communication and mediating role of organizational citizenship behaviour was also probed.
Durdyev et al., 2018	Construction sector in Malaysia	PLS SEM was utilized to model the barriers to sustainable construction
Silaparasetti et al., 2017	Construction projects of Oman	Smart PLS analysed the impact of five occupational health and safety factors
Iqbal et al., 2021	Innovation Performance in SMEs.	Innovation performance has direct and positive relation with organizational commitment and entrepreneurial orientations.
Joe F Hair et al., 2012	Literature Review	PLS SEM is extensively used in Marketing Research
Kura et al., 2015	Organization deviance among PG students in Nigeria	moderating effect of self-regulatory efficacy on relationship between punishment-related factors and organizational deviance.
Min et al., 2020	Manufacturing SMEs in Pakistan	PLS SEM model showed a strong relation between supervisory behaviour and sustainable employee behaviour.
Joe F. Hair et al., 2011	Literature Review	In many theoretical model and empirical data scenarios, PLS-SEM route modelling can provide a reliable estimate of causal models, making it a valuable tool.

Table 2.5: Research areas of application of Case study

Authors	Area of applications	Findings
Dou et al., 2021	Sustainable competitiveness of manufacturing	In order to analyse the recent industrial development trends in the G20 participating countries between 2008 and 2018, the purpose of this research is to construct the entire competitiveness index.
Alao et al., 2020	Choosing the best waste-to-energy technologies to generate distributed electricity	The paper considers the case study of Lagos, Nigeria to determine optimal technology using TOPSIS for distributed energy generation using the municipal solid waste
Rossini et al., 2019	MTO manufacturing company in Italy using Kaizen	Case study conducted using the new kaizen framework, which outlines the roles, duties, and project phases for every stage of the improvement process.
Ahmadabadi & Heravi, 2019	impact of critical success factors (CSF) on the outcome of public-private partnership (PPP) projects	Two case studies were selected based on Highway projects in Iran. Based on case study results, this model is able to accurately depict project terms and forecast how CSFs would impact stakeholders' goals.
Hutter et al., 2018	Production Planning and Control in Make To Stock company	It is a case study of an order release mechanism that a MTS firm successfully implemented using the WLC principle.
Heshmat et al., 2013	Production Line Simulation modelling	As a case study, a cement line is analysed by simulation model and calculates optimum buffer size with the increase in production rate.
Švančara & Králová, 2010	Production system improvement in MTO manufacturing	The provided case study demonstrates the value of simulation modelling in enhancing production processes.
Ho et al., 2007	Automotive Supply Chain Management	Using a case study methodology, this research tackles the issues of uncertainty present in the automotive supply chain.

2.4.4 Case study

One effective technique for encouraging process transformation is the case study method. It aids in the transitional stage that permits the blending of concepts at different hierarchical levels for practitioners. Consequently, it facilitates and expedites the process of developing and executing a strategic action plan (Angappa Gunasekaran et al., 2017). One of the research methods chosen was the case study because it concentrates on comprehending the dynamics that exist inside a specific setting (Leung et al., 2020). Case study research is a qualitative method that is thought to be helpful for investigating events in their real context and obtaining understanding by looking at real-world applications (Bordeleau et al., 2019). Researchers who closely collaborate with several case studies can produce new ideas through field research and exposure to real-world challenges, creative thinking from individuals at all organisational levels, and a variety of case scenarios (Frutos & Borenstein, 2004). Several applications of case studies were found in the literature. A case study was conducted by Dou et al. (2021) on G 20 participating countries for sustainable development of manufacturing. (Alao et al., 2020) included a case study in Nigeria to choose best waste-to-energy technologies to generate distributed electricity. Rossini et al. (2019) and Hutter et al. (2018) chose MTO and MTS companies respectively for the case study. The case study by Švančara & Králová (2010) demonstrates the value of simulation modelling in enhancing production processes. Using a case study methodology, Ho et al. (2007) tackles the issues of uncertainty present in the automotive supply chain. Table 2.5 discusses a few well-known studies that chose case studies as a research methodology.

2.5 Conclusions

The literature review's justification for the research goal is the necessity of Make to Order to achieve competitive advantage. This chapter includes in depth assessment of literature on the performance of key Production and Planning issues in make to order manufacturing system. AHP, TOPSIS, PLS-SEM, and other approaches have all been examined, and their uses in diverse domains have been investigated. This chapter forms an understanding of the transformation process from make to stock to make to order and gave insight to MTO system.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The primary concern of this chapter is the research methodology used in the thesis to examine make-to-order and its use in the context of manufacturing enterprises in India. Following the definition of the research objectives in Chapter 1, a research process design was needed, in which the research design and the framework for conducting the research were to be specified. This is achieved in the section on the research process, which covers the framework for the research design for the current study as well as the different kinds of research designs that can be used to finish the research task. The following sections of this chapter will address common research technique topics, including the research instrument, survey design, structure, and data collecting. These sections will also include a discussion of the different statistical and mathematical techniques that were employed in the study. Steps in data analysis and interpretation will also be covered. This will be followed by a summary of the research procedures that were used. The flow of the chapter is shown in figure 3.1.

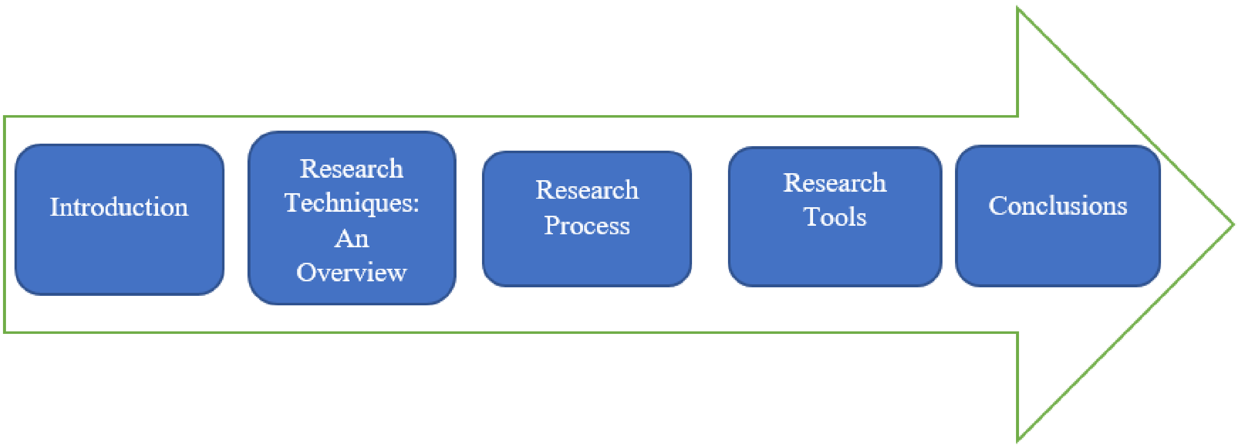


Figure 3.1: Flow of Chapter 3

Research methodology pertains to the scientific approach of rationally implementing many processes to tackle a research challenge. The approach facilitates a deeper understanding of the methods and findings of scientific research. The goals of the research methodology are to define and assess the methodologies, articulate the assumptions and conclusions in a transparent manner, and relate their potential to unexplored territory at the "frontiers of knowledge." A methodology is a broad study plan that outlines the procedures to be taken when carrying out research. It contains a number of convictions and philosophical beliefs that help frame the research issues and justify the choice of approach. The research strategy used in a dissertation or thesis must support the consistency of the techniques, resources, and underlying philosophical presuppositions. The research methodology employed should be sufficiently detailed to enable a different researcher to replicate the study in order to advance the field while maintaining the progression of previously achieved goals.

3.2 Research Techniques: An Overview

Research is the systematic process that includes theory building and generalisation. Thus, the term "research" designates a methodical procedure that involves defining the problem, formulating hypotheses, gathering data, and analysing it. After the facts are presented, a conclusion is drawn, either by offering solutions to the particular issue at hand or by drawing certain generalisations from a specific theoretical framework. The research challenge can be deliberately approached by applying research procedures. Examine the several methods that researchers commonly use to assess the research challenge and the justifications for each method. The researcher needs to be knowledgeable about both the plan and the study procedures/methods. Researchers not only need to know how to use specific research methodology, construct specific indices or tests, and discern which processes or approaches are relevant and which are not, but they also need to know what these would involve. A research project's duration, goal, surroundings, location, and methods can all be classified. While certain research are comparable to one another, others differ slightly. However, there is some significance to every kind of research. Chapter 1 discusses the research objectives that were determined by the research gap.

Here is a discussion of the different kinds of research:

Basic Research: It is also known as user research or "need-based" research. The major goal is to resolve issues that a community, business, government agency, or group is currently facing. One type of applied research is examining social, political, and economic developments that negatively impact various industries. For this kind of research, secondary data are typically used.

Pure Research: A pure research study is one that aims to further human understanding. It is finished in order to surpass the unknown realities. There is discussion of both generalisations and the creation of new theories. Basic research advances our understanding of science even though it might not offer solutions to the current issue.

Applied Research: This focuses on studies utilising the qualitative approach. It is useful for studying how people behave. It is possible to infer information about someone else's body language, attitude, beliefs, feelings, etc. by simply observing them. It will be very helpful to psychiatrists as well as interviewers. Word association tests, phrase completion tests, picture-sketching tests, and thematic apperception tests are a few of the techniques used. "Motivation Research" is a common name for it.

Empirical Research: Experimental research is another name for an empirical research. The researcher should outline the experimental procedures and provide a working hypothesis prior to beginning this investigation. Before starting an investigation, a researcher should give a working hypothesis and write out his plans for the experiments. In this kind of research, the hypothesis is examined, evaluated, and tested utilising primary data.

Descriptive Research: This study focuses on description, which is a component of descriptive research. It includes many different types of information, including survey design and information gathering techniques. The study's variables are not influenced by the researcher.

3.3 Research Process: The research process is comprised of following steps (Patel & Patel, 2019).

3.3.1 Formulation of Research Objective:

A research problem is a particular concern or knowledge gap that the researchers hope to fill through their investigation. Researchers might decide whether to focus on theoretical issues with the goal of advancing knowledge or practical challenges with the goal of bringing about change. The subjects of research are relationships between variables and natural events. As soon as it is practical, the researcher must decide on his general field of interest, a facet of the subject matter, or the issue he wishes to investigate. Once the subject has been covered in general, any questions can be answered. Prior to developing a feasible issue formulation, it is necessary to consider the feasibility of a certain solution. Therefore, the articulation of a broad topic into a particular study problem marks the beginning of scientific investigation. Chapter 1 has already covered the research gap that informs research questions and the creation of research objectives. Few of the advantage of research are:

- Many policies are formulated by the government with the help of research. Researchers work on almost all government budgets and programmes, helping to design and implement them. The monthly budget, the yearly budget, and the monetary and economic policies are all made by the government. Many organisations assist the government in using research to formulate policies.

- A wide range of businesses hire researchers to work on different topics. It's used to investigate the changes that are taking place in the market. It helps with capital budgeting, tax management, and cost-cutting strategies.
- It inspires creativity and leads to the finding of new information and theories. It encourages the advancement of the populace and society. It gives the researcher the ability to explore the problem in great detail and come up with new ideas.
- Numerous notions are produced, and accepted realities are altered.
- Prejudice, urban legends, and superstitious beliefs are rejected.

3.3.2 Extensive Literature Review

To determine the precise study topics, a review of the pertinent literature is required. A literature review needs to review and evaluate a broad range of materials, including books, articles from professional and academic journals, and online resources. The literature search facilitates the identification and location of relevant texts and other sources. Digital resources and bibliographic databases can be explored via search engines. Conceptual frameworks are a useful resource for learning about a certain subject. A literature review is prepared by scanning, taking notes, organising the review, writing the review, and compiling a bibliography (Rowley & Slack, 2012).

A systematic literature review (SLR) approach is utilised to compile and arrange existing knowledge in order to completely comprehend the mass customisation implementation process, enablers, and drivers. The collected literature was reviewed, the research was synthesised, and the findings were presented before developing a study procedure. This protocol contained precise objectives for the screening process, assessment based on inclusion and exclusion criteria, and literature review. Keyword searches were used to find research publications in the Science Direct, Emerald, Springer, SCOPUS, and Web of Science databases. The terms "make to order," "critical success factors," "Indian industries," and "production planning and control" were among those that were utilised. Finding out how much make to order in manufacturing has been treated holistically and what variables have affected its adoption were the main objectives. Only peer-reviewed articles that fell into a few designated subject categories were allowed. We further evaluated and scrutinised these research publications to look for patterns and traits. Figure 3.2 depicts the article searches and selection process. Chapter 2 contains a thorough assessment of the literature.

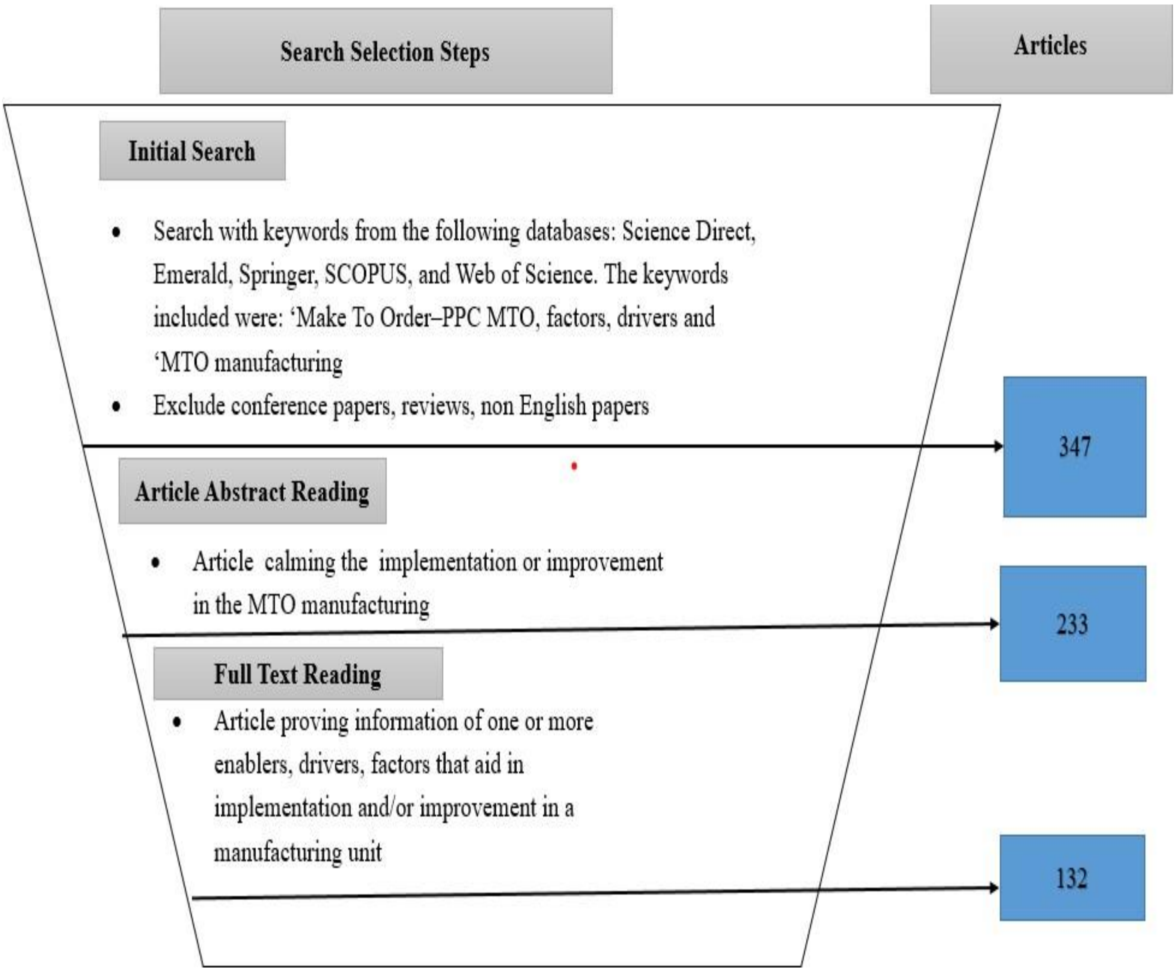


Figure 3.2: Steps for Article search and selection of Literature review

3.3.3 Research Design Preparation

Research design aims to simplify the process of obtaining pertinent data while minimising costs, time, and effort. It also serves to provide the conceptual framework for the study. Numerous scholars and researchers have already discussed study design from a variety of perspectives. The term "research design" refers to the framework and strategy of an investigation that is used to generate results in answer to research questions. That is the study's overall plan. The study design consists of an overview that covers the findings from developing hypotheses and deriving conclusions from them after doing the last round of data analysis. A structure is defined as a framework or shape that illustrates how the variables in the study relate to one another. A research design aims to guarantee that the information gathered permits scholars to tackle the research problem. If these design concerns weren't addressed early, the results can be flimsy and unpersuasive. Three types of research designs can be distinguished based on their characteristics: exploratory research designs, descriptive research designs, and explanatory research designs (Saunders et al., 2019). A baic description of various research design types is given in Table 3.1.

The research methodology utilised in this study, which integrates all three categories, is known as a combination study design. The concept of "make to order" was investigated in the study's first phase using an exploratory research design through an extensive assessment of the literature (drawing from a range of sources, such as national and international journals, websites, research reports, periodicals, etc.). This helped to obtain comprehensive information and understanding of make to order and many of its connected aspects and elements in the case of a specific segment of the Indian manufacturing industry. Exploratory research has been done to review the literature and build the study's hypothesis. This helped us get the data we needed to finish our study projects as a result. In order to ascertain the links between the dependent and independent variables specified in the first stage, explanatory research is carried out in the final step. This level of analysis has used structured equation modelling to explain the connection between the elements of make-to-order strategy, sustainable manufacturing, and competitive advantage. The research design that must be used for the study was determined by mapping the research objectives and the identified research gap to the research methods covered in Chapter 1.

Table 3.1: Comparing Research design types

Exploratory Research Design	Exploratory research is a methodology approach that investigates research questions that have not previously been studied in depth. Exploratory research is often qualitative and primary in nature.
Descriptive Research Design	Descriptive research is described as research that defines features of items, people, clusters, organizations, or surroundings. it tries to show the idea of a given situation.
Explanatory Research Design	Explanatory research is a research method that explores why something occurs when limited information is available. It can help you increase your understanding of a given topic, ascertain how or why a particular phenomenon is occurring, and predict future occurrences.

3.3.4 Research Instrument, Survey Design, Structure, and Data Collection:

Exploratory research has been done to build the study's hypotheses and review the literature. A sample design is a current strategy selected prior to gathering any data in order to select a sample from a particular population. The process of data analysis came after the data was collected. Descriptive statistics are the numerical and graphical techniques used to arrange, display, and analyse the data from questionnaire responses. A variable in a sample can be described using a variety of descriptive statistics, depending on how much measurement has been done. The assessment of hypotheses comes after the data have been examined as previously mentioned. This will help determine whether any facts support or refute the idea.

When a hypothesis is being tested, this is frequently the first question to be addressed. After testing, the hypothesis will either be accepted or rejected. A hypothesis may be able to be generalised or developed into a theory if it is tested and repeatedly found to be correct. The greatest usefulness in research comes from its ability to make certain generalisations. A statistical method called exploratory factor analysis (EFA) is used to distil a large number of observed variables down to a small number of "factors/components," and confirmatory factor analysis (CFA) was employed to determine a connection between the variables and the latent construct(s) that underlie them. PLS SEM was used to assess the manufacturing model responses to test the hypothesis. Figure 3.3 illustrates the research gaps and objectives together with the methods used in the study. The tools used in the research are discussed in detail.

3.4 Research Tools

To review the literature and build the study's hypotheses, exploratory research has been carried out. A sample design is an existing plan selected before any data are obtained in order to select a sample from a particular population. The method of gathering or collecting data is planned in the data collection design. Both primary and secondary data collecting methods can be applied to a variety of data collection tasks. The process of data analysis came after the data was collected. Descriptive statistics are the numerical and graphical techniques used to arrange, display, and analyse the information gleaned from questionnaire replies. The kind of descriptive statistics used to characterise a variable in a sample depends on how much measurement has been done. Following the previously outlined data analysis, the hypotheses are assessed. Testing will determine if the hypothesis is accepted or rejected. A hypothesis may be generalised or developed into a theory if it is tested and repeatedly shown to be correct. The research gaps and objectives are mapped with the technique used in the study in Figure 3.3. The research instruments used are described in detail.

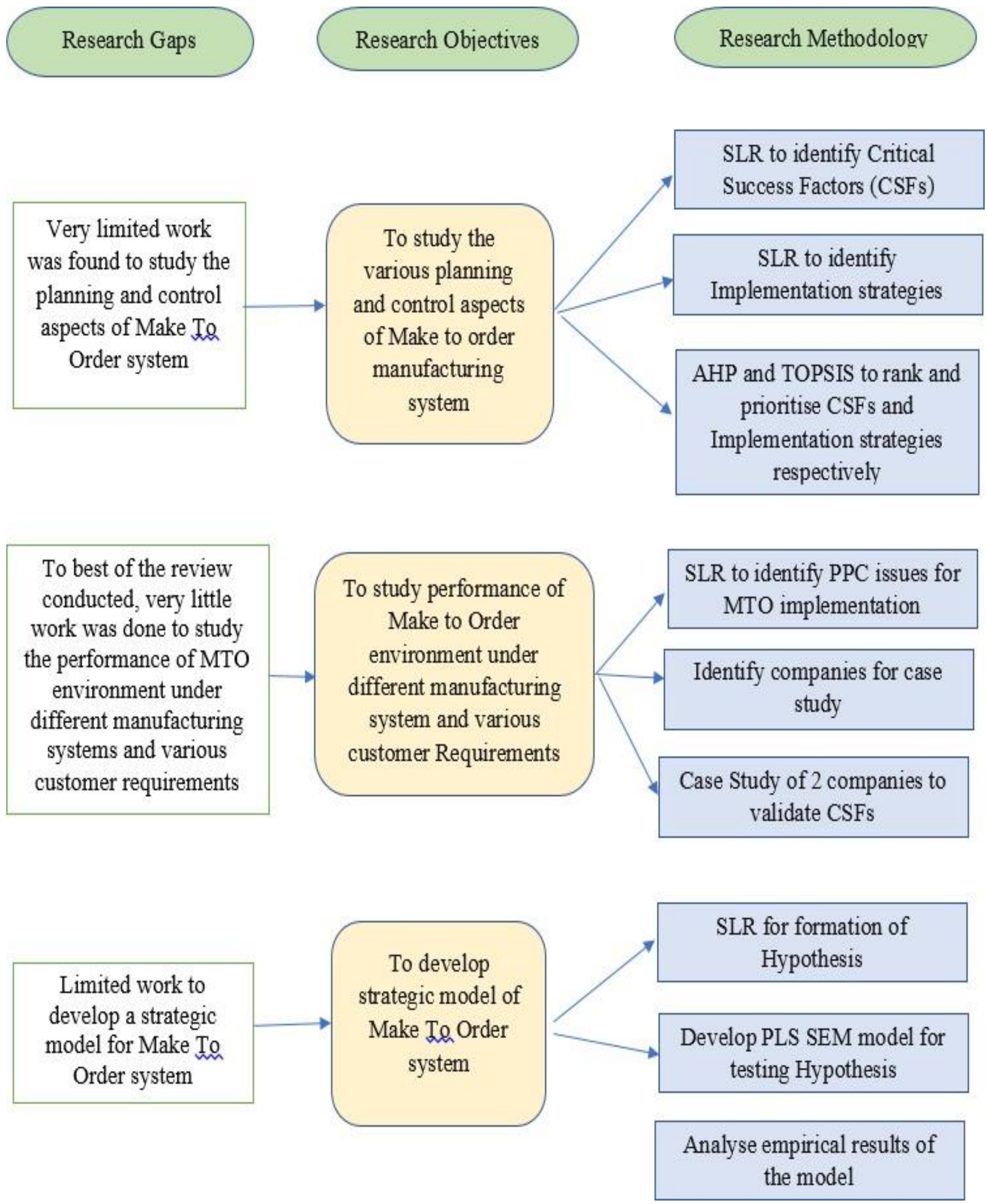


Fig. 3.3 Mapping of Research Gap, Objectives and Methodology

3.4.1 AHP and TOPSIS:

For allocating weights to critical success factors and ranking solutions in this study, a three-phase process was used. The first phase studied the Critical Success Factors (CSF) which affect the MTO implementation system for passenger cars. The weight of these factors was determined during the second phase using AHP, and in the third phase, TOPSIS was applied to rank the strategies for implementing MTO (Figure 3.4). In the data collection design, the procedure for obtaining or collecting data is scheduled. Principal and secondary data gathering methods can be combined with a variety of approaches to gather data.

Phase 1: Identification of Critical Success Factors (CSF) and Alternative Strategies

In this phase, critical success factors and alternative strategies have been identified through the use of literature review and discussion with experts, researchers, and academicians. The experts chosen are decision-makers in prestigious passenger car manufacturing companies in India. These professionals were selected based on their prior or present manufacturing organization’s titles or roles held. They were managers and consultants in the automobile industries with more than 10 years’ experience who came from geographically varied areas around India. The following arguments support this particular division of decision-makers as experts: (a) for expert practitioners, who are also the study’s biggest stakeholders and have the necessary industry expertise and knowledge of the actual ramifications of particular actions or policies, there were the most respondents; and (b), academicians and researchers are knowledgeable with the theoretical foundations of the various sustainability elements as well as specifics of some issues that are frequently disregarded by practitioners in the industry.

Phase 2: Application of AHP for Relative Importance of Critical Success Factors

Comparisons of multiple pairwise in AHP are done according to a nine-level standardized comparison scale (Najafi et al., 2014) (Table 3.2).

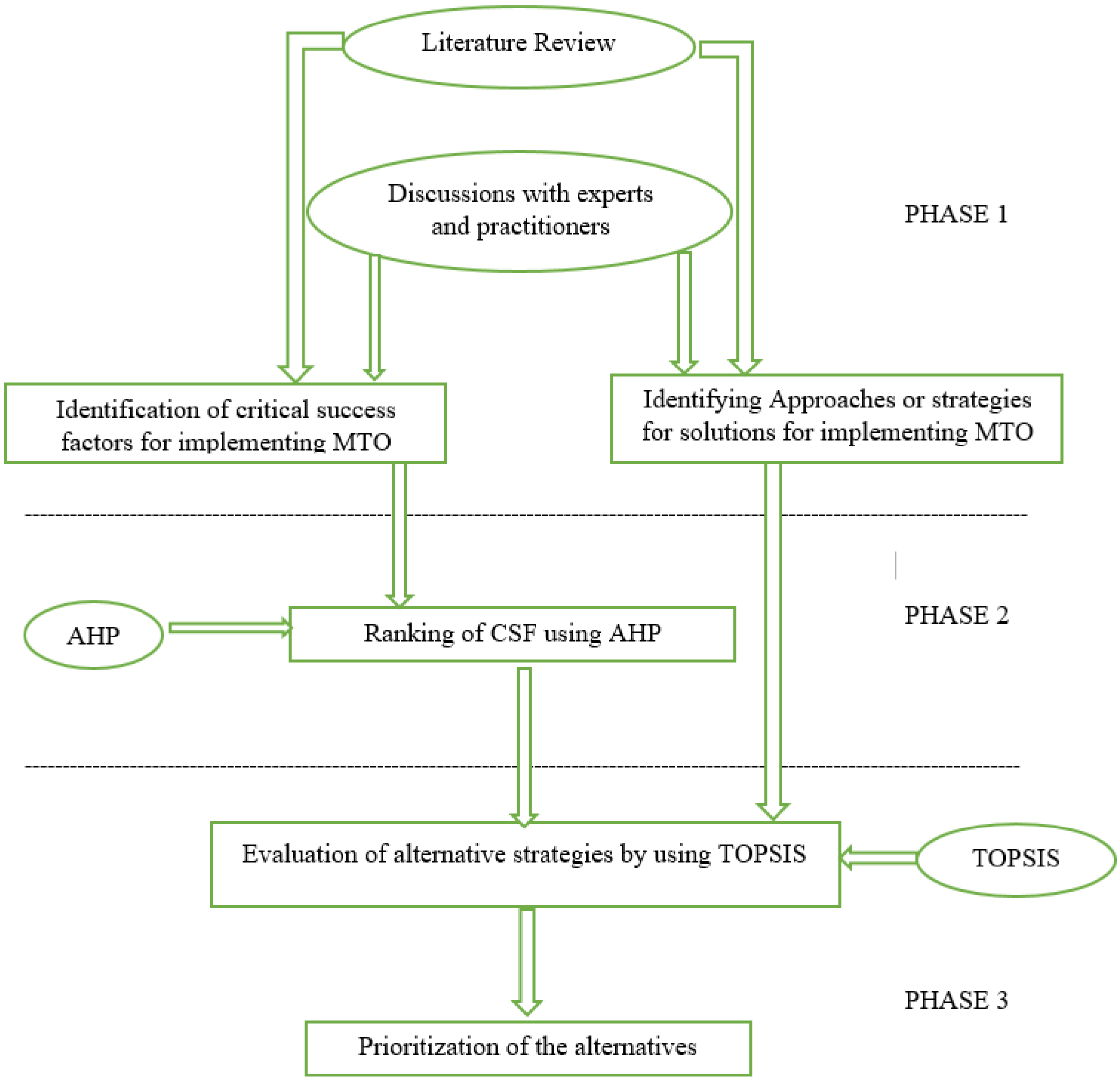


Figure 3.4. Model of selecting strategy for implementing MTO in passenger car manufacturing

Table 3.2: Nine-point intensity important scale for AHP

Definition	Intensity of Importance
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9
Intermediate more important	2,4,6,8

There are three main steps in the AHP, which are (a) developing the decision hierarchy, (b) the prioritization procedure, and (c) calculation of results. To establish the method's outcome, the Consistency Ratio (CR) for every one of the matrices is computed, as well as the total inconsistency for the hierarchy. The consistency index is a measure of inconsistency, and the equation consistency index (CI) gives the deviations from consistency.

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{1}$$

By dividing the CI by a value from the random consistency index (RI) database, the consistency ratio (CR) is computed.

$$CR = \frac{CI}{RI} \tag{2}$$

Phase 3: Selection of Best Strategy using TOPSIS

The goal of the standard TOPSIS method is to choose the alternatives that are the shortest distance from the positive ideal solution and the furthest away from the negative ideal solution. The positive ideal solution boosts advantages and lowers costs, while the negative ideal solution increases costs while lowering benefits. TOPSIS includes the following steps.

Step 1: For the ranking, create a decision matrix. The structure of the matrix is as follows

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_j \\ \vdots \\ A_J \end{array} \begin{array}{c} \begin{array}{cccccc} F_1 & F_2 & \dots & F_i & \dots & F_n \end{array} \\ \begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1i} & \cdots & f_{1n} \\ f_{21} & f_{22} & \cdots & f_{2i} & \cdots & f_{2n} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ f_{j1} & f_{j2} & \cdots & f_{ji} & \cdots & f_{jn} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ f_{J1} & f_{J2} & \cdots & f_{Ji} & \cdots & f_{Jn} \end{bmatrix} \end{array} \tag{3}$$

where A_j represents the solutions or alternatives j, j = 1,2,..., J; F_i denotes the ith criterion, i =1, 2,...,n, associated to the ith solution; and f_{ji} indicates the performance rating of each solution A_j with respect to each criterion F_i. (Yildirim et al., 2017).

Step 2: Calculate R (= $[r_{ji}]$), the normalized decision matrix, and r_{ji}, the normalized value is calculated as

$$r_{ji} = \frac{f_{ji}}{\sqrt{\sum_{j=1}^{n} f_{ji}^2}} \quad i = 1, 2, \ldots, n \; ; \; j = 1,2..., J \tag{4}$$

Step 3: To get the weighted normalized decision matrix, multiply the normalized decision matrix by the related weights. V_{ji} is the weighted normalized value derived as follows:

$$V_{ji} = w_i \times r_{ji}; \quad i = 1,2, \ldots n; j = 1,2, \ldots, J \tag{5}$$

where w_i represents the weight of the ith attribute or criterion.

Step 4: Establish the positive-ideal and negative-ideal scenarios.

$$A^+ = \{v_1^+, \; v_2^+, \ldots, v_n^+\} = \{ \left(\max_j v_{ji} \,\middle|\, i \in I'\right), \left(\min_j v_{ji} \,\middle|\, i \in I''\right)\} \tag{6}$$

$$A^- = \{ v_1^-, v_2^-, \ldots, v_n^-\} = \{\left(\min_j v_{ji} \,\middle|\, i \in I'\right), \left(\max_j v_{ji} \,\middle|\, j \in I''\right)\} \tag{7}$$

where I′ corresponds to benefit criteria, and I″ corresponds to cost criteria.

Step 5: Calculate the separation measurements using the n-dimensional Euclidean distance. The distance between alternative option and the positive-ideal solution (D_j^+) is expressed as:

$$D_j^+ = \sqrt{\sum_{i=1}^{n} \left(v_{ji} - v_i^+\right)^2} \quad j = 1, 2, \ldots, J \tag{8}$$

Each alternative is distanced from the negative-ideal solution D_j^- in the same way.

$$D_j^- = \sqrt{\sum_{i=1}^{n}\left(v_{ji} - v_i^-\right)^2} \quad j = 1, 2, \ldots, J \tag{9}$$

Step 6: Calculate and rank the performance order based on how near the alternative is to the ideal solution. The relative closeness of the alternative A_j can be expressed as

$$CC_j^+ = \frac{D_j^-}{D_j^+ + D_j^-}, \; j = 1, 2, \ldots, J \tag{10}$$

where the index value of CC_j^+ lies between 0 and 1. The higher the index value, the better the alternative's performance.

3.4.2 PLS SEM:

PLS-SEM was first introduced by Herman Wold in 1966, and since then, it has undeniably grown in popularity for survey research (Akter et al., 2017). PLS-SEM is a causal prediction method for SEM that emphasises forecasting when assessing measurable models with constructs intended to provide causal explanations (J F Hair et al., 2018). PLS-SEM emerged as a result of the lack of factor indeterminacy, the advantages of distributional assumptions, and models with more parameters than observations (Dijkstra & Henseler, 2015). Certainly, it works best with complex models, especially when prediction is the main goal, a lot of variables need to be explained, and the sample size is limited (Akter et al., 2017) (Hulland et al., 2010).

The case for PLS-SEM as a workable methodology is becoming more widely accepted in the business domain. Numerous academics have released research summarising the application of PLS-SEM in their respective domains. In studies on marketing, human resource management, and related subjects, this strategy has become increasingly popular (Tian et al., 2020) (Joe F Hair et al., 2012) (Kura et al., 2015) (Min et al., 2020) (Joe F. Hair et al., 2011).

(Joe F. Hair et al., 2011) recommended utilising PLS-SEM to forecast the effects of dependent variables. PLS-SEM is an approach that shows significant potential for SEM researchers, particularly in the fields of marketing and management information systems. It works with considerably smaller as well as much larger samples, is more robust with fewer identification concerns, and easily combines both formative and reflecting components (Joe F. Hair et al., 2011).

3.4.3 Case Study Methodology:

The data was gathered and analysed using a systematic method in order to minimise subjectivity and ensure that the findings would be interpreted consistently. In order to guarantee the internal validity of the outcomes, a structured approach must be applied (Seuring & Gold, 2012) (Cannas et al., 2020). Additionally, in order to collect information from numerous sources rather than a single origin, several data sources, such as in-person interviews, direct observations (plant visits and/or demonstrations of the configuration in action), and website and online resource analysis were merged.

Selection of case companies:

Case selection is important for developing theory from case studies. At the first stage, the following factors were taken into consideration when selecting instances for the study: (i) In every case company, businesses engaged in design and manufacturing must use an MTO business strategy. (ii) Cases need to vary in terms of industry and size. The first selection criteria was to guarantee literal replication by ensuring that all of the organisations worked with MTO and were similar in terms of industry and strategy. Criteria 2 permits a sample made up of businesses with varying sizes, supply chain configurations, and, as a result, maybe varying difficulties and management styles. The next step was to identify a group of possibly pertinent businesses. This was carried out using information from two sources: a database full of MTO companies, and the researchers' prior experience (Cannas et al., 2020). Applying the selection criteria to the group of potentially relevant companies was the third stage. Initially, web pages, emails, and direct phone conversations were employed as secondary sources to verify the criteria. Lastly, businesses that shown a desire for interviewees to actively participate in the research were selected through communication with top managers. And two companies were selected.

Data Collection:

To gather the data, a protocol for case studies was established. A case study procedure was developed to guide the interviews and discussions at the case companies. In order to ensure that the analysis is comprehensive, the questionnaire was designed to cover all relevant features and address the primary variables and relationships found in the research questions. This questionnaire was later changed in response to interviewee feedback. Company visits, in-person interviews, and document analysis served as the information sources.

The technique for gathering or collecting data is planned in the data collection design. Both primary and secondary data gathering methods can be applied to a variety of data collection startegies. From one perspective, the open-ended questions in the interview questionnaire helped direct the participants towards the research issues of the study. Respondents who played a key role in the MTO's implementation and took part in all stages of its execution were the ones targeted for the interviews. The interviewees were Plant head, Lead sales, Senior Production Manager, Production Manager, Head R & D, Product Engineer, Supply Chain Manager, Quality Head, Production and Planning Engineer. The process of gathering data also included visiting the company and analysing historical data from sources including websites, project descriptions, and documents to obtain a more thorough picture of system. Table 3.3 shows the Case Study Protocol followed in this research.

Table 3.3: Case Study Protocol

Source 1: Personal interview/ Online meeting
General Details: Brief summary of the interview: role played within the organisation and department, responsibilities undertaken Company details: Company size, total number of employees, revenues generated Pre Implementation Phase: What were the main reasons the organisation decided to implement a MTO system? In what ways did the management alter the company's business processes? How did a MTO product get designed? How did managers set up the organisation for the MTO business model? Which challenges were the hardest to overcome? What actions did the business take to get over these challenges? How well-prepared were the company's customers or suppliers? Implementation Phase: Were staff required to possess any specific skills in order to implement MTO? What actions did a company take to help its employees grow their skills? In an effort to outmanoeuvre rivals, did the company revamp its marketing and supply chain? Post Implementation Phase: How did businesses go about retaining their customers and boosting MTO product sales? In order to promote MTO products in the market, which marketing method was used?
Source 2: Company Visit
Plant Tour: Observing and examining the operations, types of machines and machine set up,type of technology, sales and marketing, management processes, Product enquiry etc.
Source 3: Document analysis:
Company website, National database, Press, News: general company details, including the history, purpose, and types and features of its products as well as their technical specifications and applications

3.5 Conclusions

This chapter provided a detailed explanation of the research methodology used in this study. The chapter begins with a review of the objectives of the research project before moving on to several types of research designs. The combined research design was chosen based on the goals. Subsequently, the research methodology employed for this study is examined, along with a process flow outlining the steps that will be taken in the upcoming chapters. Next, the data analysis method is discussed, after the research instrument, survey design, and data gathering method. In conclusion, the research stages are determined and the process flow for completing the work in the upcoming chapters is finalised.

CHAPTER 4

PRIORITISATION OF CRITICAL SUCCESS FACTORS AND STRATEGY SELECTION OF MAKE TO ORDER MANUFACTURING SYSTEM: AHP AND TOPSIS APPROACH

4.1 Introduction

In today's manufacturing climate, the priority of every company is to strive hard to remove all kinds of bottleneck so that it can withstand the cutthroat competition in the market and can meet customer requirements for cost, quality, and delivery (Croft, 1996). In order to maintain and grow their market shares, sales, and revenue rates, organizations are believed to benefit from high levels of customer satisfaction (Konstantas et al., 2018). Market dynamics reflect all the processes along the supply chain and need to be observed and controlled closely. Manufacturing, as well as the service industry, requires to adapt to fast-changing customer requirements. The industries today are becoming complex and need to introduce the technologies to cope with changing trends. In order to compete on a worldwide scale, industries must improve their economic and business performance related to quality, cost and adaptability. Make-to-order (MTO) is becoming vital for meeting ever-changing customer requirements. Growing demand for customized items has been linked to a rise in the proportion of MTO businesses.

This chapter presents eighteen Critical Success Factors (CSFs) and three implementation strategies forthrough literature review and finalizes these with opinion from experts. These eighteen critical success factors (CSFs) are grouped into six categories and prioritised based on inputs from industry experts using the AHP technique. The implementation strategies for a MTO system are identified and they are Ranked using TOPSIS. The result and discussions are mentioned at the end of the chapter. The flow of chapter is shown in Figure 4.1.

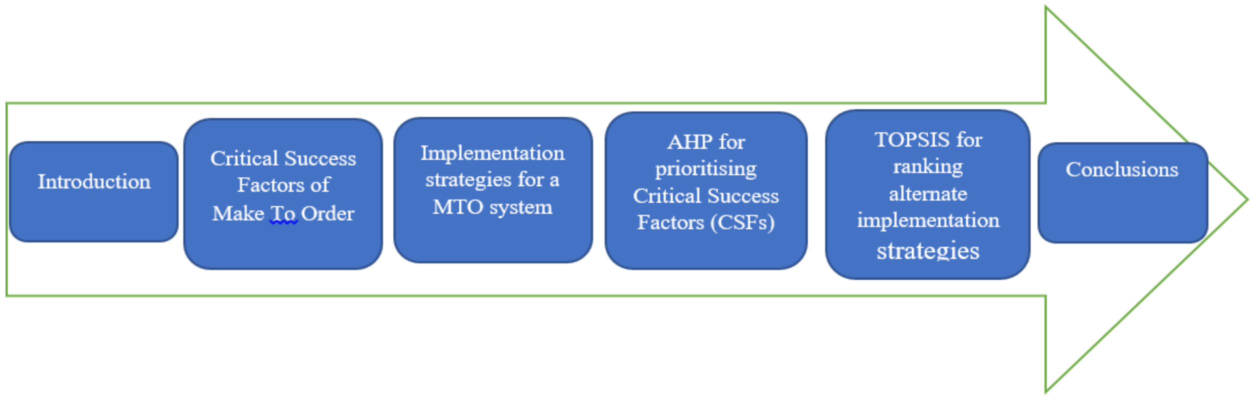


Figure 4.1: Flow of Chapter 4

With an aim to meet customers' expectations (related to quality, cost, and delivery time) and cope with the worldwide competition, make-to-order (MTO) manufacturing systems are gaining attention in manufacturing industries. Manufacturing firms must compete in an environment where flexibility, affordability, and response time are all crucial in meeting customers' demand (Almehdawe & Jewkes, 2013). These circumstances drew the attention of practitioners and researchers, who saw the advantages of MTO in terms of minimizing finished product inventories, high customization, and reacting to highly dynamic customer behaviour (Mohammadi et al., 2020). With such systems, not only is high product variety met, but it also enables the provision of on-time delivery. Growing demand for customized items has also been linked to a rise in the proportion of MTO businesses (Gharehgozli et al., 2008). Companies are seeking a way to manage products and associated processes, such as inventory, with these types of production paradigms available, where product customization is becoming so much more of a requirement for customers (Zennaro et al., 2019).

Automobile Sector in India

As a result of two decades of strong growth, India transformed from being a net importer of cars to a significant producer and exporter of vehicles and components. One of India's most significant economic development drivers and one with significant involvement in international value chains is the automobile industry (Tripathi & Talukder, 2020). Together with many new initiatives for business revival, technology has emerged as a great enabler. Building new efficiencies for sustainable recovery while identifying new growth engines has been a key task at hand. A seamless integration across all operations has assured efficiencies over the long term. Expansion across physical as well as virtual platforms is critical for business success. As MTO will only increase in the future, OEMs are forced to re-evaluate sourcing and inventory management strategies to hedge risks against multiple supply chain disruptions that might happen in the future. The automobile sector has grown manifold since the opening of the Indian economy in 1991. Along with the increase in total production, the variety of cars has increased many times more than the increase in production. New model introduction is the norm rather than the exception. In many nations, the passenger vehicle industry has emerged as one of the most powerful engines for technological innovation, economic expansion, and job creation. In recent years, the growth of this industry has characterized the competitiveness of the world’s top industrialized economies. At present the passenger car segment of the automobile sector is working on an MTS system which has large inventories at the showrooms at the same time; thus, customers have no option other than to purchase the standard products available in the stock. Emerging trends in customer-configured vehicles necessitate a change from the existing manufacturing approach of “make to stock”, which is based on market forecasts (Murugan & Ramalingam, 2019). To meet the demands of a customer-configured business scenario in the passenger vehicle industry, it is crucial to review the entire business process of sales and operations planning. Future automobiles will be controlled by software and have several customization possibilities (König et al., 2022). The motivation and contribution of the study come from the fact that customers have become variety-seeking in every kind of product including passenger cars. To attract buyers, the manufacturers offer a wide range of models, colors, features, and value-added services (Arokiaraj & Banumathi, 2014). This causes a huge rise in the amount of inventory required to fulfill customers' demands. In many nations, the passenger vehicle industry has emerged as one of the most powerful engines for technological innovation, economic expansion, and job creation. In recent years, the growth of this industry has characterized the competitiveness of the world's top industrialized economies (Bhatia, 2016). A combination of all these refers to the use of the make-to-order strategy.

Not much work has been reported till now to implement MTO in the manufacturing of passenger cars. Only a few research papers show that it has been applied at various types of manufacturing companies, for example, a steel mill (Kerkka, 2007), appliance manufacturer (S. Hemmati et al., 2012), Iranian wood industry manufacturing company (Rafiei & Rabbani, 2012), small equipment manufacturing company (H. Li & Womer, 2012), fruit juice companies (Rabbani et al., 2014), manufacturing companies for aluminum profiles for construction industry (Fernandes et al., 2015), and restaurant (Rabbani & Dolatkhah, 2017). However, a very small quantity of work has been done in the automobile sector for implementation of MTO.

4.2 Critical Success Factors of Make To Order Manufacturing system

For identifying critical success factors and mapping them with implementation strategies, several experts from various manufacturing sectors were contacted. Table 4.1 lists all the Critical Success Factors identified after discussion with the experts. Keeping in view the importance of study, ten experts agreed to participate in the study. Out of these ten, 4 were from manufacturing area, 2 from marketing and strategy, 2 from IT, 1 from product design and development, and 1 expert representing the vendor. On the basis of discussion with the practitioners and literature review, 18 critical success factors (CSFs) have been identified which are important for implementing MTO. Furthermore, three approaches are identified and ranked for the implementation of an MTO system for automobile companies manufacturing passenger cars.

4.2.1 Customer needs /choice/ passion for unique products/ self-created product (CU2):

In today's fiercely competitive market, companies have learned how important it is to satisfy and delight their customers, which has led them to become increasingly customer-centric (Rana & Lokhande, 2015) (Mujahid et al., 2021). Zennaro et al. (2019) discussed several studies regarding the variables influencing customization and production complexity, and mentioned that the role of the client has gained more attention. Customers' sensitivity to customization is mostly driven by their unique expectations and their willingness to make sacrifices in order to meet unmet wants (Hart, 1995). Shende (2014) mentioned that companies can identify the steps necessary to satisfy the needs of their customers by having a deeper awareness of the perceptions of their customers.

4.2.2 High product variety (P1):

A company operating in the produce-to-order manufacturing sector typically has to fulfill orders for a wide range of products, most of which are customized, and typically in small numbers (Haskose et al., 2004). With their large product diversity, extremely changing client demand, and short product life cycles, make-to-order systems are effective business techniques for managing responsive supply chains (Vidyarthi et al., 2009). A wider range of products indicates richer information flows, which in turn require more complex internal scheduling and coordination, increasing the requirement for information processing (G. J. Liu et al., 2015) (Jain et al., 2022). A wide range of products has the ability to open up new markets and boost income and sales. However, unless variation is carefully handled at every stage of design, planning, production and distribution, consumption, disassembly, and recycling, this favorable result is not always assured (Tseng & Bernard, 2013).

Table 4.1: Critical success factors for implementing MTO

Critical Success Factors (CSFs)	Definition	Authors
Customer needs /choice/ passion for unique products/ self-created product	Customer's needs are on topmost priority as it influences the overall production system of MTO.	Rana & Lokhande, 2015, Rabbani & Dolatkhah, 2017, Zennaro et al., 2019, Jain et al., 2022
High product variety	Range and brand of products affects the performance measures in MTO.	Haskose et al., 2004, Vidyarthi et al., 2009 Jain et al., 2022
Modular product design	Design of the product wherein it can be assembled with the standard set of constituents	A. Gunasekaran & Ngai, 2005, Zennaro et al., 2019, Zhou et al., 2020 Jain et al., 2021
Flexible manufacturing processes	Flexibility in manufacturing processes will be deciding factor for analyzing the time required for transformation of system from one type of job to other.	Pramod & Garg, 2006, Wadhwa et al., 2009, Singholi et al., 2012, Dauod et al., 2018, Kampker et al., 2019, Álvarez-Gil et al., 2021
Accessibility to flexible and real time information technology to keep the customer updated.	For effective and enhanced MTO performance, information technology has to be real time. Any kind of update or change in information will affect the whole system and thereby making it time, energy and cost saving.	Sahin & Robinson, 2005, Zennaro et al., 2019, Dewett & Jones, 2001, H. Liu et al., 2016, Mujahid et al., 2021
Information system (online system) to receive order and payments	Centralized online system for managing orders and payments effectively.	Wei et al., 2005, Razmi & Sangari, 2013, H. Liu et al., 2016, Feng & Zhang, 2017, Sindhwani & Malhotra, 2017, Custódio et al., 2018, Zennaro et al., 2019
Competition in the market	Competition in the market impacts variables like retail price, selling price, etc., and is affected by various factors like advancement in technology	Garmdare et al., 2018, Fakhrzad & Mohagheghian, 2019
Ability of MTO without increasing cost of manufacturing	Various parameters and resources have to be considered and analyzed to minimize total cost.	He et al., 2014, Pan et al., 2014, Salamati-Hormozi et al., 2018
Risk of obsolescence and perishability	Inclination towards MTO systems is more, in case the possibility of product obsolescence or perishability is high.	Zaerpour et al., 2009, Rafiei & Rabbani, 2009, Samira Hemmati & Rabbani, 2010, Zaabar et al., 2021, Acevedo-ojeda et al., 2019

Critical Success Factors (CSFs)	Definition	Authors
Skilled employees for manufacturing	MTO requires extensive use of skilled workforce due to the use of general-purpose equipment or machines	H. Li & Womer, 2012, Khakdaman et al., 2015, Blatter et al., 2012, Wejnert, 2002
Flat organization structure	Organization has less hierarchical management and fewer employees.	Kidwell, 2005, Jahangirian et al., 2010, Aslan et al., 2012, Khurana et al., 2019, Powell, 2006
Short lead time of suppliers	Shorter and accurate lead times are desirable for successful MTO firms. Also, it depends on sequencing and scheduling decisions.	Zhai & Cheng, 2022, Calle et al., 2016, Ioannou & Dimitriou, 2012, Park et al., 2010, Easton & Moodie, 1999
Technology and its spread	Advancement in technology increases competition for MTO	Bagchi, 2016, Tseng & Bernard, 2013, Garmdare et al., 2018, Valase & Raut, 2019, Chhimwal et al., 2021
Product/market innovation	It's the factor that helps MTO companies to be competitive and successful.	A. Gunasekaran & Ngai, 2005, Chhimwal et al., 2021
Business risk and economy	This market factor is critical in taking MTO decisions.	A. Gunasekaran & Ngai, 2005, Wegner et al., 2017, Gordon et al., 2009, Balcaen & Ooghe, 2006
Flexibility of the production process	Higher flexibility is one of the Prominent feature of MTO	Zhen Wang et al., 2019, Jain et al., 2022, A. S. Babu, 2016, Zennaro et al., 2019
ustomer enquiry stage	Customer enquiry process has direct and profitable impact on MTO. It further affects other decisions like acceptance or rejection of an order and capacity planning.	B. Kingsman et al., 1996, M. Stevenson et al., 2005

4.2.3 Modular product design (P4):

It is widely accepted that modularity consists of building components, or modules, that can be joined to create a significantly greater variety of product configurations (Sanchez, 2000) (Schilling, 2000). The modular design aims to decouple all other characteristics and processes from a single module that contains all qualities and processes that are similar to each other. Manufacturing products with modular design save setup costs and change times, optimize production resources, and simplify scheduling. Expanding the flexibility and economies of scale that modular products have made use of to significantly raise the end user value is the main way that modular design for manufacturing offers advantages (Sudarshan & Rao, 2014). In the automotive sector, modular product design is a new type of supplier-assembler connection that is reshaping the industry's borders and, in certain cases, the definition of the company and the risks associated with it. As it might not be required to build each component at the same location, the "modular" product and design could support a decentralization plan. Lampón et al. (2017) examined the new car modular platforms and how they affect the network capabilities of manufacturers, including economies of scale and breadth and operational flexibility. The influence of modular platforms on a number of automobile manufacturers, including Nissan-Renault, Volkswagen and PSA Peugeot-Citroën has been highlighted by various writers recently. These manufacturers have benefited from reduced expenses associated with product development and auto parts procurement. Regarding product design, the latest modular platforms have expanded the number of models that may be integrated as compared to regular platforms because they permit varying this structural element's proportions and the assembly of models from various segments.

4.2.4 Flexible Manufacturing Processes (O1):

Today's automotive sectors, and the production of inflexible automobile bodies in particular, have the difficulty of responding in a flexible way to consumer requests for customization and market changes. Therefore, it's critical to take into account strategies and ideas to improve the adaptability of automotive production systems. A flexible manufacturing system is one that has many computer-controlled machines and the ability to automatically change out equipment and parts. Flexible manufacturing systems are required in the difficult field of automotive engineering due to the growing diversity of models with concurrently lower and more volatile volumes (Kampker et al., 2019).

4.2.5 Accessibility to flexible and real time information technology to keep the customer updated (IT1):

Using technology to provide information with clients in real time is regarded as a strategic tool (Meadows & Dibb, 2012) (Jabbar et al., 2019). Real-time information sharing could be very helpful and successful in times of crisis like COVID-19 for making prompt decisions (Stephany et al., 2022). Sharing of real-time information is the primary factor influencing consumer purchasing decisions (Mujahid & Mani, 2019). The findings from the work of Mujahid et al. (2021), demonstrate how firms might profit from real-time information sharing in a way that aligns with the ideas of information processing theory, which postulates that sharing data could provide competitive edge. Utilizing real-time information sharing to share current data with consumers about daily routine operations and performances—such as average delivery times, average customer happiness, and so forth—has just lately become common in Malaysia's services sub-sectors (Mujahid et al., 2021). Significant prospects for better economic performance arise from tighter supply chain integration in make-to-order supply chains achieved through information sharing and physical flow coordination (Sahin & Robinson, 2005).

4.2.6 Information system (online system) to receive order and payments (IT2):

Better customer satisfaction, more manufacturing efficiency, and increased revenue can all be attained with a well-designed online order and payment system. Effective corporate information systems are necessary to improve competitive advantage in highly dynamic marketplaces (Wei et al., 2005). Since ERP can connect the flow of information, money, and materials and support organisational initiatives, it is becoming more and more vital in modern business. ERP systems simplify order placement and payment management, making them essential for MTO producers. They offer integrated solutions that support strong financial management, increase productivity, and improve the customer experience all of which eventually contribute to the business's overall success (Razmi & Sangari, 2013).

4.2.7 Competition in the market (M1):

In a market with intense competition, businesses usually have to concentrate on improving efficiency, cutting expenses, and developing new processes. Thus, competition for a market forces businesses to concentrate on marketing, R&D, and product design (Geroski et al., 2003). According to Taylor et al. (2012), in order for a company to survive the intense competition in the target market segment, it is now imperative that they broaden their product offering and improve the design and idea of their products.

4.2.8 Ability of MTO without increasing cost of manufacturing (CO1):

In a market where there is competition, firms are compelled to engage in cooperative decision-making processes in order to accomplish their goals of profit maximization or cost reduction (Pan et al., 2014) . When the time-varying demands are known ahead of time, classical production planning issues calculate a cost-minimizing production schedule that takes setup, production, and inventory holding costs into consideration. A great deal of the classical problems' expansions have been researched in recent years (Brahimi et al., 2006) (Buschkühl et al., 2010). Some forms of cost-minimizing, including inventory and holding costs, setup and production costs, have mostly been identified in classical production planning problems, according to basic investigations (Salamati-Hormozi et al., 2018).

4.2.9 Risk of obsolescence and perishability (M2):

In terms of the product's shelf life and nature, we tend to use the MTO approach if there is a high danger of obsolescence (Zaerpour et al., 2009) (Samira Hemmati & Rabbani, 2010). In today's highly technologically advanced market, component obsolescence is a serious issue. It is the outcome of the quick advancement of technology, which brought in new, more feature-rich, and more performant components. It caused pressure to increase for updating parts and systems. The production system, the environment, and the product life cycle are all significantly impacted by parts obsolescence, which affects operations, logistics, dependability, and cost (Zaabar et al., 2021). Because industrial, social, and ecological systems are interconnected, taking global sustainability into account is crucial for making effective decisions, even if the majority of studies on obsolescence management focused primarily on economic and technological issues (Fiksel, 2017). Items that cannot be kept indefinitely without deteriorating or losing value are referred to as perishable (Billaut & Toulouse, 2011). Numerous studies examined the issues of production planning with regard to product perishability and deterioration. Muriana (2016) examines an EOQ model for perishable goods, taking into account stochastic demand and a set shelf-life. In the context of inventory management, Dobson et al. (2017) take age-dependent demand rates for perishable goods into account. Acevedo-ojeda et al. (2019) established two methods for studying and incorporating perishability and deterioration into production and distribution planning, scheduling, and inventory management.

4.2.10 High cost of carrying inventory (CO2):

Typically, the primary goal of inventory management is to minimize overall expenses, which are often approximated and therefore unpredictable. Costs associated with ordering, holding, and storing inventory are included (Jeon & Kim, 2016). Any manufacturing organization's main objective is to increase profit by minimizing overall costs, so Samak-kulkarni & Rajhans (2013) suggested an inventory model that is effective in minimizing the total inventory cost. Physical inventory levels need to be translated into inventory costs in practically every business analysis involving inventory. It is actually an issue of cost accounting to determine the precise cost rate to apply. Knowing what creates supply and demand imbalances is the actual key to understanding inventory costs and services (Ryzin, 2016). It is crucial to understand that inventory costs, which include both obvious and hidden costs, or out-of-pocket holding costs, go much beyond the capital cost of goods. Since holding costs are frequently utilized in well-known inventory management models like Economic Batch Quantity, knowledge of them is essential to the administration of any industrial logistics system. Azzi et al. (2014) provided a number of case studies to investigate the cost factors used in the inventory carrying cost computation in many contexts and to generate helpful recommendations and ideas for real-world implementation. A significant amount of hidden inventory costs are incurred in several traditional storage systems due to the need for SKU operations and the remanufacturing, repackaging, and relabelling of products. All inventory expenses that are difficult to identify and mix in with other costs are referred to as "hidden costs," but they still need to be taken into account and calculated with a certain amount of error (Azzi et al., 2014).

4.2.11 Skilled employees for manufacturing (O2):

Process-focused manufacturing, which heavily utilizes skilled labor and multipurpose machinery and equipment, is a common description of MTO production (H. Li & Womer, 2012). The repetitive skills of the assembly lines of the past have been replaced by flexible technology and "high-performance work systems" in the emerging new knowledge economy, which depend on workers who are more skilled and independent. In a time of adaptable production and service delivery models, quicker economic change, and increased technical preparedness, workers need to have sufficiently solid skills to adjust to shifting demands at work (Carnevale & Smith, 2014). The general consensus regarding established businesses is that highly qualified workers have the power to influence the success or failure of novel processes through both official and informal organizational procedures (Wejnert, 2002) (Matricano & Matricano, 2020). Make-to-order manufacturers depend on skilled workers to guarantee that customised goods fulfil client requirements and quality standards.

4.2.12 Flat organization structure (O3):

Top management is responsible for arranging the organization's structure such that appropriate channels of communication exist amongst all organizational levels (Khurana et al., 2019). The evolving management landscape and the resulting need for alternative frameworks most suited to manage their most valuable asset, people, have a direct impact on the design of organizations, from strategy to structure, leading to leaner, fitter structures. Flattened hierarchies, quicker decision-making, environmental responsiveness, and employee empowerment are allegedly characteristics of these decentralized and more market-conscious organizations. Therefore, the organic, decentralized, and inherently flatter structures are the ones that assert to promote autonomy, personal accountability, dedication, and initiative in the current climate of constant change. flatter structures are a direct result of cost-cutting and the current economic situation. As major decision-makers, business managers perceive less bureaucracy under flatter organizational structures. (Powell, 2006)

4.2.13 Short lead time of suppliers (P3):

The period of time between placing and receiving an order is known as the lead time. Lead times can be shortened by suppliers to decrease safety stock, minimize out-of-stock loss, and raise customer satisfaction (Hsu & Chen, 2009). Delivery lead-time quotation has been identified by researchers as one of the crucial choices in MTO supply chain management, and it profoundly affects channel performance (Xiao et al., 2016) (Noori-daryan et al., 2018). An MTO manufacturer provides a delivery lead time to meet customer requests; nevertheless, a longer lead time results in a higher level of consumer disutility since the customer must wait longer. To handle demand volatility, the manufacturer needs to invest more in capacity, even though a shorter quoted lead time may draw in more customers (Xiao et al., 2016). In an MTO system with several client classes, whose sensitivity to price and quoted lead-time is presumed to be attainable through negotiation, Feng & Zhang (2017) investigated dynamic pricing and lead-time quotation. In an MTO apparel supply chain, (Choi & Cai, 2018) examined the impact of lead-time reduction on the environment, the ideal order quantity, and profit.

In addition to being interested in a quick quote lead time, customers are also worried about the lead time for delivery. Lead time influences inventory decisions made by retailers and suppliers alike, and cutting lead time may need cooperation from all parties involved in order to enhance relevant supply chain activities (Hsu & Chen, 2009). The best pricing and lead-time quotation choices made by a risk-averse agent were investigated by (Taylor et al., 2014). In order to gain a competitive edge and ensure its existence, a company must be able to fulfill the quoted lead-time (Hammami et al., 2020).

4.2.14 Technology and its spread (M3):

Manufacturers may improve consumer satisfaction, streamline operations, and maintain their competitiveness in a market that is becoming more and more dynamic by utilising contemporary tools and technologies. Adopting technology promotes creativity and growth in addition to operational excellence. Technology advancements and frequent changes in market structure have produced new environments for competition (Garmdare et al., 2018). Technology capabilities and information technology capabilities in US new ventures are favorably correlated with technology-driven strategy, according to (Hao & Song, 2015). Additionally, the strategic capabilities of technology-driven strategy can have a significant impact on the success of the company. Organizations may efficiently manage their knowledge through the interconnections of people, technology, and technique, as outlined by (Bhatt, 2001). Other technology-related tactics that directly affect manufacturing include the creation of cutting-edge technologies, the development of technical skills, and the implementation of technology practices. Technology, Information, knowledge and innovation may all be used to improve sustainability and provide value while also giving an advantage over competitors. Technologies such as cutting edge, and next generation are assisting businesses in increasing profits and enhancing their financial performance. Many businesses have a long-term technological needs strategy included into their technology management approach (Bagchi, 2016).

4.2.15 Product/market innovation (P2):

Product-market innovation, or innovation involving market research, product design, and other marketing-related activities, is a crucial component of an effective innovation strategy (Lyon & Ferner, 2015). According to the literature on innovation, performance is impacted by product innovation (Aksoy, 2017) (Prajogo, 2015) (Avlonitis & Salavou, 2007). The goal of innovative entrants is to persuade complementary producers and consumers to take a different approach, invest in a new product, and, more broadly, adopt a new pattern of production or consumption behaviour (Geroski et al., 2003). In order to succeed in providing innovative goods and services, businesses must include innovation culture into their operations. Innovation is fueled by empowerment, inventiveness, and a shift in corporate culture (Binnewies & Ohly, 2014). The two main factors influencing market performance are marketing and product innovation strategies. While innovation efforts provide higher value and benefits, such as enabling a company to separate itself from its competitors, competitiveness has become an essential component of survival in the marketplace (Blocker et al., 2011) (Rosenbusch et al., 2011). An investigation by Aksoy (2017) aims to investigate the connections among innovation culture, product innovation, marketing innovation, and market performance with a particular emphasis on small and medium enterprises. In MTO manufacturing system, a combination of cutting edge technologies, agile procedures, and customer collaboration drives product innovation.

4.2.16 Business risk and economy (M4):

A. Gunasekaran & Ngai (2005) considered Business Risk and economy as one of the important market factors that forces companies to build a MTO supply chain. The goal of the study, conducted by Dvorsky et al. (2021)was to examine how entrepreneurs' attitudes towards specific business risks affected their assessment of the future of SME enterprises. According to the findings, SMEs' future business will benefit from the identified operational, financial, human, and market risks. The state of the economy and business risks are important variables for MTO manufacturing. Businesses using this approach need to have strong risk management plans in place and maintain their flexibility to adjust to shifting market conditions. They can keep a competitive advantage in the market and guarantee sustainable operations by doing this. Decisions in business are made in an environment of risk and uncertainty. The necessity of risk management and control is becoming increasingly apparent to SMEs (Wegner et al., 2017). A company's very survival may be threatened by the negative effects of not having business risk management (Balcaen & Ooghe, 2006). The establishment of an enterprise risk management system is the foundation for the stability and effectiveness of a business (Gordon et al., 2009).

4.2.17 Flexibility of the production process (O4):

For MTO manufacturing, production process flexibility is critical because it allows businesses to manage customised orders, adapt to changing market conditions, and preserve competitive advantage while guaranteeing cost effectiveness and risk management. The high degree of production facility flexibility to accommodate a broad range of products, the high degree of uncertainty in processing times, the equipment's functional layout, and the design, manufacturing, technological requirements, and precedence constraints of unique products are the defining characteristics of MTO strategy (A. S. Babu, 2016).These businesses must be flexible and capable to verify that their items meet customer needs while offering an appealing pricing and prompt delivery in order to be competitive in the market (Zennaro et al., 2019).

4.2.18 Customer enquiry stage (CU1):

As soon as a client inquires, planning and control are initiated. This allows choices about due date (DD) commitments to be made based on data about the workload of the shop at the moment and unfinished bids that are pending customer approval or rejection (L. Hendry et al., 2008). For the MTO industry, the customer enquiry stage is especially crucial since capacity planning should be addressed at multiple stages, including the point at which orders are initially evaluated (Brian G Kingsman, 2000). As per (B. Kingsman et al., 1996), a company's proposal in response to a customer's inquiry should include reasonable and competitive delivery dates and costs, but other elements like the company's reputation and financing options may also be crucial. Power will have been lost before reaching the job release or shop floor dispatching stages without control at the client inquiry and job entry phases, increasing pre-shop pool delays (M. Stevenson et al., 2005).

These critical success factors are further grouped into six categories. The criteria and categories are primarily based on the factors that researchers have stated, such as (Gharehgozli et al., 2008), (Albayrak, 2004) (Zaerpour et al., 2009).

1. Product related category:

   Numerous factors significantly influence the choice regarding product partitioning. Intangible and qualitative elements make up the majority of these requirements. The critical success factors among this category are High product variety (P1), Product/market innovation (P2), short lead time of suppliers (P3), Modular product design (P4).

2. Organization related category:

   This category examines how organizational factors contribute towards MTO implementation. Organizations' ability to adapt to their external environment is critical to their long-term survival. Monitoring and feedback methods are required for companies to track and perceive changes in their relevant work environments, as well as the ability to make timely modifications (Albayrak, 2004). This category includes Flexible manufacturing processes (O1), skilled employees for manufacturing (O2) factor is vital since MTO is feasible if the employee's skills are as per the requirement, Flat organization structure (O3), Flexibility of the production process (O4).

3. IT related category:

   Information Technology (IT) category includes how Accessible and flexible is real time information technology to keep the customer updated (IT 1) and should be the priority for the organization striving for implementing MTO (Gharehgozli et al., 2008) , Information system (online system) to receive order and payments (IT 2) is another important critical success factor under this category.

4. Market related category:

   The strategic choices and operational effectiveness of manufacturing companies are influenced by a variety of market conditions. This category includes Competition in the market (M1), Organization is most likely to reject an order if there is a high risk of obsolescence and perishability (M2) Technology and its spread (M3),

5. Customer related category:

   The MTO system is used for a variety of reasons, including maintaining long-term relationships with consumers and facilitating them in articulating their goals and customer needs. Customer inquiry stage (CU1) is one of the vital factor in this category. As per Zaerpour et al. (2009), Capacity planning should be addressed at multiple stages, including the moment when orders are first examined, which is why the customer inquiry stage (CU1) is so important to the MTO industry. Second crititcal success factor under this category is Customer Need (CU2).

6. Cost related category:

   The higher the cost of each item, the more acceptable the MTO system is, because the firm has less cost volatility when product demand fluctuates. Ability of MTO without increasing cost of manufacturing (CO 1) and High cost of carrying inventory (CO 2) are two critical success factors that can be related to overall cost element of MTO.

4.3 Implementation strategies for a MTO system

For the implementation of an MTO system or changing the existing MTS to MTO system, the organization needs to select the appropriate implementation strategy. The following strategies that are significant for implementing MTO in the automotive industries have been identified through with practitioners and research review.

4.3.1 IT centric strategy:

Jain et al. (2021) considered Information Technology enabled technology as one of the critical enabler for customization. Jitpaiboon et al. (2013) supported the need for enterprises to integrate their usage of IT for strategy, infrastructure, and operational activity. According to Vinodh et al. (2010) and M. Zhang et al. (2015), manufacturing sectors need to use CAD, CAM, and CAE solutions to reduce customer response times. Any firm attempting to deploy make to order should put the most emphasis on the Internet's ability to connect customers and suppliers, online product setup, and IT-enabled techniques. In order to achieve the greatest strategic outcomes—organizational efficiency and innovation—IT modifies the interaction between organizational features including size, learning, culture, and inter-organizational linkages (Dewett & Jones, 2001). IT has a function in modulating the relationship between the most strategic outcomes—organizational efficiency and innovation—and organizational characteristics including size, learning, culture, and inter-organizational relationships (H. Liu et al., 2016).

4.3.2 Design, Innovation and Production Centric strategy:

Rossini et al. (2019) illustrated implementation of Kaizen through a real case study for high mix low volume production. Companies need to offer more and more customized items on the market in order to stay competitive. The sort of production method that must be chosen is impacted by this customization (Guillaume et al., 2013). Production planning in MTO systems is more difficult than in MTS systems because of the large range of products, the small number of standard items, and the impossibility of accurate forecasts (S. Hemmati et al., 2012). MTO reduces the expense of carrying inventory, but it also introduces issues like production scheduling issues when demand is high or issues with precise due-date setting, etc. (Günalay, 2011).

4.3.3 Customer-centric/Customer-focus strategy:

The customer's choice is the foundation of Make to Order Production. MTO companies employ many production policies to increase customer satisfaction and has its own benefits and drawbacks (Rabbani & Dolatkhah, 2017). In an MTO system, production doesn't start unless there is a demand. The system manufactures in accordance with customer requirements and does not maintain an inventory of finished goods (Fernandes et al., 2015). There is a constant pressure from customer on suppliers to increase quality, reduce costs, decrease delivery delays (Günalay, 2011). In MTO, before a customer places a request, the product's parameters are unknown, and even after the order has been accepted, they may change during processing (Corti et al., 2006). Therefore, and effective MTO strategy is the one which efficiently utilizes all the organization's professional resources to produce products as per the customer's needs.

Table 4.2: Attributes of different implementation strategies in the supply chain of passenger car manufacturing.

Stage	Description	Role of IT	Role of Design, Innovation and Production	Role of Customer
Procurement	Procuring raw materials, parts and subsystems.	Through information sharing, Supply chain management permits supply-chain participants to work closely in order to facilitate interactions of supplier-customer and lower transaction costs.	Design of the passenger car is the critical factor for purchasing raw materials, machines, tools and other resources.	There is a constant pressure from customer on suppliers to increase quality, reduce costs, and decrease delivery delays.
Manufacturing	Transforming raw materials into intermediate and finished products.	Activities related to IT, such as information processing, inf6rtormation coordination, and information integration are very useful for product development.	Design of the passenger car decides the manufacturing strategy.	Manufacturing strategy depends upon customer's demand.
Distribution/ retailer	Distributing the finished products to retailers	The use of technology in the distribution system is seen as a key competitive feature since it gives clients access to a limitless number of locations, times, and even product types. Get update related to due date.	Vital to coordinate the two functions in industrial issues where production and distribution expenses are both of a similar magnitude in order to keep overall costs to a minimum.	Customer location and demand affects the distribution system of passenger cars.
Demand Management	Methodology for forecasting, planning for, and managing the demand for goods and services	Information about various options on the website. Placement of order by customer.	Consumer segmentation and pricing discrimination are two demand management techniques that help increase the supply chain's overall distribution efficiency while ensuring the necessary responsiveness to address real customer needs.	Customer provides requirements which further helps in calculating the demand of the specific variant of passenger car.

The role of these three strategies in different phases of supply chain of passenger car manufacturing has been discussed in Table 4.2 to understand their importance and need. Automobile experts were interviewed, and their valuable inputs were used for this part of the study.

4.4 AHP for prioritising Critical Success Factors (CSFs)

This section discusses the weights of factors of MTO implementation for passenger cars by using AHP (data collection). The criteria's weights to be utilized in the ranking process are determined by an AHP approach after the decision hierarchy of the problem has been formed and data were collected. There were three phases to the data collection. In the first phase, the advantages of introducing MTO in the automotive industry were explained to the specialists. In the second phase, an online platform for self-assessment data collection was developed and made available to the experts via email. The automobile experts were interviewed as part of the third step of data gathering and were tasked with constructing individual pairwise comparison matrixes using the nine-point intensity important scale.

A total of 18 critical success factors are broadly grouped into 6 categories as shown in level 2 and level 3 of Figure 4.2. Initially, all the six categories at level 2 are compared among themselves. The next step is to extract the weights of each member in the pairwise comparison matrix after it has been constructed. Table 4.3 shows the comparison results and the weight of 6 categories of factors. The next step includes comparison and relative weights among 18 critical success factors toward the six categories and are shown in Tables 4.4 to 4.9. Along with local weights, global weights are also calculated for the product's local weight and its category's priority. Finally, the weights of 18 critical success factors are compiled in Table 4.10. The consistency of pairwise comparison of factors is measured by λ_{max} (Lambda), CI, and CR. In this case, for pairwise matrix of six categories of critical success factors, λ_{max} =

6.57, CI = 0.11, and CR = 0.09. The consistency ratio (CR) is the third ratio, and it is used to directly measure the consistency of pairwise comparisons. The comparisons are permitted if the CR is less than 0.10. Since all CR inconsistency ratios are less than 0.1 in this case, all judgments are consistent.

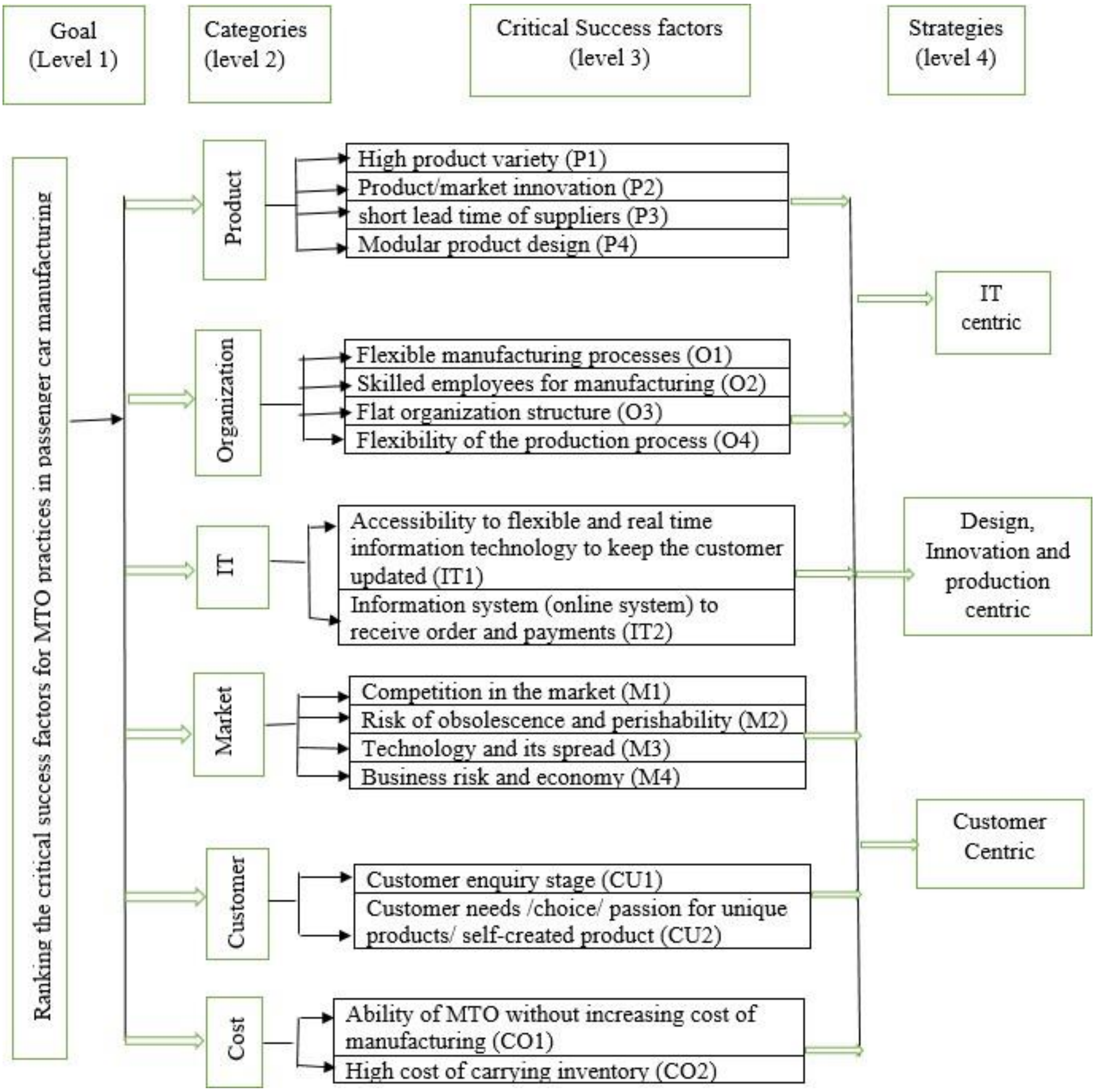


Figure 4.2. Proposed model for selecting the best strategy for MTO

Table 4.3: Pairwise comparison matrix of factors for implementing MTO.

MTO	Product	Organisation	IT	Market	Customer	Cost	Weights	Ranks
Product	1	1/3	2	1/3	¼	4	0.11	4
Organisation	3	1	2	1/5	½	5	0.15	3
IT	½	½	1	1/3	1/6	2	0.07	5
Market	3	5	3	1	4	4	0.38	1
Customer	4	2	6	¼	1	5	0.25	2
Cost	¼	1/5	½	¼	1/5	1	0.04	6

Consistency Ratio = 0.0928.

Table 4.4: Pairwise comparison matrix of product-related critical success factors.

Product (0.11)	P1	P2	P3	P4	Local weights	Global weights	Ranks
P1	1	½	3	1/3	0.18	0.02	3
P2	2	1	5	2	0.43	0.05	1
P3	1/3	1/5	1	1/3	0.08	0.01	4
P4	3	½	3	1	0.31	0.03	2

Consistency Ratio = 0.0591

Table 4.5: Pairwise comparison matrix of organization-related critical success factors.

Organization (0.15)	O1	O2	O3	O4	Local weights	Global weights	Ranks
O1	1	3	5	½	0.31	0.05	2
O2	1/3	1	5	1/3	0.18	0.03	3
O3	1/5	1/5	1	1/5	0.06	0.01	4
O4	2	3	5	1	0.45	0.07	1

Consistency Ratio = 0.0817

Table 4.6: Pairwise comparison matrix of IT-related sub-factors.

IT (0.07)	IT1	IT2	Local weights	Global weights	Ranks
IT1	1	5	0.83	0.06	1
IT2	1/5	1	0.17	0.01	2

Consistency Ratio = 0.0

Table 4.7: Pairwise comparison matrix of market-related critical success factors.

Market (0.38)	M1	M2	M3	M4	Local weights	Global weights	Ranks
M1	1	1/3	1/3	1/5	0.07	0.03	4
M2	3	1	2	1/5	0.18	0.07	2
M3	3	½	1	1/6	0.13	0.05	3
M4	5	5	6	1	0.61	0.23	1

Consistency Ratio = 0.0872.

Table 4.8: Pairwise comparison matrix of customer-related sub-factors.

Customer (0.25)	CU 1	CU 2	Local Priority	Global Priority	Ranks
CU1	1	1/6	0.14	0.04	2
CU2	6	1	0.86	0.21	1

Consistency Ratio = 0.0.

Table 4.9: Pairwise comparison matrix of cost-related sub-factors.

Cost (0.04)	CO 1	CO 2	Local Priority	Global Priority	Ranks
CO 1	1	4	0.80	0.04	1
CO 2	¼	1	0.20	0.01	2

Consistency Ratio = 0.0.

4.5 TOPSIS for ranking alternate implementation strategies

With the help of experts and literature review three strategies have been selected to be ranked for implementation of MTO in passenger car manufacturing. The first strategy is IT system-centric, the second strategy is design-, innovation- and production-centric, while the third strategy is customer-centric. TOPSIS methodology is adopted for ranking the alternative strategies that have been finalized. It starts by preparing a normalization matrix of critical success factors vs. strategies, and normalized values are determined during this first step. The collected data are then organized into a decision matrix form. The weights allocated to each critical success factor are used to find the weighted normalized decision matrix (Table 4.11). The ideal and negative ideal solutions from the decision matrix are discovered once the weighted formation is performed. Thereafter, on the basis of these solutions, alternatives are ranked (Table 4.12).

Table 4.10: Weights of the CSF by applying AHP

Codes	Criteria Success Factors	Weights
M4	Business risk and economy	0.23
CU2	Customer needs /choice/ passion for unique products/ self-created product	0.21
O4	Flexibility of the production process	0.07
M2	Risk of obsolescence and perishability	0.07
IT1	Accessibility to flexible and real time information technology to keep the customer updated	0.06
M3	Technology and its spread	0.05
O1	Flexible manufacturing processes	0.05
P2	Product/market innovation	0.05
CU1	Customer enquiry stage	0.04
CO1	Ability of MTO without increasing cost of manufacturing	0.04
O2	Skilled employees for manufacturing	0.03
P4	Modular product design	0.03
M1	Competition in the market	0.03
P1	High product variety	0.02
P3	short lead time of suppliers	0.01
IT2	Information system (online system) to receive order and payments	0.01
CO2	High cost of carrying inventory	0.01
O3	Flat organization structure	0.01

4.6 Results and Discussions

Saaty's (1980) Analytic Hierarchy Process was used to rank the critical success factors for three different approaches. A hierarchy of six categories of factors, eighteen critical success factors, and three strategies was used to calculate the priority rankings for each strategy for implementation of MTO for passenger cars. On a pairwise basis, the categories and critical success factors were compared.

Table 4.11: TOPSIS matrices

CSF	Scoring of Strategies for different CSF								
	IT system centric Strategy			Design, innovation and production centric strategy			Customer centric Strategy		
	Score	Normalized Score	Weighted normalized score	score	Normalized score	Weighted normalized score	score	Normalized score	Weighted normalized score
P 1	5	0.651	0.013	3	0.391	0.008	5	0.651	0.013
P 2	7	0.704	0.035	5	0.503	0.025	5	0.503	0.025
P 3	5	0.451	0.005	7	0.631	0.006	7	0.631	0.006
P 4	7	0.523	0.016	9	0.673	0.020	7	0.523	0.016
O 1	7	0.482	0.024	9	0.620	0.031	9	0.620	0.031
O 2	5	0.402	0.012	9	0.723	0.022	7	0.562	0.017
O 3	5	0.437	0.004	9	0.786	0.008	5	0.437	0.004
O 4	5	0.366	0.026	9	0.658	0.046	9	0.658	0.046
IT 1	7	0.631	0.038	7	0.631	0.038	5	0.451	0.027
IT 2	5	0.549	0.005	7	0.768	0.008	3	0.329	0.003
M 1	7	0.768	0.023	5	0.549	0.016	5	0.329	0.010
M 2	7	0.704	0.049	5	0.503	0.035	5	0.503	0.035
M 3	7	0.562	0.028	5	0.402	0.020	9	0.723	0.036
M 4	7	0.704	0.162	5	0.503	0.116	5	0.503	0.116
CU 1	9	0.577	0.023	9	0.577	0.023	9	0.577	0.023
CU 2	9	0.620	0.130	7	0.482	0.101	9	0.620	0.130
CO 1	7	0.631	0.025	5	0.451	0.018	7	0.631	0.025
CO 2	7	0.562	0.006	5	0.402	0.004	9	0.723	0.007

Table 4.12: Ranking of strategies for implementing MTO

Alternatives or strategies for MTO	Si+	Si-	Si+ + Si-	Ci	Rank
IT system centric (S1)	0.06	0.04	0.09	0.40	3
design, innovation and production centric (S2)	0.04	0.06	0.09	0.61	2
Customer centric (S3)	0.02	0.06	0.09	0.73	1

The integrated AHP and TOPSIS methods made it more organized and effective for the decision-maker to select the best strategy for MTO implementation by ranking and prioritizing processes. The maximum weight value was used to consider the most valuable critical success factors, which were represented such that Market > Customer > Organization > Product > IT > Cost. This shows that 'market' is the most significant critical success factor for MTO implementation in passenger car manufacturing. The critical success factors in this category include market related critical success factors (which are M4 > M2 > M3 > M1) and results show that 'business risk and economy' (M4) for MTO implementation is the highest weightage sub-factor and 'competition in the market' (M1) is the lowest weightage CSF of all critical success factors. Ranking value of 'customer' factors are CU2 > CU1, respectively, in which the 'customer needs' CSF has more weight than the 'customer enquiry' stage. Organization factors' ranking values are O4 > O1 > O2 > O3, respectively, in which 'flexibility of production process' is the highest weightage CSF and 'flat organization structure' is the lowest weightage CSF. Product factors' ranking values are P2 > P4 > P1 > P3, respectively, in which 'product/market innovations' is the highest weightage CSF. IT factors' ranking values are IT1 > IT2, in which 'accessibility to flexible and real-time information technology to keep the customer updated' and 'information system (online system) to receive order and payments' are the lowest weightage CSF of all IT factors. Cost factors' ranking values are CO1 > CO2 (Table 4.9), respectively, in which ‘ability of the MTO without increasing cost of manufacturing’ is the highest weightage CSF, while ‘high cost of carrying inventory’ is the lowest weightage CSF.

To implement MTO in manufacturing of passenger cars, ranking of factors has been suggested to decision makers to make the best strategy for the same. With the help of TOPSIS, the Ci value were used to consider for prioritizing of strategies. The Ci values are such that S3 > S2 > S1 respectively, which is given in Table 4.12. The highest Ci value is Customer Centric (S3) strategy and the lowest value is IT system centric (S1) strategy. This study has strength that it considered numerous critical success factors related to automobile sector, while other authors studied a few of them and a very few studied MTO in automobile industry. Some of these studies have been discussed here: Yue & Jia (2015) worked only on manufacturing lead time in make to order production, X. Y. Sun et al. (2008) considered only two factors, i.e., customer delivery time and demand variance, while this study focused on numerous other factors. Chua et al. (2018) analysed MTO Supply chain taking into consideration only two factors, i.e., lead time market elasticity and price.

4.7 Conclusions

To help Indian manufacturing companies plan strategically and take the first step toward a long-term business model in a competitive market, this chapter focuses on identifying and prioritizing the critical success factors. It also helps them understand strategic goals to build a competitive business structure. This chapter also includes identifying and ranking the implementation strategies or alternates, which will help decision makers and managers concentrate on transition from make to stock to make to order. Organizations would be able to map their current manufacturing system, pinpoint the essential critical success factors, and formulate MTO implementation strategies.

CHAPTER 5

IMPLEMENTATION OF MAKE TO ORDER MANUFACTURING SYSTEM: PLS SEM MODEL

5.1 Introduction

The aim of the current chapter is to identify the factors that influence the integration of MTO, Competitive Advantage and sustainable manufacturing. Manufacturing sectors in India see a potential in adaptation of MTO, need a manufacturing model to boost competitive advantage over rivals as well as achievement of sustainable manufacturing. Thus it can be said that this study's objective is to empirically fill the gaps in implementing MTO, by developing hypothesis, with an aim to achieve competitive advantage (CA) and sustainable manufacturing (SM). With the use of PLS SEM (SMART PLS 4) factors have been related (depicted as items in the tool) with three other items, i.e. MTO, CA and SM. The flow of the chapter is shown in Figure 5.1.

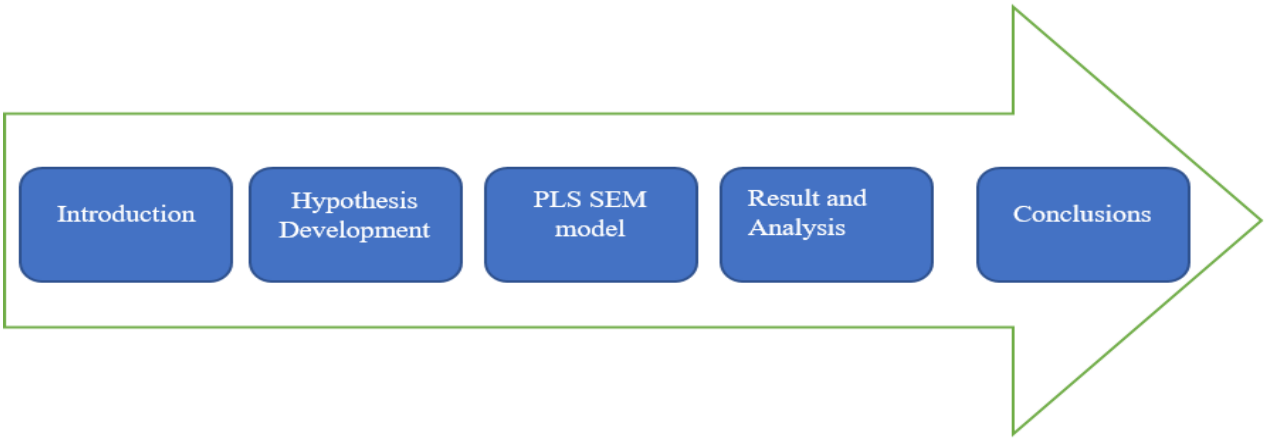


Figure 5.1: Flow of Chapter 5

The strategic objectives of manufacturing organizations are always changing in tandem with the growth of the new competitive market (Y. Li et al., 2020). As per He et al. (2014) manufacturing companies must learn to be adaptable to these rapid shifts in the business environment if they want to endure in the current market. It is well acknowledged that these businesses need to succeed in other ways as well as financially. They should be devoted to sustainability so that the environment is protected and the well-being of future generations is ensured (Angappa Gunasekaran & Spalanzani, 2012). Many companies are beginning to adopt sustainable practices in the current environment, moving in an innovative direction that is geared toward sustainability (Jones et al., 2016). Sustainability refers to the goal of reducing a company's negative impact on the environment, societies, and people while consecutively increasing value for customers, stakeholders, and business partners (Luthra et al., 2015). In today's fiercely competitive market, where many businesses still rely on natural resources while also producing waste and environmental degradation, sustainable manufacturing (SM) has become increasingly important (Bhanot et al., 2015). Role of manufacturing is significant in creating a society that is more sustainable. The constant shift in product types, fluctuating demand, and unforeseen changes in client needs put increasing pressure on manufacturing organizations today. Manufacturing was viewed by Guo & Wu (2023) as one of the key indicators of social sustainability. Sustainability has been acknowledged as a critical component to obtain an edge in future competitiveness; as a result, more money is being invested in sustainability, and this innovation is now essential in all sectors of the economy (Khurana et al., 2019). Sustainability has drawn a lot of attention and is an important strategic issue for nations, as well as for specific businesses (Barbosa & Azevedo, 2018). Utilising sustainable business practises can help firms grow their income, brand value, and stakeholder involvement (Kaur, 2017).

This adaptation for achieving competitive advantage has led to this present study which focuses on the impact of the MTO strategy on Sustainable manufacturing. Several studies have been done to understand the importance and various issues of MTO manufacturing strategy. A few of them have been discussed here. In MTO businesses, for on-time delivery, order acceptance and scheduling are particularly crucial production planning activities (Lödding & Koch, 2020). To address the unique requirements of MTO businesses, Lödding & Koch (2020) suggested a new value stream analysis and design. Taylor et al. (2009) provided the evidence empirically on the unique needs of Production Planning and Control (PPC) by small and medium-sized MTO enterprises.

Very few studies have shown the contribution of MTO strategy towards competitive advantage of the company and only some of the studies have discussed the impact of MTO over sustainable manufacturing. To effectively implement MTO in an organisation and gain competitive advantage and sustainable manufacturing, it is required to design a model that identifies the aspects a manufacturer must take into account.

5.2 PLS SEM Model of MTO and Sustainable Manufacturing

The field of sustainable manufacturing is one that is fast emerging, although there aren't many reliable reports on how prevalent it is currently among business operations (Despeisse et al., 2012). Therefore, a thorough literature review is conducted to find the key elements that would motivate firms to adopt MTO strategy for achieving competitive advantage and sustainable manufacturing. Also, a detailed literature review has been done to select PLS SEM as the tool for measuring relationship between different constructs.

An in depth literature study was undertaken to identify the factors of Make To Order that lead to Competitive advantage which finally results in sustainable manufacturing. Based on the literature review and the advice of multiple experts, hypotheses were developed. To look into these theories, a questionnaire was created, and information was gathered related to the theories. Five-point Likert scales were used in the questionnaire. To address some of the questions, though, a pilot survey was employed. After that, the questionnaire was modified to increase its appeal to the respondents. Using mathematical models based on the survey responses, hypotheses were assessed and verified. The results include an anticipated description of the statistical process that was used to determine the frequency distribution of the respondents. A review of the literature and the opinions of industry professionals have been used to determine the different aspects that affect MTO organisations. The dependability and internal consistency of these factors are evaluated using Cronbach's alpha. The structural equation modelling method and the SMART PLS software are used to test the hypotheses. This study uses PLS SEM to construct and evaluate the hypotheses as it investigates the influence of several factors on the competitive advantage of MTO companies and sustainable manufacturing. 95% confidence is used to test the hypothesis level and a significance threshold of 5% (Fig. 5.2).

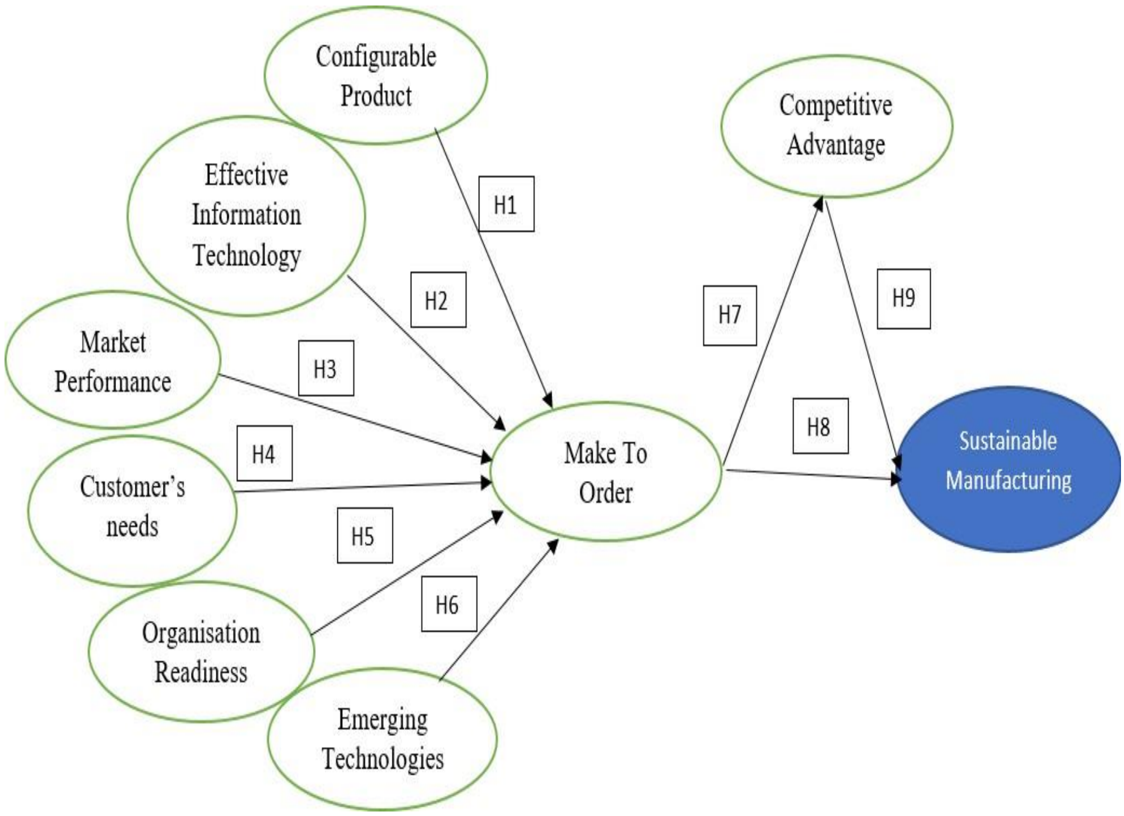


Fig: 5.2: Model for achieving Sustainable manufacturing through MTO manufacturing system

The hypotheses offered in the current study consider factors that are critical for MTO approach and further reinforced by examining relationship between MTO ability for competitive advantage and Sustainable Manufacturing. MTO is also directly linked to three pillars of sustainability, i.e., Social, Economical and Environmental (Garetti & Taisch, 2012) (Sari et al., 2021) and two other effects of supply chain manufacturing; sustainable supply chain and sustainable product design (Garetti & Taisch, 2012). The following hypotheses are tested using PLS-SEM.

Hypothesis H1: Configurable Product is positively related to MTO ability

Hypothesis H2 : Information Technology is positively related to MTO ability

Hypothesis H3: Market Performance is positively related to MTO ability

Hypothesis H4: Customer need is positively related to MTO ability

Hypothesis H5: Organisation Readiness is positively related to MTO ability

Hypothesis H6: Emerging Technologies is positively related to MTO ability

Hypothesis H7: MTO is positively related to Competitive Advantage

Hypothesis H8: Competitive Advantage is positively related to sustainable Manufacturing

Hypothesis H9: MTO is positively related to Sustainable Manufacturing

5.3 Constructs and Hypothesis of PLS SEM model

A thorough review of the literature is conducted out to identify the important factors influencing the implementation of MTO to achieve sustainable manufacturing. A thorough analysis helps to acquire a sense of the research being done by researchers in the subject of sustainable manufacturing. Literature for the concept of sustainable manufacturing, Competitive Advantage and MTO has been reviewed. Expert's opinion has also been taken. Accordingly, six factors each having further sub factors strengthening the sustainable manufacturing implementation in companies have been determined. These factors and their related Hypotheses are given below:

5.3.1 Configurable Product (CP)

The development of configurable products is based on in-depth expertise and methodology (Custódio et al., 2018). For creating MTO capability, manufacturing sector has to deliver huge product variety (Haskose et al., 2004). Due to competition in the market for product variety, various organisations use MTO strategy for offering a variety of items and prevent multiplication of product (Vidyarthi et al., 2009). Customer needs are given top consideration because they have an impact on MTO's entire manufacturing system (Rabbani & Dolatkhah, 2017) (Zennaro et al., 2019). A. Gunasekaran & Ngai (2005) highlighted that product innovation helps MTO companies to be successful and competitive. Easton & Moodie (1999) pointed out that for successful MTO enterprises, shorter and more precise lead times are preferred. Modular product design, which allows for easy assembly using a common set of components, is another crucial consideration (Zennaro et al., 2019). The MTO business must provide a wide range of items, typically in less numbers, varying from a selection of conventional products to all requests as required by a customised product (Haskose et al., 2004). MTO businesses must provide their goods faster than the whole lead-time for production in order to remain competitive (Gonçalves Filho & Marçola, 2001). The two main competitive advantages in MTO circumstances are the ability to specify assured delivery dates and quick delivery periods (Ebadian et al., 2008).

Hypothesis H1: Configurable Product is positively related to MTO ability

5.3.2 Information Technology (IT)

IT is a tool made to add value and that value comes from improved productivity, a competitive advantage, cost savings, better supplier relationships, etc. Process improvements and improved organizational performance occur when the appropriate technology is applied within the proper business process (Dalcher, 2016). Despite the fact that applying IT to enhance company performance requires little organisational changes (Mcafee, 2002), successful IT implementation frequently results in major organisational change (Cooper et al., 2000) (Brynjolfsson et al., 2002) (Moody, 2020) including organizational structure and culture, workplace policies and practices. On-time shipping (Mcafee, 2002), customer satisfaction (Devaraj & Kohli, 2000), and inventory turnover (Barua et al., 1995) are just a few examples of business processes performance measures that have been employed in earlier IT business value research. The entire system will be affected by any information update or change, saving time, energy, and money (Sahin & Robinson, 2005). In order to successfully manage orders and payments, Zennaro et al. (2019) underlined the role of IT as a centralised online system. There is an increasing requirement for seamless task coordination and real-time information transfers across various nodes of product development life cycle (Eswaran & Bahubalendruni, 2022). IT is valuable because it offers a wide range of possible advantages, from increased flexibility and improved quality to lower costs and higher production. (Dalcher, 2016)

Hypothesis H2 : Information Technology is positively related to MTO ability

5.3.3 Market Performance (MP)

Numerous businesses are using MTO manufacturing processes as a result of the growing trend of customization in consumer market.(Fakhrzad & Mohagheghian, 2019). Variables like retail price, selling price, etc. are impacted by factors like technological improvement in the market competition (Fakhrzad & Mohagheghian, 2019) (Garmdare et al., 2018). In cases when there is a high likelihood of product obsolescence or perishability, a preference for MTO systems is greater (Rafiei & Rabbani, 2009) (Zaerpour et al., 2009) (Samira Hemmati & Rabbani, 2010). Market penetration is another significant factor which affects the market performance of any kind product and in this case it's customised product. The uncertainty surrounding the uptake of electric vehicles in the American market was highlighted by Noori & Tatari (Noori & Tatari, 2016). Propfe et al. (2013) conducted an EV (electric vehicle) market analysis for the German passenger automobile market until 2030. Gong et al. (2020) also reviewed penetration of EVs in Australian market and studied the impact of government incentives on it. According to studies conducted by Jo et al. (2003) effective global manufacturing that results in cost advantages is dependent upon a strong brand image. Essoussi & Merunka (2007) analysed the outcome of brand image on Consumer's product evaluations in emerging markets. Towers et al. (2013) studied Scottish industry to determine the beneficial effects of SSCM (Sustainable Supply Chain Management) on brand image and social responsibility performance. As per Accenture, by creating sustainable supply chains, companies could save costs, enhance risk management, explore new revenue streams, and elevate brand value (Hong et al., 2018).

Hypothesis H3: Market Performance is positively related to MTO ability

5.3.4 Customer Need (CN)

Using MTO strategy is essential if consumers have a broad range of customization needs (Samira Hemmati & Rabbani, 2010). The correlations among sharing of real-time information, consumer focus, buying behaviour, and buyback behaviour were investigated by Mujahid et al. (2021). Adopting technology to communicate real-time information to clients is viewed as a strategic tool (Meadows & Dibb, 2012) (Jabbar et al., 2019). System performance suffers dramatically when real-time information about items that are available in the Work in Process is ignored (Calle et al., 2016). It would be impossible to offer a large product variety and the amount of customisation that the consumer requires on a system other than MTO (Samira Hemmati & Rabbani, 2010). In many industries, mass customization is starting to become popular. As a result, businesses are implementing the MTO production method to make it easier to produce different product variants (Fakhrzad & Mohagheghian, 2019).

Hypothesis H4: Customer need is positively related to MTO ability

5.3.5 Organisation Readiness (OR)

Organization Readiness is associated with Flexible manufacturing processes. Analysing the amount of time needed to switch a system from one type of job to another will depend on how flexible the production processes are (Pramod & Garg, 2006). Due to the utilisation of multipurpose machinery or equipment, MTO demands a significant amount of skilled labour (H. Li & Womer, 2012) (Khakdaman et al., 2015). Kidwell (2005) highlighted Flat organization structure, i.e. organisation has fewer employees and less hierarchical management, as another important factor to be considered. It is also important to take into account MTO's capacity without raising manufacturing costs. To reduce total cost, various factors and resources need to be taken into account and examined (He et al., 2014) (Salamati-Hormozi et al., 2018) (Pan et al., 2014) (Rafiei & Rabbani, 2009). The key characteristic of MTO is lower carrying or storage costs (Zhen Wang et al., 2019). Also, Reduced stock holding costs result from a wide range of customization requirements (Samira Hemmati & Rabbani, 2010).

Hypothesis H5: Organisation Readiness is positively related to MTO ability

5.3.6 Emerging Technologies (ET)

With the advent of immersive technologies, the manufacturing industry is currently going through its fourth revolution, with a heavy focus on flexible production and human-machine interaction. Utilising technology during the manufacturing process can eliminate the barriers to creating a variety of goods with unchanged quality in the shortest possible period of time (Eswaran & Bahubalendruni, 2022).

Industry 4.0, Internet of Things (IOT), Artificial Intelligence (AI), Big Data, these terms describe a variety of ideas, instruments, and techniques that have the potential to fundamentally alter contemporary industry and society (Osterrieder et al., 2020). Industry 4.0 incorporates information exchange, Smart Supply Chain, and production coordination with vendors to lower time of delivery and alterations of information that cause "bullwhip effects." Customized products and additive manufacturing are two favourable technology of the Industry 4.0 concept (Frank et al., 2019). These technologies can enhance MTO system using real-time data and can be used for optimization of production processes, reduce lead times, and improve quality.

Industry 4.0 is regarded as a new industrial stage where a number of developing technologies are combining to offer digital solutions. Industry 4.0 is dependent on the use of digital technology to collect data in real-time, analyse it, and provide meaningful information to the industrial system. The cyber-physical system concept of Industry 4.0 was made possible by the emergence of the Internet of Things (IoT), cloud services, big data, and analytics. (Frank et al., 2019) listed the base technologies for Industry 4.0 as Internet of Things (IoT), Cloud computing, Big data and Analytics (S. Wang et al., 2016) (Zhong et al., 2017).

The Internet of Things (IoT) has arose as a key topic in the context of advanced manufacturing (Durão et al., 2018). The Internet of Things (IoT) gives up-to-the-minute information on happenings in the real world, by connecting virtual data environment and the physical devices (Domingos et al., 2014). Improvements in productivity, lower production costs, and more efficient resource use are all achieved by industrial IoT. It aims to create seamless connectivity between industrial resources and various control systems (Wan et al., 2018). In order to achieve customisation for various product versions, the manufacturing sectors have given a lot of attention to Augmented Reality (AR) and Virtual Reality (VR) immersive technologies (Eswaran & Bahubalendruni, 2022). Eswaran & Bahubalendruni (2022) demonstrated the progress of AR/VR technologies for product design and evaluation, assembly, repair and maintenance, quality control, warehouse management, CNC simulation and plant planning. AR VR provides support, simulation and assistance in improving processes of industries before they are actually implemented in production. This will save money on reworks and changes to manufacturing tasks like product design, process planning, machining, and other related ones (Yuan et al., 2005) (J. Zhang et al., 2012).

3D Printing (3DP), has gained international recognition of a disruptive technology that can transform manufacturing and design. The design and manufacture of items is being fundamentally altered by 3DP (Corsini et al., 2022). Recent developments in fused material deposition (FMD) and additive manufacturing (AM) methods have led to the commercialization and extensive use of 3DP (Bassett et al., 2015). 3DP is a relatively new industrial technology that may have significant positive effects on sustainable development (Gebler et al., 2014). It simplifies the manufacturing process by minimising the number of required processes (Corsini et al., 2022). Additionally, it promotes environmentally friendly manufacturing by lowering carbon emissions, energy use, and material waste. Researchers are examining various techniques to obtain natural materials for 3DP, including cellulose-chitin material, coffee grounds, and algae. This will enable more sustainable production (Nadagouda et al., 2020). (Gebler et al., 2014) carried out a descriptive sustainability assessment to identify the qualitative effects of the 3DP on the three sustainability dimensions of economy, environment, and society. It is a manufacturing technique with a lot of sustainability potential, especially if it can be used in mass production markets and if social consequences are completely taken into account. It is linked to a significant reduction in the amount of money and energy used in production, which lowers the price of goods and reduces CO_2 emissions. The future impact of 3DP on the spare parts business is another significant industrial market segment. This means that when a component breaks and the industry is no longer producing its replacement part, the entire item must be discarded, having a negative influence on the environment. However, if the replacement part can be printed, the item will last longer, which is excellent from a sustainability perspective. A quantitative analysis of the sustainability effects of 3D printing on costs, energy use, and CO_2 emissions reveals that there are sustainability potentials throughout the full life cycle of 3D-printed products.

Hypothesis H6: Emerging Technologies is positively related to MTO ability

5.3.7 Make To Order (MTO)

Customers often anticipate speedy delivery, which is an order winner for businesses, therefore if the lead time of product delivery is lengthy, it will be difficult to use the MTO strategy and could lead to in backorder cost (Samira Hemmati & Rabbani, 2010). Increase in varieties: Using MTO strategy is essential if consumers have a broad range of customization needs (Samira Hemmati & Rabbani, 2010). Many businesses are attempting to capitalise on this trend by employing MTO production processes that provide greater product diversity and flexibility in response to the increased interest in product variants.(Fakhrzad & Mohagheghian, 2019). Today's manufacturing companies must produce different items for a range of different customers because of the rise of customised production (E. Kim & Van Oyen, 2021). In MTO situations, timely work delivery and total delivery cost are the two performance metrics that are most frequently taken into account. (Tang & Chen, 2019). In order to compete with other businesses, make-to-order companies offer products in response to customer orders, evaluating factors such as cost, technical proficiency, delivery time, and timely delivery.

Hypothesis H7: MTO is positively related to Competitive Advantage

5.3.8 Competitive Advantage (CA)

Consumers typically want quick deliveries, which is a competitive advantage for businesses (Samira Hemmati & Rabbani, 2010). MTO manufacturing allows firms to offer customized products and services, which can differentiate them from their competitors and provide a competitive advantage. It is observed that the literature available does not properly value employee satisfaction for MTO manufacturing. Employee satisfaction and its effect on productivity are both strongly influenced by the workplace environment (Sukdeo, 2017).

Hypothesis H8: Competitive Advantage is positively related to sustainable Manufacturing

5.4 Sustainable Manufacturing (SM)

The U.S. Department of Commerce defines sustainable manufacturing as the "creation of manufactured products which use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound" (Ebrahimi et al., 2021). This study considers three pillars of sustainability (Garetti & Taisch, 2012) (Sari et al., 2021) and two other effects of supply chain manufacturing; sustainable supply chain and sustainable product design. Sustainability concerns will have an impact on all facets of human life, including the economic, political, social, and environmental spheres (Garetti & Taisch, 2012).

Sustainability has emerged as a crucial concern in all walks of life. The early idea of sustainability is driven by the necessity for economic growth, with its social and economic goals, to take conservation into consideration by taking resource constraints and ecosystem-carrying capacity into account (Purvis et al., 2018). The "general model" of sustainable development that appears in the literature underlines trade-offs between economic expansion, worsening environmental conditions, and a drop in the standard of living (Macnaghten & Jacobs, 1997). The authors (Macnaghten & Jacobs, 1997) proposed a model in which "economic welfare" is a factor of "quality of life," which is in turn limited by "environmental limits." Numerous authors have seen such a nested model as superior to a "Venn diagram" of trade-offs because it emphasizes how the three systems represented by the pillars cannot be separated and are actually subsystems of one another. From both a "quality of life" or social standpoint and an ecological perspective, the concept of "sustainable development" emerged here as a double critique of the previously prevalent idea of "economic development" (Purvis et al., 2018).

Sustainability in manufacturing and services has been a tactical tool used to achieve success not only economically but also environmentally and socially. The goal of sustainability is to prevent manufacturing and service organizations from exploiting natural resources for their own productivity and competitiveness. Environmental-friendly manufacturing has attracted the attention of businesses worldwide (Angappa Gunasekaran & Spalanzani, 2012). Sustainable business practices enable organizations to innovate by developing innovative, environmentally friendly goods and services, decreasing risk, preventing the creation of waste, and boosting material and energy efficiency (Angappa Gunasekaran & Spalanzani, 2012). This will support an organization's efforts to meet social and environmental goals and requirements in addition to improving its financial success. To achieve sustainability, a sustainable design strategy for new products and services with significantly improved environmental (sustainable) performance would be essential. Businesses are utilizing a variety of approaches and technologies to evaluate the economic, social, and environmental effects of their products and supply chains as they adapt to the challenging future of sustainable manufacturing. For assessing the environmental impact of assets across their full life cycle, life cycle assessment

(LCA) and life cycle costing (LCC) are being utilized more frequently (Garetti & Taisch, 2012).

It has become necessary to develop and pursue manufacturing activities in order to maximize economic and social benefits while minimizing environmental impact. This is because the ongoing trend of rising demand for materials and energy is severely limiting the availability of natural resources like fossil fuels, water, minerals, and land, driving up energy and commodity prices, and making the country's momentum unsustainable (Bhanot et al., 2015). Increased energy use results in air pollution, which harms the ecosystem and biodiversity and ultimately undermines sustainable economic growth (Ali et al., 2023). In order to achieve a more sustainable energy and economic transformation, global economies must take the initiative to increase the use of renewable and alternative resources (Kamran et al., 2022). Manufacturers by developing newer methods of production can greatly reduce the consumption of materials and the discharge of effluents thus contributing to sustainability. This will also reduce the cost of the products and services.

Manufacturing will be significantly impacted by sustainability challenges and will be crucial in constructing a sustainable future. Manufacturing enterprises face a number of challenges, including the depletion of natural resources, tougher laws and regulations, economic stagnation, and consumer demands for improved product quality. The paradigm of sustainable manufacturing has drawn a lot of interest in the last ten years as a new production strategy designed to help businesses overcome these challenges and help them stand out in today's cutthroat marketplace (Franciosi et al., 2020). Garetti & Taisch (2012) grouped the challenges of sustainable manufacturing as business processes and models, Asset and product life cycle management, energy and resource management, and enabling technologies.

Almost all manufacturing models in use today are based on the outdated paradigm. In light of the fact that manufacturing is entirely dependent on technology if humanity wishes to prevent a return to the primitive past, it should rely on the technology's obvious contribution to sustainability (Garetti & Taisch, 2012). In their study of the relationship between business performance and sustainable supply chain management (SSCM) practices, (Hong et al., 2018) analyzed the mediation effect of the dynamic capacities of the supply chain (SC). According to Bhanot et al. (2017) SM has been a key component of a sustainable supply chain, which essentially covers product-related activities like design, production, and recovery operations up until the product's end of life.

Hypothesis H9: MTO is positively related to Sustainable Manufacturing

5.5 Research Instrument and data collection

For developing a sustainability model with the MTO system and considering the mediating effect of competitive advantage on attaining sustainable manufacturing, a three-stage process was used. The initial stage examined the important factors influencing the implementation of MTO to achieve sustainable manufacturing. In the second stage of the process, a questionnaire was created based on these factors. In the third phase, PLS-SEM was used and the validity was accessed to analyze the influence of the factors.

5.5.1 Design of Questionnaire and its Reliability

Following a thorough assessment of the literature, the questionnaire was created as a research tool. There were three sections in the questionnaire. The demographics of the respondents, the industry in which they are employed, and number of employees (company size) and revenue are all covered in the first section of the questionnaire. The questions in the next section examine how the respondents perceived their level of MTO skill. It had thirty-seven variables that were measured using a Likert scale using a five-point scale. The questionnaire utilized the five-point Likert scale since it is easy for respondents to read out and provides a comprehensive list of scale descriptors (Dawes, 2008; Sari et al., 2021). A panel of experts reviewed the questionnaire to make sure it was clear and accurate (Mendes & Machado, 2015). Ten experts who were particularly briefed on the concept of research and its scope were a part of this panel. It was finalized through individual discussions with six manufacturing industry experts who held positions such as managers, vice presidents, general managers, and assistant general managers, as well as two consultants with extensive experience. It also included two experts from academics. Further, two experts were from the area of environment, three were concerned with the area of manufacturing cost and three experts were social scientists (Table 5.1). The expert screening procedure was designed so that the panel of assessors could identify items with overly similar wording (Maklan, 2011). As suggested by Forza (2002), a pilot survey is carried out with a small sample size (15 respondents) to test the questionnaire (Sari et al., 2021).

5.5.2 Target organizations and target respondents

An important factor in the evaluation of empirical research projects is the quality of the respondents. Respondent lists were gathered from reliable sources such alumni associations, trade associations, and chambers of business and industry. The most crucial requirements, restrictions, and challenges were to find responders with potential expertise to answer questions about knowledge from a range of areas covered by diverse domains (Valase & Raut, 2019). The survey was carried out in the processing and manufacturing sectors of India. The responders were chosen from businesses that used or had experience with such technology.

Table 5.1: Experts of decision panel

Expert	Position	Type of Industry/Expertise	Years of Experience
Expert 1	Head, Asset Management	Supply chain Management	28 years
Expert 2	Regional Manager (Key Account manager)	Supply chain ,make to order consultant	23 Years
Expert 3	Assistant General Manager	Procurement	20 Years
Expert 4	Deputy General Manager	Product planning , Automobile	20 Years
Expert 5	Chief Mechanical Maintenance manager	Operation and Maintenance, Furniture Industry	25 Years
Expert 6	Senior Project Manager	Project Expert, Automobile Industry	22 Years
Expert 7	Associate Partner	IT Expert, Textile Industry	25 Years
Expert 8	Vice President	Start-up, Entrepreneurship, Food Industry	20 Years
Expert 9	Academic Expert	Industrial and Manufacturing	17 Years
Expert 10	Academic Expert	Industrial and Manufacturing	25 Years

5.5.3 Collection of data

The questionnaire was disseminated both offline and online in order to get answers from possible respondents. Respondents were asked to set up an appointment in advance for the offline mode. For online mode, the questionnaire was produced as a Google form, along with an additional background note on MTO so they could better understand all of its various components and around 300 concerned professionals received it in the mail. After two weeks, a follow-up email was sent to all the experts involved. After receiving the responses through offline and online modes, the surveys were analyzed to see if the respondents provided meaningful input.

5.5.4 Demographic of Respondents

A total of 192 questionnaires out of the 300 disseminated questionnaires were finished and submitted. Outliers and missing data were explored in the questionnaires (Schreiber et al., 2013). All of the respondents have a diploma as a minimum qualification. The maximum of them hold Master's Degree (42.8%), holders of graduation came second (41.4%), and those holding doctorate were third (5.9%), followed by diploma holders (5.3%) and post doctorate (4.6%) (Fig. 5.3).

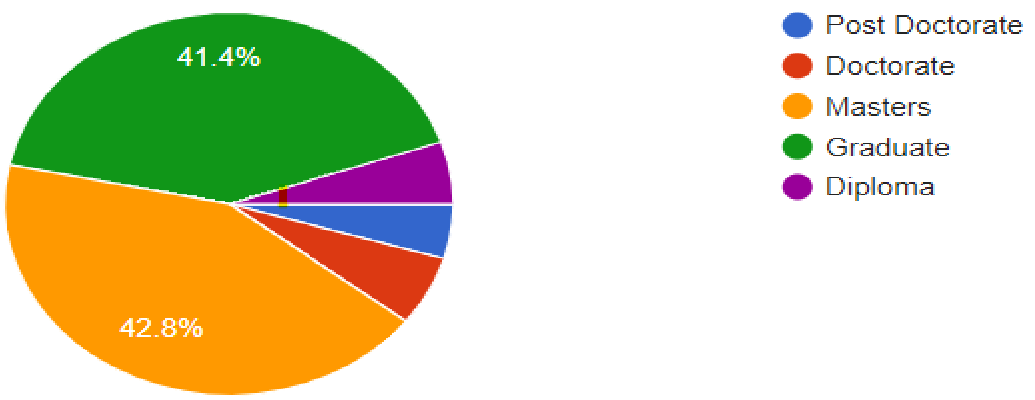


Fig 5.3: Level of education of the Respondents

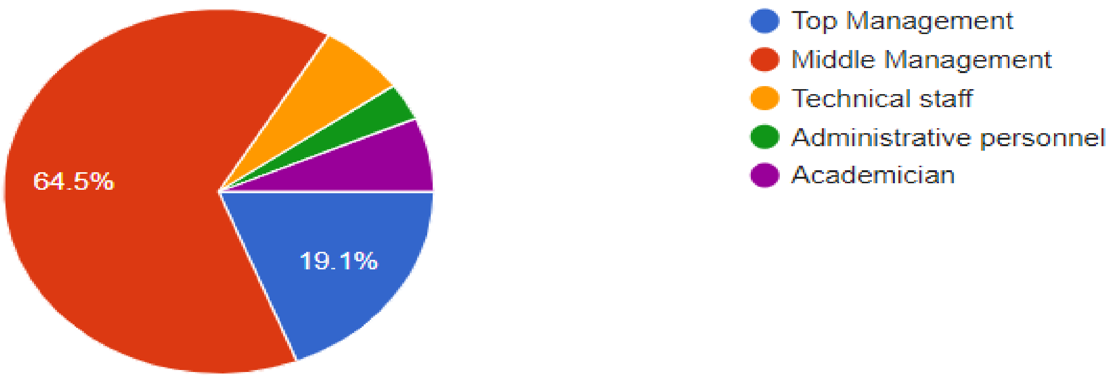


Fig 5.4: Designation of the Respondents

According to the respondents' sample characteristics, top management made up 19.1% of respondents, followed by middle management (64.5%), administrative staff (3.3%), technical staff (6.6%), and academicians (6.6%) (Fig. 5.4).

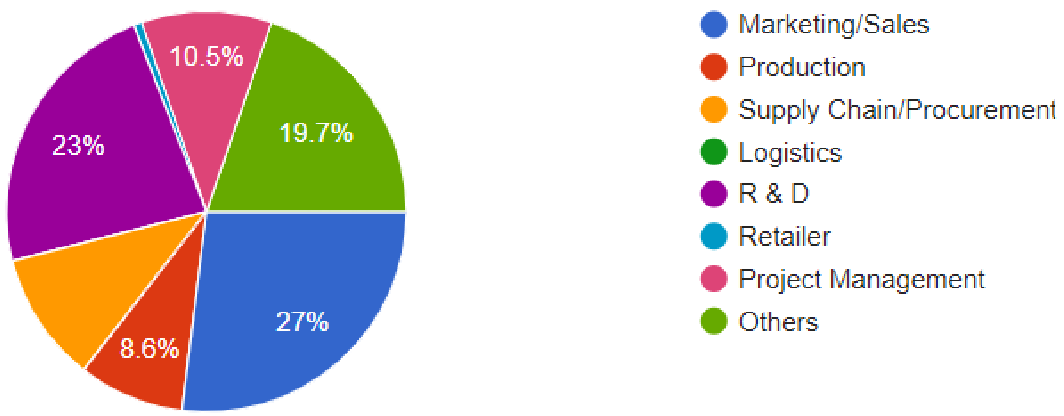


Fig 5.5: Functional Area of the Respondents

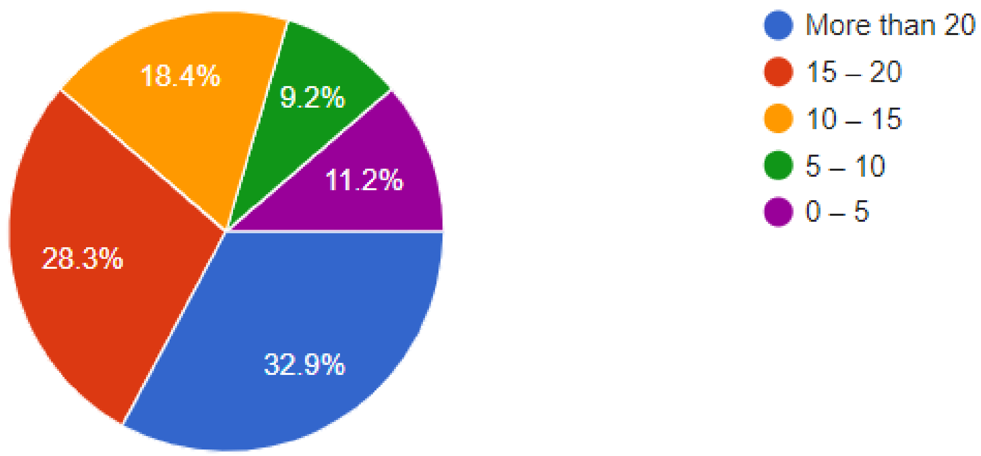


Fig 5.6: Experience (in years) of the Respondents

As per the different departments, Marketing/Sales made up 27% of the respondents, R& D constituted 23% of the respondents, followed by 10.5% of Supply Chain/Procurement, 10.5% of Project management, 8.6% of Production department, 0.7% of Retailer and 19.7% of others (Fig. 5.5). Concerning the years of experience, 32.9% of respondents had work experience of more than 20 years, 28.3% of employees had work experience of 15 to 20 years, followed by 10 to 15 years (18.4%), 0 to 5 years (11.2%) and 5 to 10 years of experience (9.2%) (Fig. 5.6).

5.6 Result and Analysis

In this study, the complicated, hierarchical research model including mediating effects was estimated using PLS-SEM. To quantify the relationship between constructs in this study's data analysis, the PLS-SEM method was applied using the Smart-PLS 4 software. Comparing PLS SEM to covariance-based SEM, it is more capable of handling formative and reflective underlying paths (Joe F. Hair et al., 2014) (Sarstedt et al., 2019).

5.6.1 The Reliability Analysis and Convergent Validity

Convergent validity measures the level of correlation between various variables within similar framework (Joe F. Hair et al., 2014). Table 5.2 displays the findings of the reliability and convergent validity analyses conducted for this study. Furthermore, all constructs' Cronbach's alpha values were above the threshold, ranging from 0.847 to 0.917. The composite reliability (CR) values varied from 0.848 to 0.917, and the Average Variance Extracted (AVE) values ranging from 0.567 to 0.734. To demonstrate that the tool is reliable and valid, the recommended values for Cronbach's alpha and CR should be greater than 0.7 and AVE should be greater than 0.5, respectively (Shahzad et al., 2020) (Joe F. Hair et al., 2014) (Larcker, 1981). Therefore, results demonstrate that the convergent validity and reliability of the data utilised of current study remain unaffected, and they can be used for subsequent structural analysis.

5.6.2 Discriminant validity

The level of empirical difference between variables is described by discriminant validity. Discriminant validity evaluation is known for widely acknowledged platform for examining the relationship between potential factors (Joe F. Hair et al., 2014).

Table 5.2: Reliability Analysis and Convergent Validity

Constructs	Construct Name	Outer loadings	Cronbach Alpha	Composite Reliability	Average Variance Extracted
CA1	Competitive Advantage (CA)	0.757	0.852	0.854	0.596
CA2		0.825			
CA3		0.63			
CA4		0.856			
CN1	Customer Need (CN)	0.767	0.868	0.867	0.686
CN2		0.818			
CN3		0.896			
CP1	Configurable Product (CP)	0.807	0.901	0.9	0.602
CP2		0.849			
CP3		0.756			
CP4		0.687			
CP5		0.74			
CP6		0.805			
ET1	Emerging Technologies (ET)	0.838	0.917	0.917	0.734
ET2		0.89			
ET3		0.895			
ET4		0.8			
IT1	Information Technology (IT)	0.777	0.849	0.848	0.65
IT2		0.817			
IT3		0.824			
MP1	Market Performance (MP)	0.779	0.888	0.888	0.665
MP2		0.811			
MP3		0.831			
MP4		0.84			
MTO1	Make To Order (MTO)	0.708	0.847	0.848	0.582
MTO2		0.782			
MTO3		0.748			
MTO4		0.81			
OR1	Organization Readiness (OR)	0.761	0.875	0.874	0.585
OR2		0.821			
OR3		0.592			
OR4		0.731			
OR5		0.888			
SP1	Sustainable Manufacturing (SM)	0.818	0.865	0.865	0.567
SP2		0.788			
SP3		0.841			
SP4		0.749			
SP5		0.522			

The distinctiveness of a construct is measured by Discriminant validity (Joe F. Hair et al., 2020). In this work, discriminant validity was evaluated using two different techniques. Heterotrait Monotrait ratio of correlations (HTMT) and Fornell Larcker criterion. HTMT should be used for Discriminant validity (Larcker, 1981) (Joe F. Hair et al., 2014) (Henseler et al., 2015) (Shahzad et al., 2020). Also, the predominant method for testing discriminant validity is the Fornell Larcker criterion (Henseler et al., 2015) (Shahzad et al., 2020). Table 5.3 shows the Fornell Larcker criterion, which is based on inter-construct correlations and the square root of AVE, was used to assess the instrument's discriminant validity. The diagonal values in Table 5.3 show that the square root of AVE values are larger than the coefficients of the correlations of all variables. This suggests strong discriminant validity.

Table 5.3: Fornell Larcker criteria for Discriminant Validity

	Competitive Advantage	Configurable Product	Customer Need	Emerging Technologies	Information Technology	Make To Order	Market Performance	Organisation Readiness	Sustainable Manufacturing
Competitive Advantage	0.772								
Configurable Product	0.467	0.776							
Customer Need	0.555	0.652	0.829						
Emerging Technologies	0.491	0.581	0.691	0.857					
Information Technology	0.533	0.685	0.635	0.623	0.806				
Make To Order	0.669	0.752	0.782	0.754	0.76	0.763			
Market Performance	0.601	0.637	0.671	0.585	0.655	0.743	0.815		
Organisation Readiness	0.532	0.576	0.662	0.665	0.604	0.711	0.523	0.765	
Sustainable Manufacturing	0.728	0.636	0.741	0.693	0.617	0.895	0.642	0.615	0.753

Because the HTMT ratio is nearer to 1, it can be concluded that the path analysis does not have discriminant validity (Larcker, 1981). HTMT should be less than 1 in order to differentiate the two components clearly (Henseler et al., 2016) (Henseler et al., 2015). The data in Table 5.4 show that the highest value is 0.884, which is below the aforementioned cut off point and demonstrates that the discriminant validity of the present investigation is sufficient.

Table 5.4: HTMT ratio for discriminant analysis

	Competitive Advantage	Configurable Product	Customer Need	Emerging Technology	Information Technology	Make To Order	Market Performance	Organisation Readiness	Sustainable Manufacturing
Competitive Advantage									
Configurable Product	0.46								
Customer Need	0.556	0.653							
Emerging Technology	0.496	0.578	0.69						
Information Technology	0.535	0.684	0.631	0.622					
Make To Order	0.666	0.751	0.78	0.752	0.762				
Market Performance	0.599	0.634	0.671	0.585	0.655	0.744			
Organization Readiness	0.534	0.573	0.663	0.665	0.601	0.707	0.524		
Sustainable Manufacturing	0.732	0.63	0.734	0.691	0.614	0.884	0.635	0.608	

5.6.3 Path Coefficient

In order to test the hypothetical relationship between constructs using standardised routes (Joe F. Hair et al., 2014) (Henseler et al., 2016) the reliability, convergent validity, and discriminant validity of the study model were examined. This was done using the Smart PLS 4 programme. The values of the path coefficient are shown in Fig. 5.7.

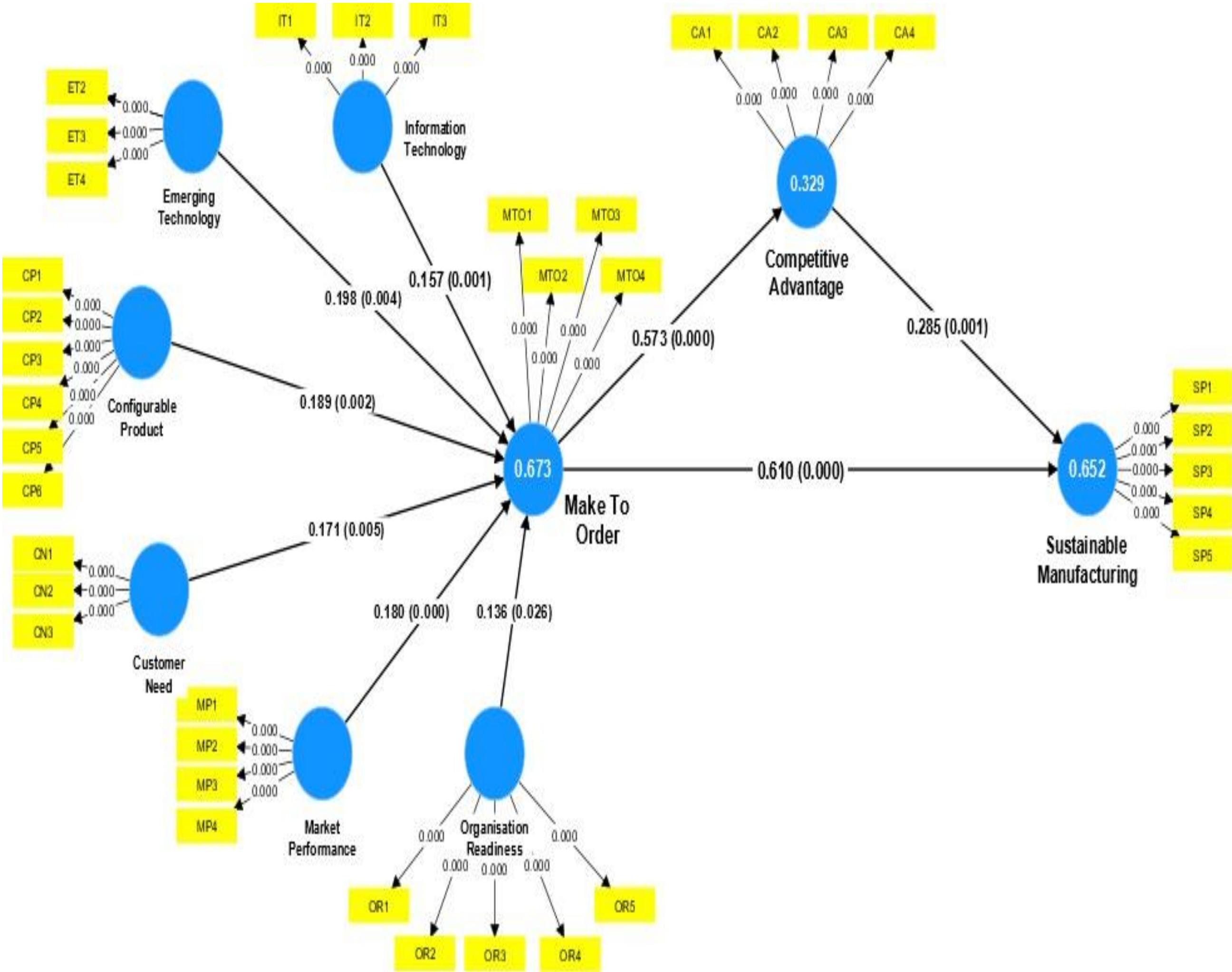


Fig. 5.7: Structural model with path coefficients and p values

(Henseler & Sarstedt, 2013) (Henseler & Sarstedt, 2013) claim that the quality of the structural model and its capacity for prediction are determined by the standardised path coefficients and R^2 values of endogenous latent variables. The direction, strength, and significance of the hypothesised route coefficient are tested using the bootstrap approach with 5000 subsamples in Smart PLS 4 software. PLS SEM indices for goodness of fit include SRMR = 0.044 (<0.08), d_ULS = 1.463, d_G = 1.07, Chi-square = 987.277, NFI = 0.822 (Table 5.5) demonstrate a significantly adequate and reliable fit (Henseler et al., 2016).

Table 5.5: Goodness of Fit

	Saturated model	Estimated model
SRMR	0.042	0.044
d_ULS	1.297	1.463
d_G	1.05	1.07
Chi-square	970.161	987.277
NFI	0.825	0.822

Explanatory variation, or the R-squared value of a finding, is a measure of a research model's descriptive power (Shahzad et al., 2020). The value of the adjusted R square of SP is 0.663, indicating that selected variables show 66.3 % of the variation. Meanwhile, the adjusted R square values of CA and MTO are 0.341 and 0.685 respectively, indicating 34.1 % and 68.5% of effective involvement of selected factors. According to the SEM results, all of the exogenous constructs in this investigation are significantly and favourably connected to the endogenous constructs. Table 5.6 provides the specific path coefficient values, direct effect significance, and bootstrapping path analysis. It reveals that the T-statistics values are higher above the cut-off point of 1.96, proving the importance of the connection between the proposed variables (Leguina, 2015) (Streukens & Leroi-Werelds, 2016). Also, the p-value is provided to support the relevance.

P values are used to draw a conclusion about all the hypotheses and indicate that they are all supported. The p value for the path of hypothesis 1 of Configurable Product (CP) and MTO ability is 0.002, which is less than 0.05, therefore the hypothesized path between CP and MTO is significant. Similarly, the path of Hypothesis 2 between Information Technology (IT) and MTO ability has a p value of 0.001 (< 0.05), indicating that it is significant. The p value for the path of Hypothesis 3 of Market Performance (MP) and MTO ability is 0 (<0.05), hence this is significant. The p value for the hypothesized path 4 of Customer need (CN) and MTO ability is 0.005 (<0.05), hence it is significant. Further, the p value for the path of Hypothesis

5 of Organisation Readiness (OR) and MTO ability is 0.026, which is less than 0.05, therefore the hypothesized path between OR and MTO is significant. The p value for the path of Hypothesis 6 of Emerging Technologies (ET) and MTO ability is 0.004 (< 0.05), thus this is significant. The path of Hypothesis 7 of MTO and Competitive Advantage (CA) has the p value as 0 (< 0.05), and so the hypothesized path between MTO and CA is significant. The p value for the path of Hypothesis 8 of Competitive Advantage (CA) and Sustainable Manufacturing is 0.001 (< 0.05), therefore the hypothesized path between CA and SM is significant. The path of Hypothesis 9 of MTO and Sustainable Manufacturing (SM) has p value of 0 (< 0.05), thus this path is also significant.

Table 5.6: PLS SEM results for hypotheses testing

Hypothesis	Exogeneous Construct	Endogenous Construct	Path Coeff	Standard Error	T stats	P value	conclusion
CP → MTO	Configurable Product	Make To Order	0.186	0.059	3.184	0.002	supported
IT → MTO	Information Technology	Make To Order	0.156	0.048	3.238	0.001	Supported
MP → MTO	Market Performance	Make To Order	0.179	0.048	3.743	0	Supported
CN → MTO	Customer Need	Make To Order	0.171	0.06	2.828	0.005	Supported
OR → MTO	Organization Readiness	Make To Order	0.132	0.061	2.24	0.026	Supported
ET → MTO	Emerging Technology	Make To Order	0.204	0.069	2.854	0.004	Supported
MTO → CA	Make To Order	Competitive Advantage	0.581	0.06	9.629	0	Supported
CA → SM	Competitive Advantage	Sustainable _Performance	0.285	0.081	3.503	0.001	Supported
MTO → SM	Make To Order	Sustainable _Performance	0.611	0.107	5.724	0	Supported

5.7 Summary of Hypotheses Testing

A summary of every hypothesis that was tested is shown in table 5.7

Table 5.7: Summary of Hypotheses Testing

Hypotheses	Conclusion
Hypothesis H1: Configurable Product is positively related to MTO ability	Accepted
Hypothesis H2: Information Technology is positively related to MTO ability	Accepted
Hypothesis H3: Market Performance is positively related to MTO ability	Accepted
Hypothesis H4: Customer need is positively related to MTO ability	Accepted
Hypothesis H5: Organisation Readiness is positively related to MTO ability	Accepted
Hypothesis H5: Organisation Readiness is positively related to MTO ability	Accepted
Hypothesis H7: MTO is positively related to Competitive Advantage	Accepted
Hypothesis H8: Competitive Advantage is positively related to sustainable Manufacturing	Accepted
Hypothesis H9: MTO is positively related to Sustainable Manufacturing	Accepted

5.8 Conclusions

This chapter employs PLS SEM methodology to test the hypothesis and identifies the aspects a manufacturer must take into account. The empirical results of the measurement model are mentioned including reliability analysis, convergent validity and discriminant validity. Structural model with path coefficients and p values are also discussed. P values are used to determine the conclusion for each hypothesis and show that each one is supported. Because the investigation was conducted in India, where mto is still in its formative stages, the unexpected result may have been caused by the respondents' ability to comprehend how the difference between the items provided and those desired by the client results in mto being a nascent notion.

Chapter 6

IMPLEMENTATION OF MTO: CASE STUDIES

6.1 Introduction

Objective 2 calls for further statistical validation of the Make To Order (MTO) manufacturing models developed in the prior chapter with the aid of case studies. The case study approach is a useful tool for theory validation or theory extension to promote process transformation. A qualitative technique is used in case study research, which is seen to be relevant and helpful for examining phenomena in their natural environments and producing understanding by seeing real-world applications (Yin, 2023). By building on models developed in the literature, qualitative studies ensure that the explanation of the phenomenon remains independent of any previous methodological bias and remains open to new insights. They also increase the possibility of understanding latent and non-obvious issues and conducting a flexible study. Furthermore, the retrospective case study is an effective method for examining a project's chronology and the variables that changed throughout the course of that timeline (Cannas et al., 2020). This chapter will examine the measures adopted by Indian manufacturing firms to implement MTO and address the issues they encountered. Two businesses of Indian ancestry that had adopted MTO strategy were contacted to undertake the case studies. Figure 6.1 depicts the flow of the chapter.

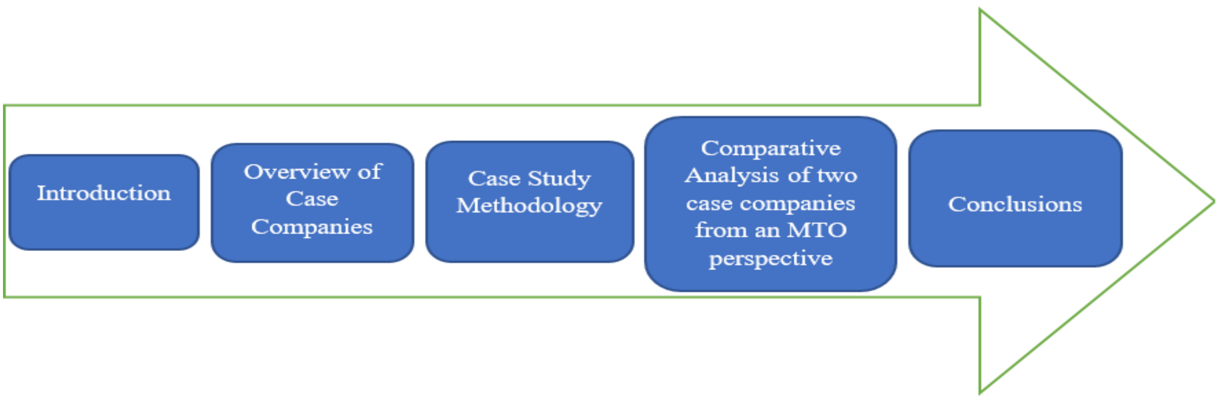


Figure 6.1: Flow of Chapter 6

6.2 Implementation of MTO in Case Companies

A comprehensive search was done to identify organisations with Indian ancestry that had used MTO approach. As the study attempted to create a framework for MTO in the Indian manufacturing sector, businesses in the unorganised sector and the service sector were excluded. Two organisations were selected to participate in this study. The companies' profiles are shown in Table 6.1. The research involved an SME and one large-scale company.

Table 6.1: Profile of Case Study Companies:

Company	Type of Industry	Product	Company Size	Expert's Profile
ABC	Automobile Industry	Auto components	Large Scale	PPC expert, Sales and Marketing expert, IT expert, Head of operations, Product expert
XYZ	Garment Industry	Fashion Apparels	SME	Design Specialist, IT expert, Business strategy expert, Sales Expert

6.2.1 Case Study 1: Company ABC

The first case study is from a focused, diverse and forward thinking organization that offers customers value added products, services and creative solutions. The group has a diverse portfolio of products and services in the automotive, engineering and design services, renewable energy and education sectors with a global infrastructure of 40 manufacturing plants and four engineering and design centres spread across 18 locations. The group has extended its horizons by concentrating on quality delivery, solutions approach, product development methods, flexible manufacturing systems, and contract manufacturing with a total revenue of USD 1.2 billion.

Background of Company ABC

The company started producing cylinders in 1983 as a first step of its journey. It manufactures half a million auto components on daily basis and these auto components are used in nearly every vehicle manufactured in India. This company has come a long way from working with the largest automaker in India in 1987 to being a $2.6 billion global corporation with operations in more than 10 countries. The structure of the organization allows each business unit to chart its own course while also leveraging synergies across its competencies. Figure 6.2 depicts the product management cycle of the company. The organization has smoothly diversified into new sectors while integrating its activities along the whole value chain. It has made steps to lead Mobility 2.0, which stands for Cleaner, Greener and Safer, from producing its own buses to offering comprehensive and sustainable solutions for the future through its EV ecosystem business segment. It is driven by innovation and the application of cutting-edge technology to provide superior service and the most possible value to all of its stakeholders. The company's passion lies in delivering holistic and sustainable solutions for the future. The change is being driven through the company's leadership in various below mentioned sectors.

- Auto component and systems
- EV Ecosystem
    - Electric Vehicles and Buses
    - EV Aggregates
    - Charging Infrastructure
- Renewable energy
- Artificial Intelligence
- Environment management solutions

The company is driven by reduced wastage, high performance, and quality products, thereby modernizing the facilities to improve its expertise. Products are produced by using the finest technology and are matched with the customer's needs.

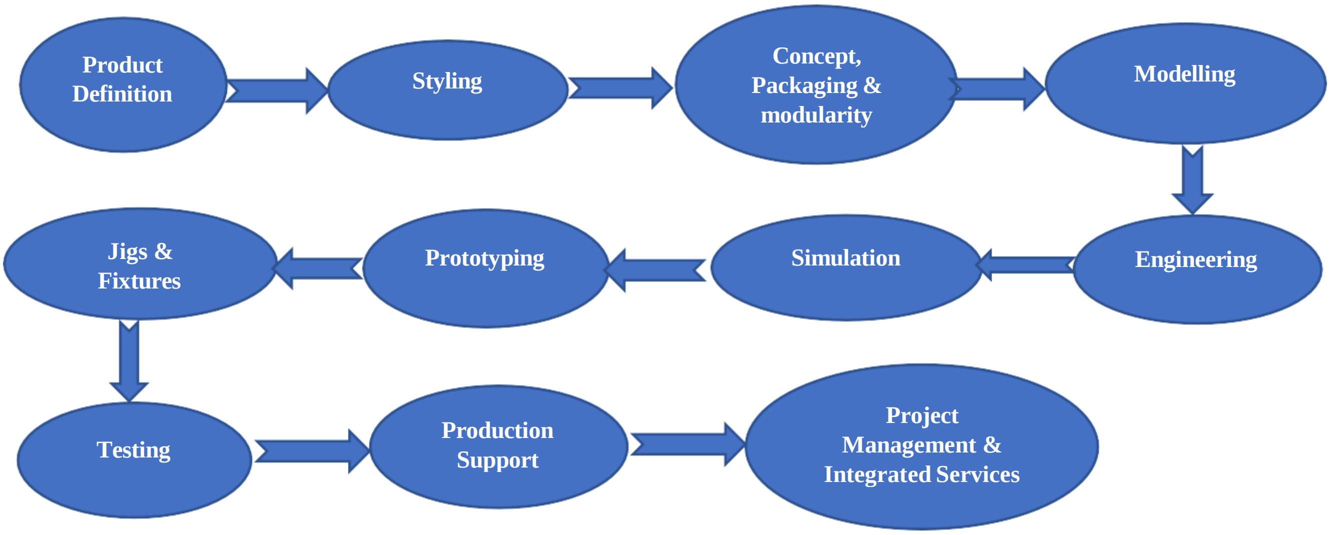


Fig 6.2 : Product Management cycle of the company

Products and services

The group is primarily a tier–one supplier to the automotive OEM industry, offering services to prestigious automotive clients. Also, it has coalitions with more than 20 renowned companies globally. New benchmarks have been created by the case study group in the automotive industry with the manufacturing of die casting, Jigs and fixtures, chassis and suspension systems, exhaust systems, tubes and tubular parts, weld assemblies, skin panels, Body in White (BIW) and engineering services. The company provides complete solutions for all business sectors, including 2 and 3 wheelers, passenger and commercial vehicles , farm and construction equipment, and motorcycles.

The product considered for case study is Flue Neck pipe and has been categorized into four lines and and 13 models. All these models of this common product go through 21 processes and take final shape. One of the line that maufactures 5 models of FNP has been simulated (Fig. 6.3). A number of visits were made to the company in order to collect rich data to carry out the study. Factory's observations, in house expert's input and information along with the in depth study of the system was done to analyze current status. For the purpose of simulation, all the processes of the concerned line were deeply studied and data was collected. Results and observations are presented subsequently.

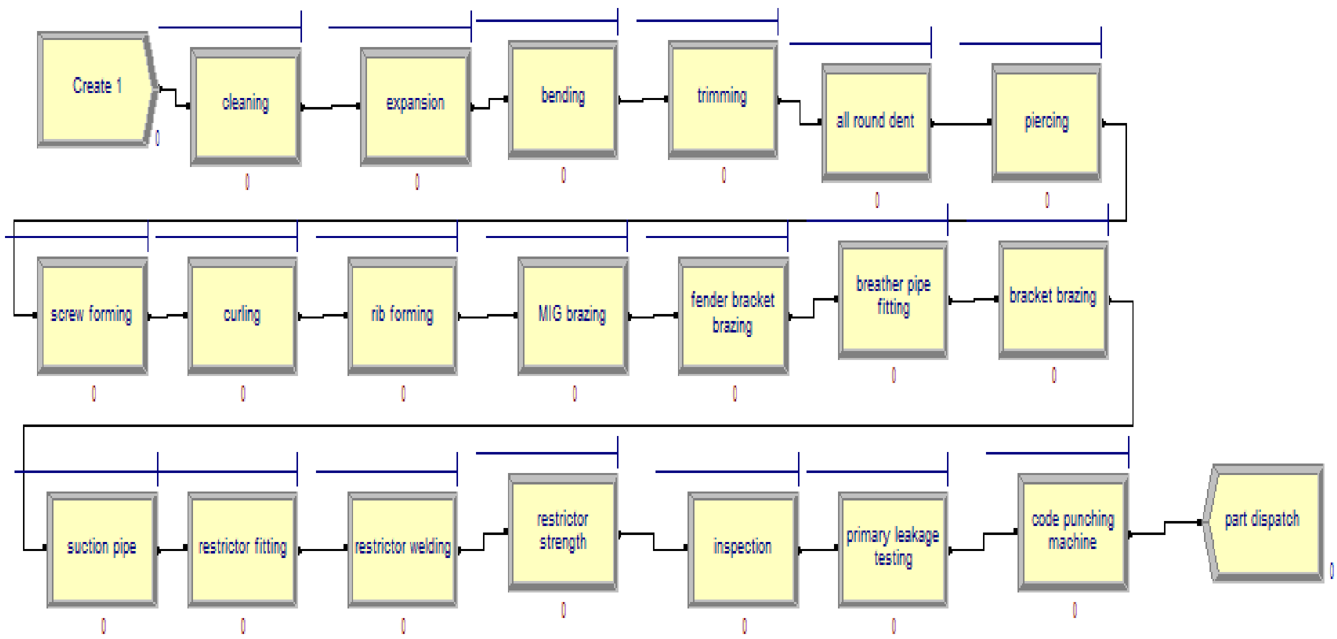


Fig 6.3: Model of Fuel Neck Pipe Manufacturing line

6.2.2 Case 2: Company XYZ

This research includes a case study of a renowned make to order women's fashion apparel manufacturing company based in Delhi, India. From a home outlet to a factory outlet to hundreds of renowned exhibits across the country to two flagship stores to website, the label has been growing steadily from strength to strength. In the past ten years, the label has served thousands of women across India and abroad. The label's belief in clean aesthetics, intricate embroidery and decent silhouettes has resonated with women who believe in themselves and whose clothing is an expression of their personality. The company bring its professional acumen and cutting-edge working style to the platform to provide customers the best of their design legacy at honest pricing.

The case study investigated how customer centric approach is the best system for MTO. For apparel, end customers have various choices among fabrics, brands, colours, drapes, etc. To meet consumer demand, designers and merchandisers must concentrate on a wide range of new products (Ibrahim et al., 2011). Meeting the unique challenge of these diverse fashionable elements, and produce high degree of variety, garment companies must implement business strategies that would help sustain the growth of this sector.

Why Garment Industry/selection of company:

More and more people are choosing customised clothing items for themselves (Ibrahim et al., 2011). Today's demand is for smaller batch sizes since consumers desire a wider array of clothing options (Satam et al., 2015). In previous times, customers were tolerant of things that fell short of their expectations since there weren't many options available. This has changed, though, as consumers now demand and anticipate quick, personalized attention and more options. Ibrahim et al. (2011) considered structural changes and technological changes while including customization in garment industry. The COVID-19 epidemic poses a serious threat to the conventional clothes business. The apparel businesses must move their operations online (Q. Sun & Sun, 2021). In an effort to lead the apparel sector towards smart production, M. Kim et al. (2020) carried out a comprehensive evaluation study on technological issues. Customer integration into the value creation processes is necessary due to the impact of shifting market trends and growing competitive pressure on business processes (Ibrahim et al., 2011).

The challenge of trying to meet the intricate demands of the fashion business is now on apparel makers, who risk losing ground to rivals if they don't.

Issues or challenges in Garment Industry:

Among the various issues faced by garment industry Supply Chain Management is one of the crucial one. In the fashion sector, where collections are always changing, supply chain management is extremely important because of the industry's variable demand, short product life cycles caused by seasonal fluctuations, and extensive, rigid, and complex supply networks (Sen, 2008). Other challenges include labour efforts for production processes, small quantities with few repetitions, frequently changing styles and short delivery times. Additionally, In terms of the garment's usefulness and lifespan, consumer requirements have an impact on both the aesthetic design and the functional specifications. Hence this industry should always be ready to respond to the ever changing and unexpected demands of the customer (Ibrahim et al., 2011). Due to the constantly changing nature of the product due to fashion trends and the size and design variations in the production process, garment manufacturing processes are challenging to automate. As a consequence of this, MTO has become important in this industry.

Process of manufacturing in Company XYZ:

The first activity of the case study company is to design garment collections and to make master prototypes of the garments (Fig. 6.4). Initially, the company manufactures only prototypes of the garment collection, and produces duplicates as per customer’s specification later on. These prototypes are used for demonstrations at the two stores of the company and at the exhibitions. There are broadly five departments including: Procurement, Quality Control, Designing, Stitching and Order Dispatch. The company has a total strength of 30 employees. Six types of different machines are used namely, Single needle stitching machines (10 nos.), Embroidery machines (3 nos.), Overlock Machine (1 number), Industrial boiler steam Iron (2 nos.), Industrial Iron (4 nos.) and Industrial Hydro Dryer (1 no.). The business has made investments in tools like CAD systems, which offer 3D visualisation solutions and speed up the creation of new goods. For creative design, product illustration, sample production, and product costing, CAD programmes are crucial in the fabric and apparel design industry (Ibrahim et al., 2011). Businesses employ CAD/CAM systems to accelerate, simplify, and boost the effectiveness of their production processes (Dong et al., 2012). The company under case study uses Autocad Software for designing purpose. Initially the company prepares the standard or the basic design (prototype) of the apparel and displays them online and offline in both the showrooms. Customers can explore the designs through both the mode, i.e., through the website and showrooms and can order the same. The customers can customize the prototype as per their requirements while making sure that basic design is not changed. After forecasting, raw material is procured from various vendors across India. Quality Control team inspects the received raw material and further sends it to dye section for dyeing or colouring. This coloured fabric is then converted into pattern as per the required size and design. Next operation in this whole process is embroidery which is further inspected. This is followed by cutting, stitching, and hemming operations to finalise the dress. The ready dress is then sent for petrol wash to give the final shine to it. Before, packing and dispatching the customer order, it is being tagged with all the required details.

6.3 Comparative Analysis of two case selection from MTO perspective

1. Customer needs choice/passion for unique products/self-created product:

As one of the leading companies in India's automotive parts market, company ABC offers a product that meets customer needs. ABC uses following five steps to create and capture customer value–

i. Understanding customers and marketplace

ii. Creating Customer Value

iii. Building an integrated marketing strategy to deliver superior value

iv. Engaging customers to build a profitable relationship

v. Capturing value from customers in form of profits and customer equity

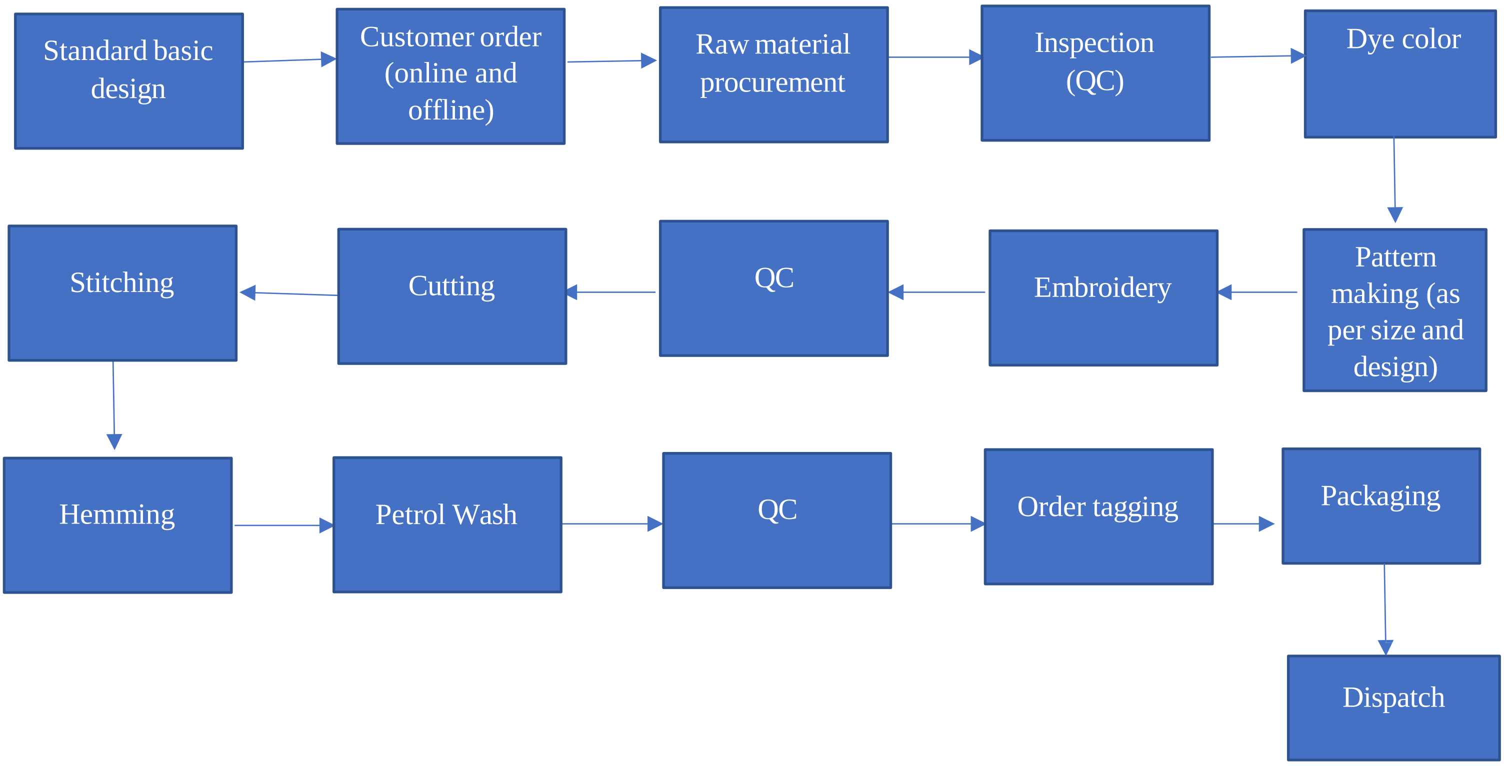


Fig 6.4: Process Flowchart of Company XYZ

Clients have requirements, wants, and demands. By providing unique products and services, company ABC is meeting customer requests. Customer-driven value generation relies significantly on the strategic trade-off that the business has made. A value proposition that can optimise this company’s institutional capabilities has been thoughtfully selected. Firm ABC marketing managers must provide answers to these two crucial issues in order to add value for customers for MTO.

i. Which clients will ABC provide services to?
ii. In what ways can ABC best cater to these clients?

Customised clothing in MTO of fashion not only fits the customer's body type, but also has the desired unique design. In XYZ, starting with the needs of the customer, the 2D intelligent design system-based MTO process is initiated. In the initial phase of taking the order, the customer provides XYZ firm with its customised criteria, including style, body size and fabric. These needs or requirements are further entered into the designing system and the customer receives 2D style and access it. If the style meets his needs, it is approved, and the third phase is carried out. The pattern is automatically generated in the third stage when the approved style is transmitted to the specialised pattern design module. Finally the customized garment is manufactured efficiently as per the customer’s need.

2. High product variety

Factors including shifting energy prices and trade patterns, market globalisation, and rising customer sophistication are all contributing to the automotive industry's increased product variety. ABC’s decision regarding product variety necessitates that manufacturing facilities handle a specific degree of product mix complexity and hence adopting MTO. Programmable and flexible technologies open up new possibilities for managers to customise products for the customer without having to pay the rising expenses associated with product variety. They also make it more feasible to achieve economies of scope. For ABC, variability in products and the complexity that comes with manufacturing them is "good" if it gives competitive advantages at low cost, and "bad" if it gives customers no value at all, regardless of the cost. A business that can reduce the price of product variety has greater leeway in determining how much variability to provide to customers. ABC believes that offering a variety of products allows a company to cater to different market segments and meets the needs of consumers who are looking for variety, which makes it a successful strategy for growing market share. One major issue is managing these product variation categories, which calls for careful consideration of trade-offs between meeting client wants and minimising adverse effects. ABC did planning of capacities and capabilities on the manufacturing side to have variety oriented manufacturing. The production system is therefore made to accommodate the range of products that will be produced. A suitable example of this is the use of standardized fixtures. With the use of a specified products reference point system, these fixtures are made to match the anticipated product variety without requiring changeovers. It has undergone a paradigm shift towards greater changeability (both physically and conceptually) in order to adapt swiftly and effectively to the variety of products and to economically carry out early and predictable modifications of the industrial structures and processes at all levels. The ultimate stage of the value-adding process, usually symbolised by final assembly, is when the greatest degree of product variation is achieved.

In apparel industry, customers want a variety of products that differ greatly in terms of size, colour, materials, cost, style, and quality. The company XYZ consistently invests in Customer Relationship Management (CRM) techniques to learn about client preferences and does marketing research to comprehend the expanding market trend. For Apparel Company following MTO strategy, variety in products has the ability to open up new markets and boost sales and profits. The firm desires to strengthen the product variety since it lowers engineering expenses and time to market, broadens the product offering, and boosts market share. XYZ has high degree of product component modularity and commonality so that it can attain high degree of product variety. It has well designed models and strategies to manage the complexity of planning for including product variety.

3. Modular product design

According to ABC, for a successful MTO approach, following should be included in the car's modular design rules: the range of vehicle parameters, performance, application of new technologies, hard-point range and hard spots, style and brand, configuration, and modelling; comfort between humans and computers. The ABC automotive company embraced modularity to improve supply chain management, design, and production processes in a variety of ways, particularly through commonality.

The term "modular garment design" signifies the process of breaking down clothing goods into a number of fundamental modules based on the manufacturing process and the structural design of the clothing, then modifying and reshaping the modules to meet customer demands or design goals, and ultimately creating distinct clothing products (Zhou et al., 2020). It is necessary to look MTO manufacturing from modular product design point of view. Company XYZ adopts the modular design of clothing, since it creates directed design standards for the design of different clothing components by streamlining the design process, which significantly increases the flexibility and productivity of clothing production. The inventive growth of the XYZ is significantly impacted by the modular mode, from the design process to the application procedure.

4. Flexible manufacturing processes

As per ABC, in the context of automotive manufacturing systems, the phrases "flexibility" can be classified as "product flexibility" and "production flexibility." Product flexibility is the capacity of a system to generate various goods using a single production line. Production flexibility refers to the degree of variation possible in the output quantity of each product (output flexibility) and the volume of all products (output flexibility) produced within a single production system with the goal of responding profitably to market demands. ABC converted the manufacturing system to Flexible manufacturing system by incorporating some technologies. The ABC Company's flexible fixturing and tooling technologies eliminated the majority of the setup expenses related to a complex model mix. It uses rotating fixtures, flexible conveyor technology and mobile lifting for customer dedicated utility vehicle. To carry the various components or parts modular shuttle elements are being used in flexible conveyor technology. It replaced brand and product-specific grippers with flexible grippers, which cuts down on setup times and storage space.

XYZ firm does an effective scheduling system in order to fully utilise the FMS for clothing manufacturing. In its flow shop, scheduling and resource allocation are merged, and tasks are assigned flexible resources (like cross-trained labour) in an effort to reduce make span. The added benefits of using a Flexible Manufacturing System (FMS) include the ability to quickly establish cells for new product families by simply reprogramming the system to route clothing, as well as the ability to operate each cell efficiently by automatically transporting clothing between machines in stations. In order to maintain their competitiveness in the market, fashion clothing company XYZ adopted MTO. Increasing customer brand loyalty and refining forecasting methods are two ways to make proactive use of flexibility.

5. Accessibility to flexible and real-time information technology to keep the customer updated

For MTO, ABC Company ensures that customers get reliable real-time data irrespective of their location worldwide. A lot of effort was put into making sure that the company can communicate with customers more quickly and effectively by building predictability, consistency, and visibility into the system. Prominent online retailers not only revolutionised the retail sector, but they also conditioned consumers to anticipate retail services in all other sectors of the economy, including the automobile sector. XYZ extensively uses computerised

3D body modelling because it allows consumers to easily customise the body model to fit their own body shape when shopping online and makes it easier for clothing manufacturers to communicate with their customers during the ordering process. The firm uses Pretture software which has multiple columns denoting all the stages of the process, like order receiving, Dyeing, Embroidery, Stitching, Finishing, Packaging and dispatching. This software has this flexibility that customer can login to this software with the particular order ID and can have the real time information about about the status of the order.

6. Information system to receive order and payments

MTO businesses must accept the best possible mix of incoming orders in order to grow their profit margin and market share in the cutthroat industry (S. Hemmati et al., 2012). Hence, At the order entry stage, ABC created a productive decision-making framework that allowed the business to choose the best possible mix of incoming orders. Also, the framework assisted to decide whether to accept or reject the order as per the MTO strategy. The information system manages the incoming orders on the basis of their due dates and accepts or rejects it on the basis of time factor. ABC encourages information system for incoming orders and payments as it becomes easy for interaction and communication. The equipment's ability to appropriately fulfil the order requirements is another factor that influences decision to accept or reject an incoming order by the information system. It is often very challenging to evaluate the acceptance or rejection of incoming orders based on qualitative features and without using information system. In XYZ, orders are placed either online or offline through an information system and once the order is being received, the details of the order are sent to the order management system. The system checks the availability of the inventory as per the customised requirement of the customer across its 2 showrooms, workshop and warehouse. The product can be put into the production thereafter and delivered on time. For MTO, Information system makes it more appropriate to accept the order if its specifications match with company's existing procedures.

7. Competition in the market

In terms of the competitive in the market, the advent of new rivals and the threat of a foreign market led the company ABC to decide to switch to MTO. It has continued to employ a strategy that facilitates market penetration, establishes monopolies for some of its products, creates and sustains market needs, all of which contribute to the company's reputation in the industry and guarantee client loyalty. Owing to the growing market competition, a range of value-added services are offered to raise client pleasure. In a market with intense competition, businesses usually have to concentrate on improving efficiency, cutting expenses, and developing new processes (Geroski et al., 2003). The company needed to create a wide range of products in order to compete with both domestic and foreign businesses because of the fierce rivalry in the industry. XYZ has closely monitored and researched about what others competitors are doing to get priceless insight into how to strengthen or customise the strategy, enabling it to proceed confidently in the ever changing field of fashion apparels.

8. Ability of MTO without increasing cost of manufacturing

Manufacturers need to fulfil fast changing client needs, maintain sufficient flexibility, and produce high-quality products at reasonable costs in order to stay competitive (Jeon & Kim, 2016). ABC realised that rising demand for customised goods, market's globalisation and consumers' ever-changing expectations are pressuring producers to find a manufacturing system that can meet market demand while meeting deadlines and doing so at a reduced cost. Hence it worked towards changing manufacturing strategy to MTO without increasing the cost of manufacturing. ABC uses project management software to track cost of production. In this software, Key performance indicators (KPIs) such as expenses are automatically captured by live dashboard, which presents your projected vs actual costs in an easy-to-read graph.

XYZ made sure that the total cost of manufacturing doesn't increase while implementing by calculating the cost of direct labour, direct materials, other direct expenses and factory overheads. They recognised the importance of minimising the cost of manufacturing and controlled it and prevented unforeseen charges by keeping an eye on their expenditures. They believe that through the process of cost calculation, manufacturers can determine the most cost-effective way to make a product and gain a deeper understanding of the factors that are driving up costs. XYZ bargained with other suppliers who could be ready to provide these materials at a cheaper price if certain raw materials are pushing up expenses. If a particular raw material is driving up costs, manufacturers might negotiate with alternative suppliers who might be willing to give these commodities at a lower cost.

9. Risk of Obsolescence and Perishability

ABC is more likely to reject an incoming order if there is significant chance of risk of Obsolescence and Perishability. The production system, the environment, and the product life cycle are all significantly impacted by parts obsolescence, which has consequences for operations, logistics, dependability, and cost. ABC adopted MTO as obsolescence is one of the major reason for product deterioration. The company used statistical methods to forecast the risk of obsolescence before it actually occurs. It analyses the risk of important parts in a bill of material (BoM), uses forecasting algorithms to anticipate obsolescence dates for the various parts of a product, and takes the appropriate action to manage obsolescence of the product. The majority of studies on obsolescence management focused primarily on economic and technological aspects; however, ABC felt that because industrial, social, and ecological systems are interconnected, taking global sustainability into account is crucial for making wise decisions.

The risk of becoming obsolete is higher in the clothing business than in other industries. Fashion is always evolving, and new design creations and stylish products are made available to consumers worldwide with the introduction of technology and e-commerce platforms. The most important aspect of fashion clothing is perceived obsolescence, which occurs when customers believe their clothing is "unusable" because it is out of style. This necessitated XYZ firm to adopt MTO so that there is no risk of obsolescence and perishability.

The management of XYZ industry understood that it is imperative to design garments as per customer’s need and continually innovate in order to avoid the risk of obsolescence and perishability. It scrutinised its operations closely and determined which areas were vulnerable to risk and prioritised potential risks by the likelihood. XYZ worked on mitigating the obsolescence by taking four steps: notification of obsolescence, information gathering, selection and implementation of resolution strategy and documentation.

10. High cost of carrying inventory

ABC Company ranked prospective hazards to MTO according to the chance that they will materialize and then calculated each event's estimated financial and marketing impact. The result prioritized the carrying cost of the inventory as the topmost hazard and worked to minimise it.

A lot of work was done by XYZ to minimize cost of carrying inventory for MTO by effectively utilizing the resources. This has significant effect on efficiency and productivity and to meet dynamic customer demand. The technical specifications of clothing styles, such as the complexity of the garments, the quantity of cutting pieces, the length of the markers, and the yardage yield of fabric per garment, are evaluated by decision makers in order to determine the approximate number of different types of machines required. In addition to this, they also evaluated sufficient production resources for production, so that there is no material shortage as well as ensuring the good quality of the final product.

To manage the inventory so that its cost doesn't rise high, XYZ tracks, manages, and maintains and optimal level of inventory. For this, it uses a ERP software that tracks the items as they are moved between the locations. Previously, all of these procedures were done by hand, with data being manually recorded in logs and spreadsheets on paper. This real time automation of inventory caused improved accuracy and saved time.

11. Skilled employees for manufacturing

Company ABC has emerged as a dynamic Automobile company adopting MTO due to availability of skilled labour. Interestingly, improvements in materials, skills, and processes have taken front stage, with the availability of skilled labour emerging as a critical element for global competitiveness in automobile companies. Skilled workers are vital along the value chain in the incredibly resilient automobile industry. Shop floor workers at this company strive for the improvement of their abilities in both technical and non-technical domains.

The manufacturing sector with the highest labour intensity is clothing manufacture (M. Kim et al., 2020). For MTO, firm XYZ decided to upgrade the skills of their employees by either providing the training to the existing employees or hiring the skilled ones. Through training and strategic hiring, businesses can develop a highly skilled staff prepared to tackle the particular difficulties presented by MTO environments. A skilled employee can handle different tasks required to fulfil the needs of different types of customers. Since, the basic design is available for MTO type of manufacturing, further customization or change in the design of the apparel varies from customer to customer, so a skilled worker or employee will perform as per the customer's choice. Different types of skilled employees were hired by XYZ, with the profiles like fashion designer, software expert, skilled operator for different types of operation required in apparel industry, etc. The chosen specialists are experts in their fields and have strong decision-making abilities.

12. Flat organization structure

According to ABC, MTO becomes more effective if the company has flat organisation structure. Direct communication, less organisational cost, reduced micromanagement, and effective collaboration are some of the benefits achieved by flat kind of organization structure. For an automobile company like ABC, this type of organisation structure reduces confusion by streamlining communication and at the same time overhead costs is reduced by eliminating the middle management layer. Employees in flat organisational systems have greater freedom to do their work without continual oversight from managers. Collaboration is facilitated by a flat organisational structure, and creativity is enhanced by the ability of many teams to brainstorm. The functions involved in XYZ are mostly creativity based and flat organizations focus on creativity which gives workers more flexibility and freedom to act. For MTO based apparel industry it is important to taken faster decisions, make quick changes, respond to customer demands and changes swiftly and this all is achieved by flat organisation structure. With a flat organisational structure, new services and products can be launched more quickly because only one or two approvals are often required.

13. Short lead time of suppliers

ABC top management recognised the importance of short lead time of supplier for MTO implementation. Short lead times enable manufacturers to begin production as soon as an order is received by cutting down on the amount of time they must wait for components or raw materials. By minimizing the lead time, improved productivity, streamlined all the functions and maximized the revenue and output. It started to work on the shortening the lead time by initially mapping the entire process and then followed the below mentioned steps to shorten the lead time.

1. Processes were reassessed
2. Established strategic inventory management
3. Make sure that everyone is well informed on the operations
4. Maximized the automation power
5. Strong partnership with suppliers

XYZ worked on minimizing the supplier lead time by adopting strategies like choosing local suppliers wherever possible , increasing the frequency of order, participation of suppliers in forecasting process, removing suppliers from its supply chain who are not reliable and improving communication. It improved customer happiness, streamlined inventory management, and reduced lead times by reducing the amount of time it takes for products to go from the first order placement to the final delivery.

14. Technology and its spread

According to ABC, success of MTO depends on the technological abilities, collective competences, and dedication of human capital. The automobile industry has changed in recent years as a result of the technology's rapid development and adoption. Company ABC has a very solid technology roadmap, which enables it to provide customers a very good total cost of ownership while assisting them in becoming very competitive. For businesses to succeed, manufacturing technology must be continuously improved and streamlined. The new technology and platform created for MTO offer a more reliable and effective production system that improves customer retention and satisfaction. The speed at which technology is developing and becoming more widely accepted has caused the automotive industry to change during the past several years, placing pressure on the sector to alter its manufacturing strategy from MTS to MTO. The latest solutions from tech start-ups in the automotive industry are embracing consumer behaviour and further rebuilding the MTO production and distribution infrastructure. Contemporary automotive advancements are crafted to enhance the driving experience for the end user.

XYZ adopted new technology and platform designed to incorporate customer’s requirements. Businesses have a lot of flexibility in how they react to shifts in the business environment when they anticipate the change well in advance. Proactively adapting to change at the appropriate pace sets winners apart from laggards. The apparel sector needs to reduce production cycle times as a result of the rapid changes in fashion. The fashion apparel industry is influenced by technological factors that can affect its manufacturing, sales, distribution, and promotion strategies, as well as the way customers make purchasing decisions. Examples of these factors include the growing adoption of social media platforms, the penetration of the internet, and growing process innovations. By using CAD to enhance design skills, XYZ satisfies the unique size and shape preferences of its customers in a better way.

15. Product/market innovation

Consumer acceptance and ongoing technological advancement are essential for Product Innovation. Adoption occurs organically since the fashion and technology sectors are both consumer- and future-focused. ABC believes that Product or Market Innovation has different types like: Incremental Innovation, Process Innovation, Disruptive Innovation, Radical Innovation, Architectural Innovation and Business Model Innovation. In Incremental Innovation, company focusses on small additions or upgrades to an already existing product. It concentrates on improving particular features, functions, or design automobile components to offer clients small but significant advantages. Rather than developing completely new items, incremental innovation seeks to improve already-existing ones. At various stages of MTO, ABC believes that product's overall competitiveness and performance can be greatly impacted by process innovation. Process innovation aims to enhance the procedures, frameworks, or processes utilised in the creation, distribution, or maintenance of products, even while it is not directly tied to the product itself. It seeks to improve quality, lower expenses, simplify operations, and increase efficiency. Disruptive innovation, usually begins with a simpler, more convenient, or more economical product aimed at an underprivileged or ignored market niche. The creation of completely new goods or technology that upend established markets or open up new ones is referred to as radical innovation. Significant deviations from current products are involved, and industries may undergo profound transformations as a result. In order to produce better goods or services, architectural innovation entails rearranging or merging current parts, technologies, or systems. To obtain better performance, efficiency, or functionality, it focuses on altering a product's fundamental structure or design. Rethinking how goods are made, distributed, sold, or made profitable is known as business model innovation. Creating and capturing value from clients frequently requires coming up with novel approaches. Changes to revenue models, distribution routes, customer interaction tactics, alliances, or the launch of new value-added services are examples of business model innovation.

At XYZ, there is always a lookout for new product innovations that promise to increase the sustainability of apparel production and consumption. Commercial value and longevity are highly dependent on Product Innovation. Sustainable materials can be used in place of wasteful ones with the aid of Product innovation. It can eliminate repetitive, risky, and low-paying human occupations. Since there are numerous design components linked to the fashion Product Innovation, XYZ chose five crucial components: 1) Traditional design components, 2) Pattern design elements, 3) Decorative design elements, 4) Transformative design elements, 5) Multi material design elements. The firm took few steps to get flawless product innovation: 1) Brainstorming, 2) Create ideas that meet the needs of the client 3) Test ideas to ensure they are valid 4) Analyse the market using consumer segmentation 5) Prototyping can help you improve your idea.

16. Business Risk and economy

Business risk is one of the factor that ABC considered while adopting MTO manufacturing strategy. It identified various factors that affect business risk and economy like, competition, sales volume, larger economic climate, unit price and worked on these to make effective implementation of MTO. The impact of this comes on company's market position, long term sustainability and overall performance. To measure the business risk the company evaluates a range of risk indicators, including market volatility, financial performance, and industry-specific problems, using quantitative models and analytics. The firm examined past data, such as market trends, risk incidents, and financial performance, to find patterns and trends that can point to possible hazards. It performed scenario-based risk assessments to analyse the impact of various risk occurrences on the company's operations and financial health.

For manufacturers looking for long-term success, it is essential to comprehend and manage these business risks while keeping an eye on the larger economic landscape. XYZ believes that factors that impact a company's operations, strategies, and industry-specific conditions give birth to business risk. Effective management techniques, diversification, and innovation are all necessary components of a comprehensive approach to mitigation solutions. It monitored by market analysis, strategic planning and continuing review of industry developments. This firm identified new risks and competitive pressures by completing market research and staying up to date on market dynamics and industry developments.

17. Flexibility of the production process

In response to Flexibility of production process, ABC Company encourages to include different types of flexibility in its production process. It believes that flexibility can be everywhere and anywhere, like design flexibility, job flexibility, assembly system flexibility, machine flexibility, material flexibility, modification flexibility, routing flexibility and process flexibility. For a given facility, the optimal kind of flexibility in terms of advantages will vary significantly. Following a thorough assessment of the changes it undergoes, ABC decides which kind of flexibility to pursue. Flexible manufacturing is based on the idea that a facility may be set up and built to either minimise the negative consequences of these changes or adapt to them.

Developing production flexibility is crucial for an apparel company like XYZ to serve a variety of customer segments and satisfy erratic market demand. In order to compete in the time-sensitive market, firm XYZ therefore sought to modernise and expand its knowledge base and asset base. This was done by utilising the right kind of manufacturing flexibility, which is best suited to handle a variety of environmental risks. As a result, company XYZ wants to prioritise and assess several manufacturing flexibility options in order to finalise its manufacturing flexibility target. XYZ takes flexibility as the system's capacity to quickly adjust to changes in pertinent parameters, such as workload, machine failure, process, or product and views flexibility as a means of adjusting to unpredictable external situations. The firm has focussed on four types of flexibilities: product mix flexibility, delivery flexibility, volume flexibility and new product flexibility. With its infinite flexibility to adapt to changing business needs and real-time visibility into precise inventory levels, current ERP software delivers inventory functionality. MTO manufacturing systems benefit greatly from flexibility in the production process since it increases responsiveness, shortens lead times, and boosts overall efficiency.

18. Customer enquiry stage

This stage is most desirable and is the special need for MTO and has been very well understood by both ABC and XYZ companies. Both these organisations adopt multi stage decision process for this stage. Whether to prepare a bid and, if so, how much work to invest into the specification and estimation process are the first decisions to be made. ABC firms makes sure that it does capacity planning at the customer enquiry stage while taking into account the price and the delivery date. At the first stage, customer is being enquired about its needs to be fulfilled. Second and third stage includes creating a highly comprehensive specification and properly estimating the cost of every task. Finally it is to be checked that when can this production plan can be put into action (Fig. 6.5)

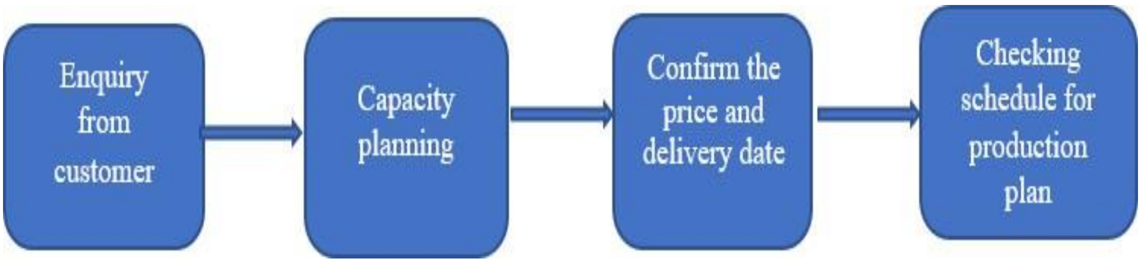


Fig 6.5: Customer Enquiry stage in ABC firm

XYZ firm follows the steps mentioned below for customer enquiry stage.

1. Customer explores dress designs online thorough websites or offline through showrooms.
2. Customer selects a basic design and enquires about further options to get it customized.
3. If the customization is possible then the order is being accepted by the manufacturer
4. All the parameters such as measurements, nature of embroidery, fabric, colour, size, etc., are mentioned by the customer.

Customer Centric/Customer focus approach:

These case studies validate the results of TOPSIS approach that shows that customer centric strategy is most ideal for MTO manufacturing system. Emerging trends in customized garments necessitated a change from the existing manufacturing approach of “MTS” to “MTO”. In XYZ company, the receipt of a customer order initiates all company activities, including sales, procurement, and product delivery. For ABC, Customer involvement and feedback are increasingly important and serve as valuable touch points for gathering ideas and building products and services. In ABC, Customer demand, when translated into supply problems, is recognised as four independent inputs that must be provided before a client order is fully characterised from a supply perspective.

- What? What product does the customer want?
- How much? How much (many) of the product does the customer want?
- When? When does the customer want delivery?
- Where? Where does the customer want the product delivered?

In order to create unique, fashionable, and customized products that would appeal to more consumers, XYZ has adopted cutting-edge technologies. For XYZ, Garment customization is a crucial business model and strategy that enables consumers to get personalised products and the company to receive higher customer satisfaction and less accumulated inventory. Additionally, it is a practical way to accelerate cash flow turnover and shorten responsiveness times. In terms of the garment's usefulness and lifespan, consumer demands have an impact on both the aesthetic design and the functional specifications. More than ever, apparel businesses must be able to quickly respond to customer demands. Personal dressing preferences are increasingly shifting to customized products, which are nevertheless available at a reasonable price. Additionally, consumers spend more on ready-to-wear apparel. The garment industry's manufacturers are being compelled to respond to changing demand with extreme flexibility due to growing challenges in predicting client wants. XYZ understands that the first and foremost requirement to initiate the customer centric MTO process is to understand customer's needs. With the changing trend in apparel industry, MTS doesn't fulfils the customer's desire to get the customized product and stand out in the crowd. This requires one to one interaction with the customer regarding their specifications and to get to know other details for customization.

Why Customer Centric/Customer focus approach ?

Customer focus is anticipating and meeting the wants and expectations of both present and future clients by gaining a comprehensive understanding of their requirements and then providing them with valued services (Islamgaleyev et al., 2020). Realizing customer expectations is the ultimate goal of customer focus (Han et al., 2021). A key driver of business organization performance has been identified as customer focus (Kumar, V. and Reinartz, 2018). The findings of Abrokwah-larbi (2024) support the present need to look into the specific effects of customer-focus on SME performance, as they show that this focus significantly improves SME performance. According to the findings, customer-focus positively and significantly affects financial performance, customer performance, internal business process performance, and learning and growth performance. These findings corroborate previous research that found a favourable association between customer-focus and SME performance. In order to optimise SME performance, this study equips managers and owners of SMEs with the tools they need to implement a customer-focused approach as a key strategic objective. Opportunities for SMEs' survival, profitability, and expansion are created by the introduction of customer focus as a key strategic competency.

Small and medium-sized businesses (SMEs) must implement workable strategies to increase their responsiveness and sensitivity to the evolving needs of their clientele due to the constant changes in the business environment. Because SMEs and their customers have a unique relationship, they must strategically choose to implement a customer-focus approach to concentrate on their consumers (Domi & Musabelliu, 2020). "Organizations' concerns with customers' needs, wants, and expectations (i.e. past, present, and future); their strong commitment to understand and satisfy them in a proactive manner for long-term growth" is how Bartley et al. (2007) characterized customer-focus. Realizing customer expectations is the ultimate goal of customer focus. SMEs and other business organizations can apply customer-focus as a strategic direction that recognizes their capacity to process market intelligence and create and communicate enhanced customer value. Creating value for the customer, which fosters customer loyalty and improves business organization performance, are the expected outcomes of a customer-focus approach (Madhani, 2020).

Due to inconsistent results from various studies, previous research, such as that done by (Pekovic, S. Rolland, 2016), has increasingly questioned the general acceptance of the beneficial impact of a customer-focused approach on business organization success. Several research studies, including those by Han et al. (2021), have found a positive correlation between customer focus and business organization performance. However, other studies, such as those by Manishimwe et al. (2022), have found a major negative correlation.

Consequently, numerous recommendations have been made by academics highlighting the necessity of conducting additional studies to ascertain the kind or nature of the relationship between customer focus and company success in a variety of contexts. An amalgamation of strategic elements can lead to the customer-focused performance outcome that has been consistently demonstrated by prior research. (Neneh, 2018) (Madhani, 2020). According to Husain et al. (2022), a company organization's internal resource that can strengthen its competitive advantage is customer focus. In prior research, customer-focus has even been deemed more superior to business organisations' external resources (Kang et al., 2021) (Kaburu et al., 2021) in terms of performance and the creation of competitive advantage. A customer-focus advantage can lead to a cascade effect that fosters the development of competitive superiority in areas such as cost, context-based product/service functionality, pricing, and other supplementary and extra-value services (Santos et al., 2020).

A customer-focused approach motivates customer engagement behaviors that result in distinctiveness and value in the customer experience, according to the body of existing research. Customer focus must become deeply ingrained in the company organization's culture before the strategy can truly be implemented. Enhancing an organization's total performance (i.e., sales, market share, profitability, and customer happiness) and creating a competitive edge are guaranteed by cultures and practices that prioritize the needs of the customer (Lee & Lee, 2019). The idea of customer focus has been discussed in the literature that already exists, and its implications have been thoroughly investigated. (Santos et al., 2020) (Marta et al., 2021) (Assen, 2021). By utilizing a methodology that assesses customer-focus culture and an organization's degree of customer focus, Bartley et al. (2007) offer useful insights into how commercial organizations might become more customer-focused.

The idea of customer focus, as noted by M. M. Babu (2017), has been treated in a disaggregated manner based on the idea that it primarily consists of the creation and distribution of intelligence related to consumers who are regarded as major actors in the market. The potential of SMEs to originate, create, and develop innovations is embodied in the innovative capability that they gain from customer-focused processes (Santos et al., 2020). The main goal is to effectively investigate market opportunities by utilizing customer-focused competencies and abilities. The ability of SMEs to prioritize their customers can lead to both financial growth and a competitive edge (Islam & Zhe, 2022). This strategy guarantees businesses keep a competitive edge, boosts client loyalty and improves general satisfaction – all of which can contribute to greater lonf term success.

6.4 Conclusion

With the use of case studies, the research has validated the manufacturing framework for make to order implementation for competitive advantage and sustainable manufacturing. This chapter looked at the steps Indian manufacturers took to use MTO and deal with the problems they ran into. A clear image of MTO as a business strategy is provided by the difficulties encountered by the case firms and the organisational lessons learned as well as the conclusion. This approach will assist managers in determining the necessary elements for the transition from make to stock to make to order.

Chapter 7

SUMMARY, LIMITATIONS AND SCOPE OF FUTURE WORK

7.1 Introduction

The final chapter provides a summary of the study, with particular focus on how this thesis has added to the body of knowledge regarding the acceptance of make-to-order in the context of developing countries like India. There is also a focus on the study's theoretical and managerial implications. The limitations of the study are also acknowledged, and some suggestions for further research are made. The primary result of the research serves as the chapter's final point. Figure 7.1, presents the flow of the chapter.

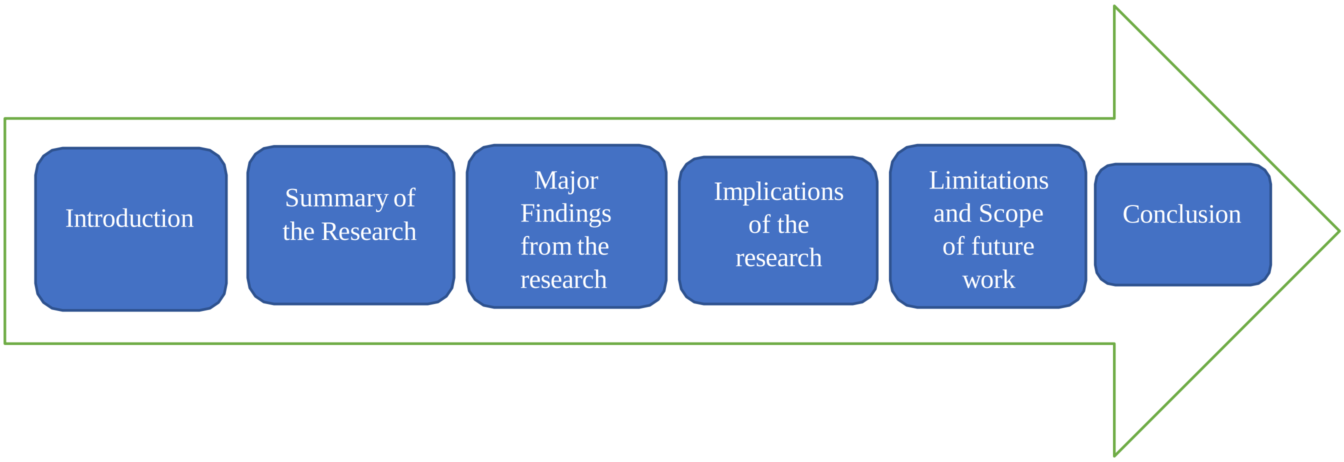


Figure 7.1: Flow of chapter 7

High-quality research is linked to pertinent results and insightful suggestions. The several goals of the study, which make the research significant, should be discussed in the conclusions. If the research findings can be applied in real-world scenarios, then the recommendations based on the findings are deemed significant. Even if the conclusions are susceptible to a number of limitations, these limitations would offer guidance to researchers operating in a related field.

The first chapter of the research study deals with the introduction of the production systems and its types, detailed discussion of make to order manufacturing system, planning and control aspects in MTO system. The second chapter is dedicated to review of make to order system, its benefits and challenges and the tools or methodologies used in the research. The third chapter discusses the research methodology adopted in detail. The fourth chapter deals with the prioritisation of critical success factors and strategy selection of make to order manufacturing system (ahp and topsis approach). The next chapter deals with the hypothesis testing and modeling with the help of PLS-SEM (smart PLS 4) and the results are validated and interpreted. The sixth chapter includes the case studies from Indian Manufacturing units to have an insight of make to order implementation. The final chapter contains some findings that are derived from all of the study and additional research.

7.2 Summary of the Research

This section covers the work done in this research. In today's rapidly evolving economic environment, make to order has become an important area of study. This section covers the work done in this research.

In today's rapidly evolving economic environment, make to order has become an important area of study. A comprehensive review of the literature was done to determine current research topics and their applicability to the Indian manufacturing sector. A thorough bibliography comprising 132 publications on make to order published in reputable national and international journals, books, and pertinent websites was created as a result of the survey. It is anticipated that this bibliography may prove beneficial to scholars and professionals working in this field. The literature review in Chapter 2 looks at the importance of MTO as a manufacturing paradigm for excellence and reviews the points of view of various authors to identify what is needed for the study work. The production and planning difficulties discussed in the literature have been highlighted in order to understand the subject's significance for further research. However sound the theory may be, practitioners must first grasp the transformation model before attempting to apply the challenging paradigm. The shift of manufacturing system to make to order from make-to-stock was investigated in this study in terms of critical success factors and implementation strategies. For the fulfilment of first objective, as discussed in chapter 4, a review of the literature and discussions with practitioners, eighteen vital success factors and three implementation strategies have been determined as being crucial for the successful implementation of MTO in the automotive industry.

- These CSFs are Customer needs /choice/ passion for unique products/ self-created product, High product variety, Modular product design, Flexible manufacturing processes, Accessibility to flexible and real time information technology to keep the customer updated, Information system (online system) to receive order and payments, Competition in the market, Ability of MTO without increasing cost of manufacturing, Risk of obsolescence and perishability, High cost of carrying inventory, skilled employees for manufacturing, flat organization structure, short lead time of suppliers, Technology and its spread, Product/market innovation, Business risk and economy, Flexibility of the production process, Customer enquiry stage. These critical success factors were functionally grouped under six broad categories, Product, Organization, Information Technology (IT), Market, Customer and Cost.
- The organization must decide which implementation method is best for either converting the current MTS system to an MTO system or implementing an MTO system. Three implementation strategies that were identified in this study are IT centric strategy, Design, Innovation and Production Centric strategy and Customer-centric strategy.

- Initially, the AHP technique is used for prioritizing the identified Critical Success Factors in Indian Manufacturing Industry. Since the implementation of the MTO system is the main focus of the research, it is crucial to support relevant Critical success factors in the Indian Manufacturing Sector. Further, TOPSIS is being employed to rank the three identified implementation strategies.

For attaining second objective, case study approach was adopted to find the evidences of critical success factors and implementation strategies practically.

- To find organizations with Indian ancestry that had applied the MTO approach, a thorough search was conducted. Two organisations agreed to participate for this research and case study was carried out. The purpose of this theory extension was to gather data that would help explain the tactics that businesses should use to understand and support their transformation.
- PPC expert, Sales and Marketing expert, IT expert, Head of operations, Product manager, Design Specialist, Business strategy expert, Sales Manager from the two MTO companies were in interviewed in depth. The case companies vary widely in terms of their ownership, size, and target markets.
- Challenges were noted and tactics were suggested for firms attempting to apply MTO in order to improve MTO implementation for a competitive edge.In order to validate the identified critical success factors, implementation strategies and determine what motivated two organizations of Indian descent to pursue the more praised but understudied field of mto, case studies were carried out in each of the two organizations.

In order to achieve objective number three, constructs for developing a manufacturing model for MTO implementation were found and discussed in chapter 5. The hypotheses offered in the current study consider factors that are critical for MTO approach and further reinforced by examining relationship between MTO ability for competitive advantage and Sustainable Manufacturing.

- A thorough detailed literature review is conducted to find the key elements that would motivate firms to adopt MTO strategy for achieving competitive advantage and sustainable manufacturing. The detailed literature review has been done to select PLS SEM as the tool for measuring relationship between different constructs.
- The questionnaire was developed as a research instrument after a careful evaluation of the literature and it consisted of three parts. The questionnaire utilised the five-point Likert scale since it is easy for respondents to read out and provides a comprehensive list of scale descriptors.
- The questionnaire was disseminated and the market's perception of key model components impacting the usage of MTO for competitive advantage and sustainable manufacturing shown by the survey results.
- The study employed the Partial Least Square Structural Equation Modeling (PLS SEM) method with a sample of 192 Indian firms to test nine generated hypotheses. Using content and construct validity, reliability the received responses were analyzed. A statistical validation was conducted on the manufacturing model.

7.3 Major Findings from the Research

This study examines the implementation techniques and critical success factors (CSFs) required for a Make-To-Order (MTO) system. The Indian manufacturing sector can gain a lot from switching to MTO systems, including lower inventory costs, more customisation options, and happier customers. But to successfully navigate this shift, one must adopt a calculated strategy that prioritizes key success criteria and chooses the best execution techniques. Automakers can successfully deploy MTO systems and increase their competitiveness in the global market by utilizing cutting-edge IT systems, creative design, and a customer-centric strategy. Companies must remove bottlenecks and satisfy consumer demands for cost, quality, and delivery in today's cutthroat industrial market. Sustaining and expanding market shares, revenue, and sales all depend on high levels of customer satisfaction.

The literature review identified eighteen critical success variables, which were then categorized into six groups: market, customer, organization, product, information technology, and cost, in chapter 4. These eighteen factors were further prioritised using AHP methodology and the result revealed that Business Risk and economy is rated first while Flat Organisation Structure scored last. The implementation strategies for a MTO system are identified and they are Ranked using TOPSIS. As a result, the customer-centric strategy is the most desired method of applying MTO. This is followed by the design, innovation, and production-centric strategies, and lastly, the IT system-centric approach.

With the goal of achieving sustainable manufacturing and a competitive edge, this study aims to close the knowledge gap on MTO strategies. This research attempts to present a comprehensive model for MTO integration by identifying and analyzing the crucial aspects involved, ultimately helping to make manufacturing sectors more competitive and sustainable. The hypotheses proposed in the study focus on critical factors influencing MTO implementation and its relationship with sustainable manufacturing. These factors include Configurable Product (CP), Information Technology (IT), Market Performance (MP), Customer Need (CN), Organizational Readiness (OR), Emerging Technologies (ET), MTO itself, Competitive Advantage (CA), and Sustainable Manufacturing (SM). All of the hypotheses suggest that these variables are positively correlated, which highlights the significance of these variables in developing MTO capacities and environmentally friendly production methods. Overall, the study aims to contribute to the understanding of how MTO strategies can enhance competitive advantage and drive sustainable manufacturing practices in contemporary business operations. The research successfully applied PLS-SEM to test hypotheses about the correlations between constructs in the context of sustainable manufacturing with an MTO system, validate the measurement model, and demonstrate reliability and validity.

The findings provide substantial evidence in favor of the suggested correlations and advance knowledge of how these variables affect sustainable manufacturing. The present investigation has examined the application of Make-To-Order (MTO) tactics in Indian manufacturing enterprises, with an emphasis on comprehending the challenges and strategies employed. The case studies offered more in-depth understandings of the real-world difficulties and effective tactics used in MTO implementation. They emphasized the significance of technology integration, adaptable manufacturing processes, and customer-centric approaches in satisfying a range of consumer needs.

In summary, both ABC and XYZ exhibit a proficient application of MTO tactics to augment customer satisfaction, operational efficiency, and competitive positioning within their respective markets, while operating in distinct industries and facing distinct problems. Their strategies emphasize how crucial it is to achieve sustained growth and profitability through customisation, flexibility, and cutting-edge technological integration. All things considered, ABC and XYZ show how MTO concepts are strategically aligned with their respective businesses, making use of highly qualified workers, efficient workflows, cutting-edge technologies, and strong innovation frameworks to gain an advantage over competitors. These approaches not only improve customer happiness and operational efficiency, but they also put them in a strong position for long-term growth and market dynamics adaption.

7.4 Implications of the Research:

In order to facilitate make to order, the research employed a variety of methodologies and created model for linking critical success factors with competitive advantage, and sustainable manufacturing. The manufacturing model was designed to facilitate MTO implementation. Following are some implications of the research for managers and academicians.

7.4.1 Implications for Academics:

There are numerous significant implications of the research for scholars or Academicians:

- In Chapter 2, the research examined the numerous reviews of the literature on mto, with a focus on PPC and manufacturing-related difficulties.This can serve as a foundation for researchers in the future as they identify areas of MTO that need more investigation and study.
- In chapter 3, significant approaches were uncovered through research, along with their significance and literary applications. These approaches are applicable to different areas of research.
- The critical success factors discussed in this thesis can serve as a foundation for future research on manufacturing organizations in other countries.
- Further empirical research in manufacturing companies could be conducted using the questionnaire generated by this study.
- Academicians can employ the case study technique described in chapters 3 and 6 in their future case study research.

7.4.2 Implications for Industries:

- Very little research has been done on MTO in the manufacturing industry of India. The study's conclusions can be used by businesses to guide decisions about developing unique operational capabilities and upgrading from their current MTS systems to competitive MTO ones.

- The results of this study will help managers better understand the critical areas where greater emphasis is needed when they are considering a shift from mass manufacturing to mass customization. The PLS SEM model in the current study consider factors that are critical for MTO approach and these can be further reinforced by the manufacturing companies to achieve Sustainable Manufacturing through Competitive advantage.
- Managers and decision-makers can focus on the best plan to help with the transition from MTS to MTO by ranking and identifying implementation options for MTO.
- Practitioners will get insight from the case studies into how specific companies utilized the critical success factors for MTO implementation in real-world scenarios.MTO will help organizations entering this market generate creative methods, even though it is not a "one size fits all" solution.
- The way the manufacturing model's components interact will help management identify the causal relationships between the constructs and how those relationships affect overall operation to gain a competitive edge.

7.5 Limitations and Scope of the future Research

The fact that make to order is still a novel concept in India was a major constraint of this research. Despite being aware of the problem, management is still determining the best course of action at this point. The goal of this study was to get deeper insight into the technique and variables influencing the transition of the Indian economy from MTS to MTO. The following limitations also apply to the current study, which examines MTO and its performance concerns in a specific segment of the Indian manufacturing industry.

In Chapter 5, theory has been developed using the PLS SEM approach. This method solicits professional opinions, whose bias may distort study findings and hinder the method's acceptance. As the Indian manufacturing environment and organized sector provided the basis for this research's inputs, there is a possibility that the results will differ for different sectors and different regions. Only the sectors of organized production are covered by this idea. Studying the critical success factors of make to order in the service sector can be helpful since it is another area where the technology is progressing. Other methodologies could also be used to communicate the estimation of these critical success factors and their interactions.

As with any empirical study, several limitations were necessary to be further explored. To make sure that this framework functions in different marketplaces, it should be tested in a different nation in the future. Secondly, the manufacturing sector is the focus of the research. In the future, a cross-industry comparison research might be carried out to evaluate the model described in this study in other sectors. It is also possible to test the strategy in the service industry. The strategy can also be tested in the service industry. Financial problems and other topics not included in this study may be the subject of future research. Most suitable choices for this framework are businesses with a strong technical base. It may be possible to look into a similar framework for MSMEs and start-ups in order to apply make to order to a range of industries. In addition, the idea was tested in order to provide it an advantage over rivals. The same model can be tested to evaluate if it works well for different business opportunities. Though it has gained popularity recently, make-to-order—which uses modularization to increase product variety while preserving mass production (MP) efficiency—has several disadvantages. Customers may have to wait longer than with Make-to-Stock (MTS) models because production doesn't start until an order is received. In businesses where prompt delivery is essential, this could be a drawback. Production scheduling and planning become more challenging when distinct materials, components, and production methods are needed for every order. This intricacy may result in inefficiencies and a higher chance of mistakes. Overall, MTO involves substantial operational issues that must be properly managed to ensure profitability and customer happiness, even while it can reduce some types of inventory costs and gives the benefit of personalized products.

For the critical success factors of make to order, the data collected and the results of AHP and TOPSIS mostly rely on manufacturing companies in the region of India. The results' applicability to a wider range of industries with different sizes, types, and locations is limited. Nonetheless, a broad and varied sample set may be used to assess the findings' relevance. More investigation may be conducted to compare the findings of this study with those of other developed and developing nations. The theory may be developed using alternative decision analysis techniques like TISM and MICMAC, and it may then be tested using structural equation modeling. Additionally, because MSMEs and start-ups are struggling to survive in any form of economic instability, future studies can pinpoint the factors that motivate widespread customization for these businesses.

7.6 Conclusions

MTO's capacity will unavoidably become more essential for companies of all sizes to survive and grow in the face of ever greater economic volatility. Under these circumstances, companies getting ready to go from MTS to MTO will need an execution framework.This process will be facilitated by the attainment of the research objectives and frameworks. The research successfully achieved all of its goals and produced conclusions. The managerial and acamedic implications satisfy the practical implacability request of the research.

Biblography

1. Ã, M. S., & Hendry, L. C. (2006). Aggregate load-oriented workload control : A review and a re-classification of a key approach. 104, 676–693. https://doi.org/10.1016/j.ijpe.2005.05.022

2. Abdel-Basset, M., Saleh, M., Gamal, A., & Smarandache, F. (2019). An approach of TOPSIS technique for developing supplier selection with group decision making under type-2 neutrosophic number. Applied Soft Computing Journal, 77, 438–452. https://doi.org/10.1016/j.asoc.2019.01.035

3. Abrokwah-larbi, K. (2024). The impact of customer-focus on the performance of business organizations : evidence from SMEs in an emerging West African economy. African Journal of Economic and Management Studies, 15(1), 31–59. https://doi.org/10.1108/AJEMS-04-2022-0167

4. Acevedo-ojeda, A., Contreras, I., & Chen, M. (2019). Two-level lot-sizing with raw-material perishability and deterioration. Journal of the Operational Research Society, 0(0), 1–16. https://doi.org/10.1080/01605682.2018.1558942

5. Ahmadabadi, A. A., & Heravi, G. (2019). The effect of critical success factors on project success in Public-Private Partnership projects: A case study of highway projects in Iran Transport Policy, 152–161. https://doi.org/10.1016/j.tranpol.2018.07.004

6. Aksoy, H., 2017. How do innovation culture, marketing innovation and product innovation affect the market performance of small and medium-sized enterprises (SMEs)?. Technology in Society, 51, pp.133-141.

7. Akter, S., Fosso Wamba, S., & Dewan, S. (2017). Why PLS-SEM is suitable for complex modelling? An empirical illustration in big data analytics quality. Production Planning and Control, 28(11–12), 1011–1021. https://doi.org/10.1080/09537287.2016.1267411

8. Alao, M. A., Ayodele, T. R., Ogunjuyigbe, A. S. O., & Popoola, O. M. (2020). Multi-criteria decision based waste to energy technology selection using entropy-weighted TOPSIS technique: The case study of Lagos, Nigeria. Energy, 201, 117675. https://doi.org/10.1016/j.energy.2020.117675

9. Albayrak, E. (2004). Using analytic hierarchy process (AHP) to improve human performance : An application of multiple criteria decision making problem. Journal of Intelligent Manufacturing, 15, 491–503.

10. Ali, A., Ramakrishnan, S., Faisal, F., Akram, T., Salam, S., & Rahman, S. U. (2023). Bibliometric analysis of finance and natural resources : past trend , current development , and future prospects. Environment, Development and Sustainability, 25(11), 13035–13064. https://doi.org/10.1007/s10668-022-02602-1

11. Almehdawe, E., & Jewkes, E. (2013). Performance analysis and optimization of hybrid manufacturing systems under a batch ordering policy. International Journal of Production Economics, 144(1), 200–208. https://doi.org/10.1016/j.ijpe.2013.02.005

12. Álvarez-Gil, N., Rosillo, R., de la Fuente, D., & Pino, R. (2021). A discrete firefly algorithm for solving the flexible job-shop scheduling problem in a make-to-order manufacturing system. Central European Journal of Operations Research, 29(4), 1353–1374. https://doi.org/10.1007/s10100-020-00701-w

13. Amandeep, Guttridge, P., Dani, S., & Burns, N. (2008). Investigating factors affecting ERP selection in made-to-order SME sector. Journal of Manufacturing Technology Management, 19(4), 430–446. https://doi.org/10.1108/17410380810869905

14. Amaro, G., Hendry, L., & Kingsman, B. (1999). Competitive advantage, customisation and a new taxonomy for non make-to-stock companies. International Journal of Operations & Production Management, 19(4), 349–371. http://dx.doi.org/10.1108/01443579910254213

15. Amiri, M. P. (2010). Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods. Expert Systems with Applications, 37(9), 6218–6224. https://doi.org/10.1016/j.eswa.2010.02.103

16. Arabzad, S. M., Ghorbani, M., Razmi, J., & Shirouyehzad, H. (2015). Employing fuzzy TOPSIS and SWOT for supplier selection and order allocation problem. International Journal of Advanced Manufacturing Technology, 76(5–8), 803–818. https://doi.org/10.1007/s00170-014-6288-3

17. Arokiaraj, D., & Banumathi, M. (2014). Factors Influencing the Purchase Decision of Passenger Cars in Puduchery. International Journal of Exclusive Management Research, 4(4). https://ssrn.com/abstract=2986661

18. Aslan, B., Stevenson, M., & Hendry, L. C. (2012). Computers in Industry Enterprise Resource Planning systems : An assessment of applicability to Make-To-Order companies Computers in Industry, 63(7), 692–705 https://doi.org/10.1016/j.compind.2012.05.003

19. Assen, M. F. Van. (2021). Total Quality Management & Business Excellence Lean , process improvement and customer-focused performance . The moderating effect of perceived organisational context. Total Quality Management & Business Excellence ISSN: https://doi.org/10.1080/14783363.2018.1530591

20. Avlonitis, G. J., & Salavou, H. E. (2007). Entrepreneurial orientation of SMEs , product innovativeness , and performance. Journal of Business Research, 60, 566–575. https://doi.org/10.1016/j.jbusres.2007.01.001

21. Azzi, A., Battini, D., Faccio, M., Persona, A., Sgarbossa, F., Azzi, A., Battini, D., Faccio, M., Persona, A., Sgarbossa, F., Azzi, A., Battini, D., Faccio, M., Persona, A., & Sgarbossa, F. (2014). Inventory holding costs measurement : a multi-case study. The International Journal of Logistics Management Inventory, 25(1), 109–132. https://doi.org/10.1108/IJLM-01-2012-0004

22. Babu, A. S. (2016). Strategies for enhancing agility of make-to-order manufacturing systems. International Journal of Agile Management Systems, 1(1), 23–29. http://dx.doi.org/10.1108/14654659910266682%0ADownloaded

23. Babu, M. M. (2017). Impact of firm ’ s customer orientation on performance : the moderating role of interfunctional coordination and employee commitment. Journal of Strategic Marketing, 4488(October), 1–21.

24. https://doi.org/10.1080/0965254X.2017.1384037

25. Bagchi, P. M. K. (2016). Industrial Management & Data Systems. Industrial Management & Data Systems, 116(6). http://dx.doi.org/10.1108/IMDS-07-2015-0297%0A

26. Bagheri, F., Demartini, M., Arezza, A., Tonelli, F., Pacella, M., & Papadia, G. (2022). An Agent-Based Approach for Make-To-Order Master Production Scheduling. Processes, 10, 921. https://doi.org/ 10.3390/pr10050921

27. Balcaen, S., & Ooghe, H. (2006). 35 years of studies on business failure : an overview of the classic statistical methodologies and their related problems. The British

Accounting Review, 38, 63–93. https://doi.org/10.1016/j.bar.2005.09.001

28. Barbosa, C., & Azevedo, A. (2018). Towards a hybrid multi-dimensional simulation approach for performance assessment of MTO and ETO manufacturing environments. Procedia Manufacturing, 17, 852–859. https://doi.org/10.1016/j.promfg.2018.10.137

29. Bartley, B., Gomibuchi, S., & Mann, R. (2007a). Best practices in achieving a customer-focused culture. Benchmarking: An International Journal, 14(4), 482–496. https://doi.org/10.1108/14635770710761889

30. Bartley, B., Gomibuchi, S., & Mann, R. (2007b). Best practices in achieving a customer-focused culture. Benchmarking: An International Journal, 14(4), 482–496. https://doi.org/10.1108/14635770710761889

31. Barua, A., Kriebel, C. H., & Mukhopadhyay, T. (1995). Information Technologies and Business Value: An Analytic and Empirical Investigation. Information Systems Research, 6(1), 3–23. http://dx.doi.org/10.1287/isre.6.1.3

32. Barut, M., & Sridharan, V. (2005). Revenue Management in Order-Driven Production Systems. Decision Sciences, 36(2), 287–316.

33. Bassett, K., Carriveau, R., & Ting, D. S. K. (2015). 3D printed wind turbines part 1: Design considerations and rapid manufacture potential. Sustainable Energy Technologies and Assessments, 11, 186–193. https://doi.org/10.1016/j.seta.2015.01.002

34. Berman, O., Krass, D., & Mahdi Tajbakhsh, M. (2011). On the benefits of risk pooling in inventory management. Production and Operations Management, 20(1), 57–71. https://doi.org/10.1111/j.1937-5956.2010.01134.x

35. Bertrand, J. W. M., & Muntslag, D. R. (1993). Production control in engineer-to-order firms. International Journal of Production Economics, 31, 3–22.

36. Bhanot, N., Rao, P. V., & Deshmukh, S. G. (2015). Enablers and barriers of sustainable manufacturing: Results from a survey of researchers and industry professionals. Procedia CIRP, 29, 562–567. https://doi.org/10.1016/j.procir.2015.01.036

37. Bhanot, N., Rao, P. V., & Deshmukh, S. G. (2017). An integrated approach for analysing the enablers and barriers of sustainable manufacturing. Journal of Cleaner

Production, 142, 4412–4439. https://doi.org/10.1016/j.jclepro.2016.11.123

38. Bhatia, J. (2016). Porter's Five Forces Industry Analysis of Indian Passenger Car Industry. Pacific Business Review International, 8(7), 113–123. http://oaji.net/articles/2016/3050-1456208479.pdf

39. Bhatt, G. D. (2001). Knowledge management in organizations : examining the interaction between technologies , techniques , and people. Journal of Knowledge Management, 5(1), 68–75. https://doi.org/10.1108/13673270110384419%0A

40. Billaut, J., & Toulouse, D. (2011). This regular paper was presented as part of the main technical program at IEEE ETFA ' 2011 New scheduling problems with perishable raw materials constraints.

41. Binnewies, C., & Ohly, S. (2014). European Journal of Work and Organizational Psychology Taking personal initiative and communicating about ideas : What is important for the creative process and for idea creativity ? European Journal of Work and Organizational Psychology, December, 37–41. https://doi.org/10.1080/13594320701514728

42. Blatter, M., Muehlemann, S., & Schenker, S. (2012). The costs of hiring skilled workers $. European Economic Review, 56(1), 20–35. https://doi.org/10.1016/j.euroecorev.2011.08.001

43. Blocker, C. P., Flint, D. J., Myers, M. B., & Slater, S. F. (2011). Proactive customer orientation and its role for creating customer value in global markets. Journal of the Academy of Marketing Science, 39, 216–233. https://doi.org/10.1007/s11747-010-0202-9

44. Bordeleau, F., Mosconi, E., Santa-eulalia, L. A. De, Mosconi, E., Santa-, L. A. De, Bordeleau, F., Mosconi, E., & Santa-eulalia, L. A. De. (2019). The Management of Operations Business intelligence and analytics value creation in Industry 4 . 0 : a multiple case study in manufacturing medium enterprises case study in manufacturing medium enterprises. Production Planning & Control, 0(0), 1–13. https://doi.org/10.1080/09537287.2019.1631458

45. Brahimi, N., Najid, N. M., & Nordli, A. (2006). Single item lot sizing problems. European Journal Of Operational Research, 168, 1–16. https://doi.org/10.1016/j.ejor.2004.01.054

46. Brown, S., & Bessant, J. (2003). The manufacturing strategy-capabilities links in mass customisation and agile manufacturing – an exploratory study. International Journal of Operations & Production Management, 23(7), 707–730.

https://doi.org/10.1108/01443570310481522

47. Brynjolfsson, E., Hitt, L. M., & Yang, S. (2002). Intangible assets: Computers and organizational capital. Brookings Papers on Economic Activity, 2002(1), 137–198. https://doi.org/10.1353/eca.2002.0003

48. Buschkühl, L., Sahling, F., Helber, S., & Tempelmeier, H. (2010). Dynamic capacitated lot-sizing problems : a classification and review of solution approaches. OR Spectrum, 32, 231–261. https://doi.org/10.1007/s00291-008-0150-7

49. Cakravastia, A., & Nakamura, N. (2010). Model for negotiating the price and due date for a single order with multiple suppliers in a make-to-order environment. International Journal of Production Research, February 2015, 37–41. https://doi.org/10.1080/00207540210147007

50. Calle, M., González-R, P. L., Leon, J. M., Pierreval, H., & Canca, D. (2016). Integrated management of inventory and production systems based on floating decoupling point and real-time information: A simulation based analysis. International Journal of Production Economics, 181, 48–57. https://doi.org/10.1016/j.ijpe.2016.08.001

51. Calosso, T., Cantamessa, M., & Gualano, M. (2004). Negotiation support for Make-To-Order operations in business-to-business electronic commerce. Robotics and Computer-Integrated Manufacturing, 20, 405–416. https://doi.org/10.1016/j.rcim.2004.03.003

52. Calosso, T., Cantamessa, M., Vu, D., & Villa, A. (2003). Production planning and order acceptance in business to business electronic commerce. International Journal of Production Economics, 85, 233–249. https://doi.org/10.1016/S0925-5273(03)00112-9

53. Canco, I., & Kruja, D. (2021). AHP , a Reliable Method for Quality Decision Making : A Case Study in Business. Sustainability, 13, 1–14. https://www.mdpi.com/journal/sustainability

54. Cannas, V. G., Masi, A., Pero, M., & Ditlev, T. (2020). The Management of Operations Implementing configurators to enable mass customization in the Engineer-to-Order industry : a multiple case study research Order industry : a multiple case study research. Production Planning & Control, 1–21. https://doi.org/10.1080/09537287.2020.1837941

55. Carnevale, A. P., & Smith, N. (2014). Human Resource Development International Workplace basics : the skills employees need and employers want. Human Resource Development International, 16(5), 37–41. https://doi.org/10.1080/13678868.2013.821267

56. Chang, H., & Chen, F. F. (2002). Strategy Considering Utilisation of Machines. The International Journal of Advanced Manufacturing Technology, 19, 97–105.

57. Charnsirisakskul, K., Griffin, P. M., & Keskinocak, P. (2006). Pricing and scheduling decisions with leadtime flexibility. European Journal of Operational Research, 171, 153–169. https://doi.org/10.1016/j.ejor.2004.07.062

58. Chen, Chee-cheng, & Cheng, W. (2007). Customer-focused and product-line-based manufacturing performance measurement. International Journal of Advanced Manufacturing Technology, 34, 1236–1245. https://doi.org/10.1007/s00170-006-0686-0

59. Chen, Chin-sheng. (2006). Concurrent Engineer-To-Order operation in the Manufacturing Engineering Contracting industries. International Journal of Industrial and Systems Engineering, 1, 37–58.

60. Chen, Chin-sheng, Mestry, S., Damodaran, P., & Wang, C. (2009). The capacity planning problem in make-to-order enterprises. Mathematical and Computer Modelling, 50(9–10), 1461–1473. https://doi.org/10.1016/j.mcm.2009.07.010

61. Cheng, T. C. E., Lee, W., & Wu, C. (2010). Computers & Industrial Engineering Scheduling problems with deteriorating jobs and learning effects including proportional setup times. Computers & Industrial Engineering, 58(2), 326–331. https://doi.org/10.1016/j.cie.2009.11.008

62. Chhimwal, M., Agrawal, S., & Kumar, G. (2021). Measuring circular supply chain risk: A bayesian network methodology. Sustainability (Switzerland), 13(15), 1–22. https://doi.org/10.3390/su13158448

63. Sáenz-Royo, C., Chiclana, F. and Herrera-Viedma, E., 2024. Ordering vs. AHP. Does the intensity used in the decision support techniques compensate?. Expert Systems with Applications, 238, p.121922.

64. Choi, T., & Cai, Y. (2018). Impacts of lead time reduction on fabric sourcing in

considerations. Annals of Operations Research. https://doi.org/10.1007/s10479-018-2838-7

65. Chua, F. L. S., Vasnani, N. N., Pacio, L. B. M., & Ocampo, L. A. (2018). A Stackelberg game in multi-period planning of make-to-order production system across the supply chain. Journal of Manufacturing Systems, 46, 231–246. https://doi.org/10.1016/j.jmsy.2018.01.004

66. Cooper, B. L., Watson, H. J., Wixom, B. H., & Goodhue, D. L. (2000). Data warehousing supports corporate strategy at First American Corporation. MIS Quarterly: Management Information Systems, 24(4), 547–567. https://doi.org/10.2307/3250947

67. Corsini, L., Aranda-Jan, C. B., & Moultrie, J. (2022). The impact of 3D printing on the humanitarian supply chain. Production Planning and Control, 33(6–7), 692–704. https://doi.org/10.1080/09537287.2020.1834130

68. Corti, D., Pozzetti, A., & Zorzini, M. (2006). A capacity-driven approach to establish reliable due dates in a MTO environment. International Journal of Production Economics, 104(2), 536–554. https://doi.org/10.1016/j.ijpe.2005.03.003

69. Croft, A. (1996). Advances in production technology. In Concrete (London) (Vol. 30, Issue 3). IFIP Advances in Information and Communication Technology. https://doi.org/10.1007/978-981-10-6460-9_6

70. Custódio, D. T., Roehe Vaccaro, G. L., Nunes, F. L., Vidor, G., & Chiwiacowsky, L. D. (2018). Variant product configuration of industrial air handling units in a MTO environment. International Journal of Advanced Manufacturing Technology, 95(1–4), 1025–1037. https://doi.org/10.1007/s00170-017-1171-7

71. Dalcher, D. (2016). Novel Approaches to Organizational Project Management Research: Translational and Transformational. Project Management Journal, 47(1), e2–e2. https://doi.org/10.1002/pmj.21567

72. Das, D., Datta, A., Kumar, P., Kazancoglu, Y., & Ram, M. (2022). Building supply chain resilience in the era of COVID - 19 : An AHP - DEMATEL approach. Operations Management Research, 249–267. https://doi.org/10.1007/s12063-021-00200-4

73. Dauod, H., Li, D., Yoon, S. W., & Srihari, K. (2018). Multi-objective optimization of the order scheduling problem in mail-order pharmacy automation systems. International Journal of Advanced Manufacturing Technology, 99(1–4), 73–83. https://doi.org/10.1007/s00170-016-9123-1

74. Dawes, J. (2008). Do data characteristics change according to the number of scale points used ? An experiment using 5-point , 7-point and 10- point scales. 50(1), 1–10.

75. Despeisse, M., Mbaye, F., Ball, P. D., & Levers, A. (2012). The emergence of sustainable manufacturing practices. Production Planning and Control, 23(5), 354–376. https://doi.org/10.1080/09537287.2011.555425

76. Devaraj, S., & Kohli, R. (2000). Information technology payoff in the health-care industry: A longitudinal study. Journal of Management Information Systems, 16(4), 41–67. https://doi.org/10.1080/07421222.2000.11518265

77. Deveci, M., Pamucar, D., Gokasar, I., Koppen, M., Gupta, B. B., & Daim, T. (2023). Technological Forecasting & Social Change Evaluation of Metaverse traffic safety implementations using fuzzy Einstein based logarithmic methodology of additive weights and TOPSIS method. Technological Forecasting & Social Change, 194(September 2022). https://doi.org/10.1016/j.techfore.2023.122681

78. Dewett, T., & Jones, G. R. (2001). The role of information technology in the organization : a review , model , and assessment. Journal of Management, 27, 313–346.

79. Dijkstra, T. K., & Henseler, J. (2015). Consistent and asymptotically normal PLS estimators for linear structural equations. Computational Statistics and Data Analysis, 81, 10–23. https://doi.org/10.1016/j.csda.2014.07.008

80. Dinh, V., Tran, H., Bui, T., Vu, D., Vu, D., Vu, N., & Truong, T. (2024). Multi-Objective Optimization of a Two-Stage Helical Gearbox with Second Stage Double Gear-Sets Using TOPSIS Method. Processes, 12(1160).

81. Dobson, G., Pinker, E. J., & Yildiz, O. (2017). An EOQ model for perishable goods with age-dependent demand rate. European Journal of Operational Research, 257(1), 84–88. https://doi.org/10.1016/j.ejor.2016.06.073

82. Dohale, V., Ambilkar, P., Gunasekaran, A., & Verma, P. (2022). Supply chain risk mitigation strategies during COVID-19: exploratory cases of “make-to-order”

handloom saree apparel industries. International Journal of Physical Distribution and Logistics Management, 52(2), 109–129. https://doi.org/10.1108/IJPDLM-12-2020-0450

83. Domi, S., & Musabelliu, B. (2020). Customer orientation and SME performance in Albania : A case study of the mediating role of innovativeness and innovation behavior. Journal of Vacation Marketing, 26(1), 130–146. https://doi.org/10.1177/1356766719867374

84. Domingos, D., Martins, F., Cândido, C., & Martinho, R. (2014). Internet of things aware WS-BPEL business processes - context variables and expected exceptions. Journal of Universal Computer Science, 20(8), 1109–1129.

85. Dong, B., Jia, H., Li, Z., & Dong, K. (2012). Implementing Mass Customization in Garment Industry. Systems Engineering Procedia, 3, 372–380. https://doi.org/10.1016/j.sepro.2011.10.059

86. Dou, Z., Wu, B., Sun, Y., & Wang, T. (2021). The Competitiveness of Manufacturing and Its Driving Factors : A Case Study of G20 Participating Countries. Sustainability, 13, 1–17. https://doi.org/10.3390/su13031143

87. Durão, L. F. C. S., Carvalho, M. M., Takey, S., Cauchick-Miguel, P. A., & Zancul, E. (2018). Internet of Things process selection: AHP selection method. International Journal of Advanced Manufacturing Technology, 99(9–12), 2623–2634. https://doi.org/10.1007/s00170-018-2617-2

88. Durdyev, S., Ismail, S., Ihtiyar, A., Abu Bakar, N. F. S., & Darko, A. (2018). A partial least squares structural equation modeling (PLS-SEM) of barriers to sustainable construction in Malaysia. Journal of Cleaner Production, 204, 564–572. https://doi.org/10.1016/j.jclepro.2018.08.304

89. Dvorsky, J., Belas, J., Gavurova, B., & Brabenec, T. (2021). Business risk management in the context of small and medium-sized enterprises. Economic Research-Ekonomska Istraživanja, 34(1), 1690–1708. https://doi.org/10.1080/1331677X.2020.1844588

90. Easton, F. F., & Moodie, D. R. (1999). Pricing and lead time decisions for make-to-order firms with contingent orders. European Journal of Operational Research, 116(2), 305–318. https://doi.org/10.1016/S0377-2217(98)00101-5

91. Ebadian, M., Rabbani, M., Jolai, F., Torabi, S. A., & Tavakkoli-Moghaddam, R. (2008). A new decision-making structure for the order entry stage in make-to-order environments. International Journal of Production Economics, 111(2), 351–367. https://doi.org/10.1016/j.ijpe.2007.01.004

92. Ebadian, M., Rabbani, M., Torabi, S. A., & Jolai, F. (2009). Hierarchical production planning and scheduling in make-to-order environments: Reaching short and reliable delivery dates. International Journal of Production Research, 47(20), 5761–5789. https://doi.org/10.1080/00207540802010799

93. Ebrahimi, A., Khakpour, R., & Saghiri, S. (2021). Sustainable setup stream mapping (3SM): a systematic approach to lean sustainable manufacturing. Production Planning and Control, 0(0), 1–24. https://doi.org/10.1080/09537287.2021.1916637

94. Edirisinghe, C., Atkins, D., & Atkins, D. (2017). Author ' s Accepted Manuscript Lower bounding inventory allocations for risk pooling in two-echelon supply chains Reference : Lower bounding inventory allocations for risk pooling in two-echelon supply chains. Intern. Journal of Production Economics. https://doi.org/10.1016/j.ijpe.2017.02.015

95. Eivazy, H., Rabbani, M., & Ebadian, M. (2009). A developed production control and scheduling model in the semiconductor manufacturing systems with hybrid make-to-stock/make-to-order products. International Journal of Advanced Manufacturing Technology, 45(9–10), 968–986. https://doi.org/10.1007/s00170-009-2028-5

96. Essoussi, L. H., & Merunka, D. (2007). Consumers' product evaluations in emerging markets: Does country of design, country of manufacture, or brand image matter? International Marketing Review, 24(4), 409–426. https://doi.org/10.1108/02651330710760991

97. Eswaran, M., & Bahubalendruni, M. V. A. R. (2022). Challenges and opportunities on AR/VR technologies for manufacturing systems in the context of industry 4.0: A state of the art review. Journal of Manufacturing Systems, 65, 260–278. https://doi.org/10.1016/j.jmsy.2022.09.016

98. Fakhrzad, M. B., & Mohagheghian, E. (2019). A nash game in multi-period planning of make-to-order production system across the supply chain. International Journal of Industrial Engineering and Production Research, 30(1), 231–246.

99. Feng, J., & Zhang, M. (2017). Dynamic quotation of leadtime and price for a Make-To-Order system with multiple customer classes and perfect information on customer preferences. European Journal of Operational Research, 258(1), 334–342. https://doi.org/10.1016/j.ejor.2016.08.050

100. Fernandes, N. O., Silva, C., & Carmo-Silva, S. (2015). Order release in the hybrid MTO-FTO production. International Journal of Production Economics, 170, 513–520. https://doi.org/10.1016/j.ijpe.2015.03.025

101. Fiksel, J. (2017). Sustainability and resilience : toward a systems approach. Sustainability: Science, Practice and Policy ISSN:, 7733(December). https://doi.org/10.1080/15487733.2006.11907980

102. Fortunet, C., Durieux, S., Chanal, H., & Duc, E. (2018). DFM method for aircraft structural parts using the AHP method. International Journal of Advanced Manufacturing T echnology, 95(1–4), 397–408. https://doi.org/10.1007/s00170-017-1213-1

103. Forza, C. (2002). Survey research in operations management : a process-based perspective. International Journal of Operations & Production Management, 22(2), 152–194. https://doi.org/10.1108/01443570210414310

104. Fountzoula, C., & Aravossis, K. (2021). Analytic Hierarchy Process and its Applications in the Public Sector : A Review. Academy of Accounting and Financial Studies Journal, 25(6), 1–15.

105. Franciosi, C., Voisin, A., Miranda, S., Riemma, S., & Iung, B. (2020). Measuring maintenance impacts on sustainability of manufacturing industries : from a systematic literature review to a framework proposal. Journal of Cleaner Production, 260, 121065. https://doi.org/10.1016/j.jclepro.2020.121065

106. Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. International Journal of Production Economics, 210 (September 2018), 15–26. https://doi.org/10.1016/j.ijpe.2019.01.004

107. Frutos, J. D., & Borenstein, D. (2004). A framework to support customer – company interaction in mass customization environments. Computers in Industry, 54, 115–135. https://doi.org/10.1016/j.compind.2003.09.004

108. Gallien, J., Le Tallec, Y. and Schoenmeyr, T., 2004. A model for make-to-order

revenue management. Sloan School of Management, Massachusetts Institute of Technology.

109. Garetti, M., & Taisch, M. (2012). Production Planning & Control : The Management of Operations Sustainable manufacturing : trends and research challenges. Taylor & Francis, June 2013, 37–41.

110. Garmdare, H. S., Lotfi, M. M., & Honarvar, M. (2018). Integrated model for pricing, delivery time setting, and scheduling in make-to-order environments. Journal of Industrial Engineering International, 14(1), 55–64. https://doi.org/10.1007/s40092-017-0205-y

111. Gebler, M., Uiterkamp, A. J. M. S., & Visser, C. (2014). A global sustainability perspective on 3D printing technologies. Energy Policy, 1–10. https://doi.org/10.1016/j.enpol.2014.08.033

112. Geroski, P. A., Place, S., Park, R., Commission, T. C., & Court, N. (2003). Competition in Markets and Competition for Markets *. Journal of Industry, Competition and Trade, 151–166.

113. Gharehgozli, A. H., Rabbani, M., Zaerpour, N., & Razmi, J. (2008). A comprehensive decision-making structure for acceptance/rejection of incoming orders in make-to-order environments. International Journal of Advanced Manufacturing Technology, 39(9–10), 1016–1032. https://doi.org/10.1007/s00170-007-1275-6

114. Ghelase, D., Daschievici, L., Marinescu, V., & Epureanu, A. (2013). Method for control of the make-to-order manufacturing system on the base of earning power assessment. International Journal of Advanced Manufacturing Technology, 65(9–12), 1439–1458. https://doi.org/10.1007/s00170-012-4269-y

115. Gonçalves Filho, E. V., & Marçola, J. A. (2001). Annualized hours as a capacity planning tool in make-to-order or assemble-to-order environment: An agricultural implements company case. Production Planning and Control, 12(4), 388–398. https://doi.org/10.1080/09537280152005012

116. Gong, S., Ardeshiri, A., & Rashidi, T. H. (2020). Impact of government incentives on the market penetration of electric vehicles in Australia. Transportation Research Part D, 83, 102353. https://doi.org/10.1016/j.trd.2020.102353

117. Gordon, L. A., Loeb, M. P., & Tseng, C. (2009). J . Account . Public Policy Enterprise risk

management and firm performance : A contingency perspective. Journal of Accounting and Public Policy, 28(4), 301–327. https://doi.org/10.1016/j.jaccpubpol.2009.06.006

118. Guillaume, R., Grabot, B., & Thierry, C. (2013). Management of the risk of backorders in a MTO-ATO/MTS context under imperfect requirements. Applied Mathematical Modelling, 37(16–17), 8060–8078. https://doi.org/10.1016/j.apm.2013.03.019

119. Günalay, Y. (2011). Efficient management of production-inventory system in a multi-item manufacturing facility: MTS vs. MTO. International Journal of Advanced Manufacturing Technology, 54(9–12), 1179–1186. https://doi.org/10.1007/s00170-010-2984-9

120. Gunasekaran, A., & Ngai, E. W. T. (2005). Build-to-order supply chain management: A literature review and framework for development. Journal of Operations Management, 23(5), 423–451. https://doi.org/10.1016/j.jom.2004.10.005

121. Gunasekaran, Angappa, & Spalanzani, A. (2012). Int . J . Production Economics Sustainability of manufacturing and services : Investigations for research and applications. Intern. Journal of Production Economics, 140(1), 35–47. https://doi.org/10.1016/j.ijpe.2011.05.011

122. Gunasekaran, Angappa, Yusuf, Y. Y., & Adeleye, E. O. (2017). Agile manufacturing practices : the role of big data and business analytics with multiple case studies. International Journal of Production Research, 7543(October), 1–13. https://doi.org/10.1080/00207543.2017.1395488

123. Guo, R., & Wu, Z. (2023). Social sustainable supply chain performance assessment using hybrid fuzzy - AHP – DEMATEL – VIKOR : a case study in manufacturing enterprises. Environment, Development and Sustainability, 25(11), 12273–12301. https://doi.org/10.1007/s10668-022-02565-3

124. Ha, Y., & Woo, S.-H. (2022). Transportation Infrastructure or Economic Power ? Development of the Automobile Industry in the United States. Sustainability. https://doi.org/10.3390/ su14031649

125. Hair, J F, Risher, J. J., Sarstedt, M., & Ringle, C. M. (2018). The Results of PLS-SEM Article information. European Business Review, 31(1), 2–24.

126. Hair, Joe F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. Journal of Business Research, 109(August 2019), 101–110. https://doi.org/10.1016/j.jbusres.2019.11.069

127. Hair, Joe F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. Journal of Marketing Theory and Practice, 19(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

128. Hair, Joe F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. European Business Review, 26(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128

129. Hair, Joe F, Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. Journal of the Academy of Marketing Science, 40, 414–433. https://doi.org/10.1007/s11747-011-0261-6

130. Hammami, R., Frein, Y., & Albana, A. S. (2020). Delivery time quotation and pricing in two-stage supply chains : Centralized decision-making with global and local managerial approaches. European Journal of Operational Research, 286, 164–177. https://doi.org/10.1016/j.ejor.2020.03.006

131. Han, S., Reinartz, W., & Skiera, B. (2021). Capturing Retailers ' Brand and Customer Focus. Journal of Retailing, 97(4), 582–596. https://doi.org/10.1016/j.jretai.2021.01.001

132. Hao, S., & Song, M. (2015). Technology-driven strategy and fi rm performance : Are strategic capabilities missing links ? ☆. Journal of Business Research. https://doi.org/10.1016/j.jbusres.2015.07.043

133. Hart, C. W. L. (1995). Mass customization: Conceptual underpinnings, opportunities and limits. International Journal of Service Industry Management, 6(2), 36–45. https://doi.org/10.1108/09564239510084932

134. Haskose, A., Kingsman, B. G., & Worthington, D. (2004). Performance analysis of make-to-order manufacturing systems under different workload control regimes. International Journal of Production Economics, 90(2), 169–186. https://doi.org/10.1016/S0925-5273(03)00052-5

135. He, N., Zhang, D. Z., & Li, Q. (2014). Agent-based hierarchical production planning

and scheduling in make-to-order manufacturing system. International Journal of Production Economics, 149, 117–130. https://doi.org/10.1016/j.ijpe.2013.08.022

136. Hemmati, S., Ebadian, M., & Nahvi, A. (2012). A new decision making structure for managing arriving orders in MTO environments. Expert Systems with Applications, 39(3), 2669–2676. https://doi.org/10.1016/j.eswa.2011.08.122

137. Hemmati, S., Rabbani, M., & Ebadian, M. (2009). Positioning of order penetrating point in hybrid MTS/MTO environments. EMS 2009 - UKSim 3rd European Modelling Symposium on Computer Modelling and Simulation, 263–268. https://doi.org/10.1109/EMS.2009.82

138. Hemmati, Samira, & Rabbani, M. (2010). Make-to-order/make-to-stock partitioning decision using the analytic network process. International Journal of Advanced Manufacturing Technology, 48(5–8), 801–813. https://doi.org/10.1007/s00170-009-2312-4

139. Hendry, L. C., & Kingsman, B. G. (1993). Customer enquiry management: Part of a hierarchical system to control lead times in make-to-order companies. Journal of the Operational Research Society, 44(1), 61–70. https://doi.org/10.1057/jors.1993.7

140. Hendry, L., Land, M., Stevenson, M., & Gaalman, G. (2008). Investigating implementation issues for workload control (WLC): A comparative case study analysis. International Journal of Production Economics, 112(1), 452–469. https://doi.org/10.1016/j.ijpe.2007.05.012

141. Hendry, M. S. & L. C. (2007). Production Planning & Control : The Management of Improving supply chain integration using a workload control concept and web-functionality. Production Planning & Control: The Management of Operations, 18(2), 142–155. https://doi.org/10.1080/09537280600965785

142. Henseler, J., Hubona, G., & Ash, P. (2016). Using PLS path modeling in new technology research : updated guidelines. https://doi.org/10.1108/IMDS-09-2015-0382

143. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43, 115–135. https://doi.org/10.1007/s11747-014-0403-8

144. Henseler, J., & Sarstedt, M. (2013). Goodness-of-fit indices for partial least squares path modeling. Computational Statistics, 28, 565–580. https://doi.org/10.1007/s00180-012-0317-1

145. Herbots, J., Herroelen, W., & Leus, R. (2010). Single-pass and approximate dynamic-programming algorithms for order acceptance and capacity planning. Journal of Heuristics, 189–209. https://doi.org/10.1007/s10732-008-9096-9

146. Heshmat, M., El-Sharief, M. A., & Sebaie, M. G. E.-. (2013). Simulation modeling of production lines: a case study of cement production line. Journal of Engineering Sciences, 1045–1053.

147. Ho, C. F., Tai, Y. M., & Lee, M. X. (2007). Information sharing and coordination mechanism for supply chain management: A case study of the automotive industry. 2007 International Conference on Wireless Communications, Networking and Mobile Computing, WiCOM 2007, 4862–4865. https://doi.org/10.1109/WICOM.2007.1193

148. Hong, J., Zhang, Y., & Ding, M. (2018). Sustainable supply chain management practices, supply chain dynamic capabilities, and enterprise performance. Journal of Cleaner Production, 172, 3508–3519. https://doi.org/10.1016/j.jclepro.2017.06.093

149. Hosseini, S. M., Bahadori, M., Raadabadi, M., & Ravangard, R. (2019). Ranking Hospitals Based on the Disasters Preparedness Using the TOPSIS Technique in Western Iran. Hospital Topics, 97(1), 23–31. https://doi.org/10.1080/00185868.2018.1556571

150. Hsu, S., & Chen, C. (2009). Replenishment and lead time decisions in manufacturer retailer chains. Transportation Research Part E, 45(3), 398–408. https://doi.org/10.1016/j.tre.2008.10.005

151. Hulland, J., Ryan, M. J., & Rayner, R. K. (2010). Modeling Customer Satisfaction : A Comparative Performance Evaluation of Covariance Structure Analysis Versus Partial Least Squares. Handbook OfPartial Least Squares, Springer Handbooks of Computational Statistics, 307–325. https://doi.org/10.1007/978-3-540-32827-8

152. Husain, Z., Dayan, M., & Di Benedetto, C. A. (2022). Impact of customer focus on technology leadership via technology development capability – a moderated mediation model. Journal of Business & Industrial Marketing, 37(2), 282–293. https://doi.org/10.1108/JBIM-04-2020-0186

153. Hutter, T., Haeussler, S., & Missbauer, H. (2018). Successful implementation of an order release mechanism based on workload control: a case study of a make-to-stock manufacturer. International Journal of Production Research, 56(4), 1565–1580. https://doi.org/10.1080/00207543.2017.1369598

154. Ibrahim, H., Bo, M., & Zu, G. (2011). Computers in Industry Simulation-supported change process for product customization – A case study in a garment company. 62, 568–577. https://doi.org/10.1016/j.compind.2011.04.006

155. Ioannou, G., & Dimitriou, S. (2012). Int . J . Production Economics Lead time estimation in MRP / ERP for make-to-order manufacturing systems. Intern. Journal of Production Economics, 139(2), 551–563. https://doi.org/10.1016/j.ijpe.2012.05.029

156. Iqbal, S., Martins, M., Mata, N., Naz, S., & Akhtar, S. (2021). Linking Entrepreneurial Orientation with Innovation Performance in SMEs ; the Role of Organizational Commitment and Transformational Leadership Using Smart PLS-SEM. Sustainability (Switzerland), 1–18. https://doi.org/10.3390/ su13084361

157. Islam, M. Z., & Zhe, Z. (2022). The effect of customer orientation on financial performance in service firms: The mediating role of service innovation. Management Science Letters, 12, 101–116. https://doi.org/10.5267/j.msl.2021.10.003

158. Islamgaleyev, A., Petrova, M., Kurenkeyeva, G., Shalbayeva, S., & Kadirbergenova, A. (2020). Increasing Customer Focus in Metal Trading. Entrepreneurship and Sustainability Issues, 8(1), 604–617.http://doi.org/10.9770/jesi.2020.8.1(42)%0AJEL

159. Jabbar, A., Akhtar, P., & Dani, S. (2019). Real-time big data processing for instantaneous marketing decisions : A problematization approach. Industrial Marketing Management, November 2018, 0–1. https://doi.org/10.1016/j.indmarman.2019.09.001

160. Jahangirian, M., Eldabi, T., Naseer, A., Stergioulas, L. K., & Young, T. (2010). Simulation in manufacturing and business: A review. European Journal of Operational Research, 203(1), 1–13. https://doi.org/10.1016/j.ejor.2009.06.004

161. Jain, P., Garg, S., & Kansal, G. (2021). A TISM approach for the analysis of enablers in implementing mass customization in Indian manufacturing units. Production Planning and Control, 0(0), 1–16. https://doi.org/10.1080/09537287.2021.1900616

162. Jain, P., Garg, S., & Kansal, G. (2022). Implementation of mass customization for

competitive advantage in Indian industries: an empirical investigation. The International Journal of Advanced Manufacturing Technology, 737–752. https://doi.org/10.1007/s00170-022-09324-8

163. Jeon, S. M., & Kim, G. (2016). A survey of simulation modeling techniques in production planning and control (PPC). Production Planning and Control, 27(5), 360–377. https://doi.org/10.1080/09537287.2015.1128010

164. 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. https://doi.org/10.1080/00207543.2012.720727

165. Jo, M., Nakamoto, K., & Nelson, J. E. (2003). The shielding effects of brand image against lower quality countries-of-origin in global manufacturing. Journal of Business Research, 56, 637–646. https://doi.org/10.1016/S0148-2963(01)00307-1

166. Jones, J., Corral, G., & Zubielqui, D. (2016). Technological Forecasting & Social Change Doing well by doing good : A study of university-industry interactions, innovationess and firm performance in sustainability-oriented Australian SMEs. Technological Forecasting & Social Change. https://doi.org/10.1016/j.techfore.2016.07.036

167. Jr, E. P. R., Sahin, F., & Gao, L.-L. (2005). The Impact of E-Replenishment Strategy on Make-to-Order Supply Chain Performance. Decision Sciences, 36(1), 33–64.

168. Kaburu, R. W., Karanja, G. W., Wagoki, A. J., & Daniel, M. (2021). Influence of Customer Orientation on the Growth of Manufacturing Firms in Nakuru East and West Sub- Counties Kenya. The International Journal of Business Management and Technology, 5(4), 129–138.

169. Kafashi, S. (2011). Integrated setup planning and operation sequencing (ISOS) using genetic algorithm. International Journal of Advanced Manufacturing Technology, 56, 589–600. https://doi.org/10.1007/s00170-011-3202-0

170. Kalantari, M., Rabbani, M., & Ebadian, M. (2011). A decision support system for order acceptance/rejection in hybrid MTS/MTO production systems. Applied Mathematical Modelling, 35(3), 1363–1377. https://doi.org/10.1016/j.apm.2010.09.015

171. Kampker, A., Bergweiler, G., Bichler, M., Hansen, J. O., Paulus, T. C., & Eser, T. (2019). Identifying and evaluating flexible approaches for automobile body

production areas. E3S Web of Conferences, ICPEME, 01007, 95.

172. Kamran, M., Hai, K., Trinh, H., & Ullah, I. (2022). Sustainable economic activities , climate change , and carbon risk : an international evidence. Environment, Development and Sustainability, 24(7), 9642–9664. https://doi.org/10.1007/s10668-021-01842-x

173. Kang, M. J., Wu, Z., & Hwang, H. J. (2021). A Study on the Mediating Effect of Customer Orientation between O2O Service Quality and Customers ' Perceived Service Satisfaction. Journal of Distribution Science, 19(2), 37–44. http://dx.doi.org/10.15722/jds.19.2.202102.37

174. Kaur, A. (2017). Social sustainability in supply chain decisions : Indian manufacturers. Environment, Development and Sustainability. https://doi.org/10.1007/s10668-017-9961-5

175. Kerkka, A. (2007). Determining semi-finished products to be stocked when changing the MTS-MTO policy : Case of a steel mill. International Journal of Production Economics, 108, 111–118. https://doi.org/10.1016/j.ijpe.2006.12.006

176. Khakdaman, M., Wong, K. Y., Zohoori, B., Tiwari, M. K., & Merkert, R. (2015). Tactical production planning in a hybrid Make-to-Stock-Make-to-Order environment under supply, process and demand uncertainties: A robust optimisation model. International Journal of Production Research, 53(5), 1358–1386. https://doi.org/10.1080/00207543.2014.935828

177. Khoshnevis, D. N. . S. and B. (2003). Generation of alternative process plans in integrated manufacturing systems. Journal of Intelligent Manufacturing, 14, 509–526.

178. Khurana, S., Haleem, A., & Mannan, B. (2019). Determinants for integration of sustainability with innovation for Indian manufacturing enterprises : Empirical evidence in MSMEs. Journal of Cleaner Production, 229, 374–386. https://doi.org/10.1016/j.jclepro.2019.04.022

179. Kidwell. (2005). Journal of Applied Management and Entrepreneurship. The Journal of Applied Management and Entrepreneurship, 10(3), 87–96.

180. Kim, E., & Van Oyen, M. P. (2021). Joint admission, production sequencing, and production rate control for a two-class make-to-order manufacturing system. Journal of Manufacturing

Systems, 59(March), 413–425. https://doi.org/10.1016/j.jmsy.2021.03.010

181. Kim, M., Ahn, J., Kang, J., & Kim, S. (2020). A Systematic Review on Smart Manufacturing in the Garment Industry. Fashion & Textile Research Journal, 22(5), 660–675. doi: https://doi.org/10.5805/SFTI.2020.22.5.660

182. Kingsman, B., & Hendry, L. (2002). The relative contributions of input and output controls on the performance of a workload control system in make-to-order companies. Production Planning and Control, 13(7), 579–590. https://doi.org/10.1080/0953728021000026285

183. Kingsman, B., Hendry, L., Mercer, A., & De Souza, A. (1996). Responding to customer enquiries in make-to-order companies Problems and solutions. International Journal of Production Economics, 46–47, 219–231. https://doi.org/10.1016/0925-5273(95)00199-9

184. Kingsman, B G, & Hendry, L. (1989). Production planning systems and their applicability to make-to-order companies. European Journal Of Operational Research, 40(1), 1–15. http://eprints.lancs.ac.uk/44244/

185. Kingsman, Brian G. (2000). Modelling input - output workload control for dynamic capacity planning in production planning systems. International Journal of Production Economics, 68, 73–93.

186. König, S., Reihn, M., & Abujamra, F. G. (2022). Flexible scheduling of diagnostic tests in automotive manufacturing. Flexible Services and Manufacturing Journal.

187. Konstantas, D., Ioannidis, S., Kouikoglou, V. S., & Grigoroudis, E. (2018). Linking product quality and customer behavior for performance analysis and optimization of make-to-order manufacturing systems. International Journal of Advanced Manufacturing Technology, 95(1–4), 587–596. https://doi.org/10.1007/s00170-017-1225-x

188. Kumar, V. and Reinartz, W. (2018). CRM : Conceptual Foundation. Customer Relationship Management: Concepts, Strategy, and Tools, 3rd Ed., Springer, Heidelberg, 17.

189. Kura, K. M., Shamsudin, F. M., & Chauhan, A. (2015). Does Self-Regulatory Efficacy Matter ? Effects of Punishment Certainty and Punishment Severity on Organizational

Deviance. SAGE Open, 1–14. https://doi.org/10.1177/2158244015591822

190. Lampón, J. F., Cabanelas, P., & González-benito, J. (2017). The Management of Operations The impact of modular platforms on automobile manufacturing networks. Production Planning & Control, 7287(February), 1–14. https://doi.org/10.1080/09537287.2017.1287442

191. Larcker, C. F. and D. F. (1981). Unobservable Variables and Measurement Error : Algebra and Statistics. XVIII(August), 382–388.

192. Lee, S. M., & Lee, D. (2019). " Untact ": a new customer service strategy in the digital age. Service Business, 0123456789. https://doi.org/10.1007/s11628-019-00408-2

193. Leguina, A. (2015). A primer on partial least squares structural equation modeling (PLS-SEM). International Journal of Research & Method in Education, February. https://doi.org/10.1080/1743727X.2015.1005806

194. Leung, K. H., Lau, H. C. W., Nakandala, D., Kong, X. T. R., & Ho, G. T. S. (2020). Standardising fresh produce selection and grading process for improving quality assurance in perishable food supply chains : an integrated Fuzzy AHP-TOPSIS framework. Enterprise Information Systems. https://doi.org/10.1080/17517575.2020.1790041

195. Li, H., & Womer, K. (2012). Optimizing the supply chain configuration for make-to-order manufacturing. European Journal of Operational Research, 221(1), 118–128. https://doi.org/10.1016/j.ejor.2012.03.025

196. Li, Y., Cheng, Y., Hu, Q., Zhou, S., Ma, L., & Lim, M. K. (2019). The influence of additive manufacturing on the configuration of make-to-order spare parts supply chain under heterogeneous demand. International Journal of Production Research, 57(11), 3622–3641. https://doi.org/10.1080/00207543.2018.1543975

197. Li, Y., Haleem, F., Cheng, Y., & Farooq, S. (2020). The Management of Operations The impact of corporate social responsibility practices on sustainability performance in manufacturing networks : the moderating effect of interplant coordination. Production Planning and Control, 0(0), 1–15. https://doi.org/10.1080/09537287.2020.1856955

198. Liu, G. J., Shah, R., & Schroeder, R. G. (2015). The relationships among functional integration , mass customisation , and firm performance. International Journal of Production Research, 50(3), 677–690. https://doi.org/10.1080/00207543.2010.537390

199. Liu, H., Wei, S., Ke, W., Wei, K. K., & Hua, Z. (2016). The configuration between supply chain integration and information technology competency: A resource orchestration perspective. Journal of Operations Management, 44, 13–29. https://doi.org/10.1016/j.jom.2016.03.009

200. Lödding, H., & Koch, C. (2020). The Management of Operations Value stream analysis and design for make-to- order companies. Production Planning and Control, 0(0), 1–13. https://doi.org/10.1080/09537287.2020.1735008

201. Luthra, S., Garg, D., & Haleem, A. (2015). An analysis of interactions among critical success factors to implement green supply chain management towards sustainability : An Indian perspective. Resources Policy, 1–14. https://doi.org/10.1016/j.resourpol.2014.12.006

202. Lyon, D. W., & Ferner, J. (2015). With Product-Market Enhancing Performance Innovation : The Influence Of The Top Management Team. Journal of Managerial Issues, 14(4), 452–469. http://www.jstor.org/stable/40604404

203. Macnaghten, P., & Jacobs, M. (1997). Public identification with sustainable development Investigating cultural barriers to participation. Global Environmental Change, 7(1), 5–24. https://doi.org/10.1016/S0959-3780(96)00023-4

204. Madhani, P. M. (2020). Building a Customer Focused Strategy: Developing Conceptual Frameworks and Research Propositions. SCMS Journal of Indian Management, 17(3), 5–25.

205. Maklan, S. (2011). Customer experience Are we measuring the right things ? International Journal of Market Research, 53(6), 771–792. https://doi.org/10.2501/IJMR-53-6-771-792

206. Manishimwe, T., Raimi, L., & Azubuike, C. J. (2022). Customer - centric influence of entrepreneurial marketing on business performance of hotels in Nigeria during the COVID - 19 crisis. Journal of Revenue and Pricing Management, 668–683.

207. Marefat, R. R. and M. M. (2004). Integrated process planning using tool / process capabilities and heuristic search. Journal of Intelligent Manufacturing, 15, 141–174.

208. Marta, M. S., Hurriyati, R., & Dewi, P. (2021). How to Understand Customer Needs? The role of Market Orientation, Innovation Capability, and Learning Orientation.

Journal of Management and Business, 4(2), 95–109.

209. Martinelli, R., Cristina Martins Queiroz Mariano, F., & Bertini Martins, C. (2022). Single machine scheduling in make to order environments: A systematic review. Computers and Industrial Engineering, 169. https://doi.org/10.1016/j.cie.2022.108190

210. Matricano, D., & Matricano, D. (2020). Technology Analysis & Strategic Management The effect of R & D investments , highly skilled employees , and patents on the performance of Italian innovative startups patents on the performance of Italian innovative startups. Technology Analysis & Strategic Management, 0(0), 1–14. https://doi.org/10.1080/09537325.2020.1757057

211. Mcafee, A. (2002). The impact of enterprise information technology adoption on operational performance: An empirical investigation. Production and Operations Management, 11(1), 33–53. https://doi.org/10.1111/j.1937-5956.2002.tb00183.x

212. Meadows, M., & Dibb, S. (2012). Progress in customer relationship management adoption : a cross-sector study. Journal of Strategic Marketing, 20(4), 323–344. https://doi.org/10.1080/0965254X.2012.671337

213. Men, F., Dong, F., Liu, Y., & Yang, H. (2023). Research on the Impact of Digital Transformation on the Product R & D Performance of Automobile Enterprises from the Perspective of the Innovation Ecosystem. Sustainability (Switzerland), 15(6265). https://doi.org/10.3390/ su15076265

214. Mendes, L., & Machado, J. (2015). Employees ' skills , manufacturing fl exibility and performance : a structural equation modelling applied to the automotive industry. International Journal of Production Research, 53(13), 4087–4101. https://doi.org/10.1080/00207543.2014.993772

215. Mezzogori, D., Romagnoli, G., & Zammori, F. (2020). job - shops managed by workload control. In Flexible Services and Manufacturing Journal (Issue 0123456789). Springer US. https://doi.org/10.1007/s10696-020-09396-2

216. Min, J., Id, S. I., Aamir, M., Khan, S., & Akhtar, S. (2020). Impact of supervisory behavior on sustainable employee performance : Mediation of conflict management strategies using PLS-SEM. PLOS ONE, 1–20. https://doi.org/10.1371/journal.pone.0236650

217. Mohammadi, S., Al-e-Hashem, S. M. J. M., & Rekik, Y. (2020). An integrated production scheduling and delivery route planning with multi-purpose machines: A case study from a furniture manufacturing company. International Journal of Production Economics, 219 (April 2019), 347–359. https://doi.org/10.1016/j.ijpe.2019.05.017

218. Mohanty, A. R. R. P., & Barlow, A. C. L. N. (2005). Performance management through strategic total productivity optimisation. International Journal of Advanced Manufacturing Technology, 25, 1020–1028. https://doi.org/10.1007/s00170-003-1936-z

219. Moodie, R. (1999). Demand management : the evaluation of price and 1 due date negotiation strategies. Production and Operations Management, 8(2), 151–162.

220. Moody, W. B. (2020). Beyond computation: Information Technology, Organizational Transformation and Business Performance. Journal of Economic Perspectives, 14(4), 23–48. https://doi.org/10.5951/at.22.1.0022

221. Mujahid, A., Akhtar, P., Haq, M. A., Mani, V., Arsenyan, G., & Meyer, M. (2021). Technological Forecasting & Social Change Real-time information sharing , customer orientation , and the exploration of intra-service industry differences : Malaysia as an emerging market. Technological Forecasting & Social Change, 167(February), 120684. https://doi.org/10.1016/j.techfore.2021.120684

222. Mujahid, A., & Mani, V. (2019). International Journal of Information Management Role of real-time information-sharing through SaaS : An industry 4 . 0 perspective. International Journal of Information Management, 49(May), 301–315. https://doi.org/10.1016/j.ijinfomgt.2019.05.026

223. Muriana, C. (2016). An EOQ model for perishable products with fixed shelf life under stochastic demand conditions. European Journal of Operational Research. https://doi.org/10.1016/j.ejor.2016.04.036

224. Murugan, R. P., & Ramalingam, P. (2019). managing the change in sales and operations planning in a customer configured business scenario in commercial vehicles industry. Journal of Emerging Technologies and Innovative Research, 6(5), 500–505.

225. Nadagouda, M. N., Ginn, M., & Rastogi, V. (2020). ScienceDirect A review of 3D printing techniques for environmental applications. Current Opinion in Chemical Engineering, 28, 173–178. https://doi.org/10.1016/j.coche.2020.08.002

226. Najafi, A., Karimpour, M. H., & Ghaderi, M. (2014). Application of fuzzy AHP method to IOCG prospectivity mapping: A case study in Taherabad prospecting area, eastern Iran. International Journal of Applied Earth Observation and Geoinformation, 33(1), 142–154. https://doi.org/10.1016/j.jag.2014.05.003

227. Neneh, B. N. (2018). Article information : Customer orientation and SME performance : the role of networking ties. African Journal of Economic and Management Studies. https://doi.org/10.1108/AJEMS-03-2017-0043

228. Noori-daryan, M., Taleizadeh, A. A., & Jolai, F. (2018). Analyzing Pricing, Promised Delivery Lead time, Supplier-Selection, and Ordering Decisions of a Multi-National Supply Chain under Uncertain Environment. International Journal of Production Economics. https://doi.org/10.1016/j.ijpe.2017.12.019

229. Noori, M., & Tatari, O. (2016). Development of an agent-based model for regional market penetration projections of electric vehicles in the United States. Energy, 96, 215–230. https://doi.org/10.1016/j.energy.2015.12.018

230. Ocampo, L. A. (2019). Applying fuzzy AHP–TOPSIS technique in identifying the content strategy of sustainable manufacturing for food production. Environment, Development and Sustainability, 21(5), 2225–2251. https://doi.org/10.1007/s10668-018-0129-8

231. Oğuz, C., Sibel Salman, F., & Bilgintürk Yalçin, Z. (2010). Order acceptance and scheduling decisions in make-to-order systems. International Journal of Production Economics, 125(1), 200–211. https://doi.org/10.1016/j.ijpe.2010.02.002

232. Olhager, J. (2003). Strategic positioning of the order penetration point. International Journal of Production Economics, 85(3), 319–329. https://doi.org/10.1016/S0925-5273(03)00119-1

233. Oliveira, G. A., Tan, K. H., & Guedes, B. T. (2018). Lean and green approach: An evaluation tool for new product development focused on small and medium enterprises. International Journal of Production Economics, 205, 62–73. https://doi.org/10.1016/j.ijpe.2018.08.026

234. Osterrieder, P., Budde, L., & Friedli, T. (2020). International Journal of Production Economics The smart factory as a key construct of industry 4 . 0 : A systematic literature review. Intern. Journal of Production Economics, 221(August 2019),

107476. https://doi.org/10.1016/j.ijpe.2019.08.011

235. Özkan, B., BaŠligil, H., & Şahin, N. (2011). Supplier selection using Analytic Hierarchy Process: An application from Turkey. Proceedings of the World Congress on Engineering 2011, WCE 2011, 2, 1160–1165.

236. Pan, T., Zhang, Z. H., & Cao, H. (2014). Collaborative production planning with production time windows and order splitting in make-to-order manufacturing. Computers and Industrial Engineering, 67(1), 1–9. https://doi.org/10.1016/j.cie.2013.10.006

237. Park, S., Lee, T. E., & Sung, C. S. (2010). A three-level supply chain network design model with risk-pooling and lead times. Transportation Research Part E: Logistics and Transportation Review, 46(5), 563–581. https://doi.org/10.1016/j.tre.2009.12.004

238. Patel, M., & Patel, N. (2019). Exploring Research Methodology : Review Article. International Journal of Research and Review, 6(3).

239. Peeters, K., & van Ooijen, H. (2020). Hybrid make-to-stock and make-to-order systems: a taxonomic review. International Journal of Production Research, 58(15), 4659–4688. https://doi.org/10.1080/00207543.2020.1778204

240. Pekovic, S. Rolland, S. (2016). model of environmental customer innovation and contextual factors Customer orientation and firm ' s business performance A moderated mediation model of. European Journal of Marketing, 50(12), 2162–2191. https://doi.org/10.1108/EJM-08-2015-0584

241. Pinar Keskinocak, R. Ravi, S. T. (2001). Scheduling and Reliable Lead-Time Quotation for Orders with Availability Intervals and Lead-Time Sensitive Revenues. Management Science, 47(June 2015), 264–279.

242. Powell, L. (2006). Shedding a tier : flattening organisational structures and employee empowerment. International Journal of Educational Management, 16(1), 54–59. https://doi.org/10.1108/09513540210415541

243. Prajogo, D. I. (2015). Author ' s Accepted Manuscript performance. Intern. Journal of Production Economics. https://doi.org/10.1016/j.ijpe.2015.07.037

244. Pramod, M., & Garg, S. (2006). Analysis of flexibility requirements under uncertain

environments. Journal of Modelling in Management, 1(3), 196–214. https://doi.org/10.1108/17465660610715203

245. Prasad, S., Tata, J., & Madan, M. (2005). Build to order supply chains in developed and developing countries. 23, 551–568. https://doi.org/10.1016/j.jom.2004.10.011

246. Propfe, B., Kreyenberg, D., Wind, J., & Schmid, S. (2013). Market penetration analysis of electric vehicles in the German passenger car market towards 2030. International Journal of Hydrogen Energy, 38(13), 5201–5208. https://doi.org/10.1016/j.ijhydene.2013.02.049

247. Purvis, B. (2018). Three pillars of sustainability : in search of conceptual origins. Sustainability Science, 5. https://doi.org/10.1007/s11625-018-0627-5

248. Qiu, S., Ming, X., Sallak, M., & Lu, J. (2021). Joint optimization of production and condition-based maintenance scheduling for make-to-order manufacturing systems. Computers and Industrial Engineering, 162. https://doi.org/10.1016/j.cie.2021.107753

249. Rabbani, M., Bagherzadeh, N., & Rafiei, H. (2014). Calculating raw material and work-in-process inventories in MTO / MTS production. Journal of Research in Science, Engineering and Technology, 2(3), 109-16.

250. Rabbani, M., & Dolatkhah, M. (2017). Simultaneous production planning of make-to-order (MTO) and make-to-stock (MTS) products using simulation optimization. Case study: Soren Restaurant. International Journal of Advanced Logistics, 6(1), 30–44. https://doi.org/10.1080/2287108x.2017.1361290

251. Rafiei, H., & Rabbani, M. (2009). Order partitioning in hybrid MTS/MTO contexts using fuzzy ANP. World Academy of Science, Engineering and Technology, 58, 467–471. https://doi.org/10.5281/zenodo.1332109

252. Rafiei, H., & Rabbani, M. (2012). Capacity coordination in hybrid make-to-stock/make-to-order production environments. International Journal of Production Research, 50(3), 773–789. https://doi.org/10.1080/00207543.2010.543174

253. Rajesh, G., & Malliga, P. (2013). Supplier selection based on AHP QFD methodology. Procedia Engineering, 64, 1283–1292. https://doi.org/10.1016/j.proeng.2013.09.209

254. Rana, V. S., & Lokhande, M. A. (2015). A Study of Consumer Preferences & Attitude

towards Passenger cars of Maruti Suzuki & Hyundai Motors in Marathwada Region of Maharashtra. Pratibha: International Journal of Science, Spirituality, Business and Technology (Ijssbt), 3(2), 2277–7261.

255. Rao, R. V., & Davim, J. P. (2008). A decision-making framework model for material selection using a combined multiple attribute decision-making method. International Journal of Advanced Manufacturing Technology, 35(7–8), 751–760. https://doi.org/10.1007/s00170-006-0752-7

256. Raturi, A. S., Meredith, J. R., McCutcheon, D. M., & Camm, J. D. (1990). Coping with the build-to-forecast environment. Journal of Operations Management, 9(2), 230–249. https://doi.org/10.1016/0272-6963(90)90097-W

257. Razmi, J., & Sangari, M. S. (2013). A comprehensive decision support system for ERP pre-implementation phase. European Journal of Industrial Engineering, 7(4), 475–496. https://doi.org/10.1504/EJIE.2013.055020

258. Renna, P. (2016). Production control policies for a multistage serial system under MTO-MTS production environment. International Journal of Advanced Manufacturing Technology, 83(1–4), 449–459. https://doi.org/10.1007/s00170-015-7587-z

259. Rosenbusch, N., Brinckmann, J., & Bausch, A. (2011). Journal of Business Venturing Is innovation always bene fi cial ? A meta-analysis of the relationship between innovation and performance in SMEs. Journal of Business Venturing, 26(4), 441–457. https://doi.org/10.1016/j.jbusvent.2009.12.002

260. Rossini, M., Audino, F., Costa, F., Cifone, F. D., Kundu, K., & Portioli-Staudacher, A. (2019). Extending lean frontiers: a kaizen case study in an Italian MTO manufacturing company. International Journal of Advanced Manufacturing Technology, 104(5–8), 1869–1888. https://doi.org/10.1007/s00170-019-03990-x

261. Rowley, J., & Slack, F. (2012). Conducting a Literature Review. Management Research News, 27(6). http://dx.doi.org/10.1108/01409170410784185%0A

262. Rudberg, M., & Wikner, J. (2004). Mass customization in terms of the customer order decoupling point. Production Planning and Control, 15(4), 445–458. https://doi.org/10.1080/0953728042000238764

263. Ryzin, G. J. Van. (2016). Analyzing Inventory Cost and Service in Supply Chains Analyzing Inventory Cost and Service in Supply Chains Garrett J . van Ryzin. Columbia Buisness School, June.

264. Sahin, F., & Robinson, E. P. (2005). Information sharing and coordination in make-to-order supply chains. Journal of Operations Management, 23(6), 579–598. https://doi.org/10.1016/j.jom.2004.08.007

265. Şahin, T., Ocak, S., & Top, M. (2019). Analytic hierarchy process for hospital site selection. Health Policy and Technology, 8(1), 42–50. https://doi.org/10.1016/j.hlpt.2019.02.005

266. Salamati-Hormozi, H., Zhang, Z. H., Zarei, O., & Ramezanian, R. (2018). Trade-off between the costs and the fairness for a collaborative production planning problem in make-to-order manufacturing. Computers and Industrial Engineering, 126, 421–434. https://doi.org/10.1016/j.cie.2018.09.044

267. Samak-kulkarni, M. S. M., & Rajhans, N. R. (2013). Determination of Optimum Inventory Model for Minimizing Total Inventory Cost. Procedia Engineering, 51(NUiCONE 2012), 803–809. https://doi.org/10.1016/j.proeng.2013.01.115

268. Sanchez, R. (2000). Modular architectures , knowledge assets and organizational learning : new management processes for product creation. International Journal of Technology Management, 19(6), 610–629.

269. Santos, M. J. dos, Perin, Marcelo Gattermann Simões, C., & Sampaio, C. H. (2020). Customer orientation and financial performance relationship : the mediating role of innovative capability. Gestão & Produção, 27(4). https://doi.org/10.1590/0104-530X4706-20

270. Sari, E., Ma'aram, A., Shaharoun, A. M., Chofreh, A. G., Goni, F. A., Klemeš, J. J., Marie, I. A., & Saraswati, D. (2021). Measuring sustainable cleaner maintenance hierarchical contributions of the car manufacturing industry. Journal of Cleaner Production, 312(March). https://doi.org/10.1016/j.jclepro.2021.127717

271. Sarstedt, M., Hair, J. F., Cheah, J., Becker, J., & Ringle, C. M. (2019). How to specify , estimate , and validate higher-order constructs in. Australasian Marketing Journal (AMJ), 27(3), 197–211. https://doi.org/10.1016/j.ausmj.2019.05.003

272. Satam, D., Liu, Y., & Lee, H. J. (2015). Intelligent design systems for apparel mass

customization. 5000(September). https://doi.org/10.1080/00405000.2010.482351

273. Saunders, M., Lewis, P., & Thornhill, A. (2019). for business students fi fth edition.

274. Schilling, M. A. (2000). toward a general modular systems theory and its application to interfirm product modularity. Academy of Management Review, 25(2), 312–334.

275. Schmitt, A. J., Sun, S. A., Snyder, L. V., & Shen, Z. J. M. (2015). Centralization versus decentralization: Risk pooling, risk diversification, and supply chain disruptions. Omega (United Kingdom), 52, 201–212. https://doi.org/10.1016/j.omega.2014.06.002

276. Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & Schreiber, J. B. (2013). Modeling and Confirmatory Factor Analysis Results : A Review. September 2013, 37–41. https://doi.org/10.3200/JOER.99.6.323-338

277. Sen, A. (2008). The US fashion industry : A supply chain review. International Journal of Production Economics, 114, 571–593. https://doi.org/10.1016/j.ijpe.2007.05.022

278. Seuring, S., & Gold, S. (2012). Conducting content-analysis based literature reviews in supply chain management. Supply Chain Management: An International Journal, 17(5), 544–555. https://doi.org/10.1108/13598541211258609

279. Shahzad, F., Du, J., Khan, I., Shahbaz, M., & Murad, M. (2020). Untangling the influence of organizational compatibility on green supply chain management efforts to boost organizational performance through information technology capabilities. Journal of Cleaner Production, 266, 122029. https://doi.org/10.1016/j.jclepro.2020.122029

280. Sharma, P., & Singhal, S. (2017). Implementation of fuzzy TOPSIS methodology in selection of procedural approach for facility layout planning. International Journal of Advanced Manufacturing Technology, 88(5–8), 1485–1493. https://doi.org/10.1007/s00170-016-8878-8

281. Shende, V. (2014). Analysis of Research in Consumer Behavior of Automobile Passenger Car Customer. International Journal of Scientific and Research Publications, 4(2), 1–8. http://www.ijsrp.org/research-paper-0214/ijsrp-p2670.pdf

282. Silaparasetti, V., Khan, F. R., Oman, V., Company, P., & Pradesh, A. (2017).

Humanities & Social Science Reviews structural equation modeling analysis using smart pls to assess the occupational health and safety (ohs) factors on workers ’ behavior © Authors Humanities & Social Science Reviews © Authors Electronic. 5(2), 88–97.

283. Sindhwani, R., & Malhotra, V. (2017). A framework to enhance agile manufacturing system: A total interpretive structural modelling (TISM) approach. Benchmarking, 24(2), 467–487. https://doi.org/10.1108/BIJ-09-2015-0092

284. Singholi, A., Ali, M., & Sharma, C. (2012). Impact of manufacturing flexibility on FMS performance: A simulation study. International Journal of Industrial and Systems Engineering, 10(1), 96–116. https://doi.org/10.1504/IJISE.2012.044045

285. Sirisawat, P., & Kiatcharoenpol, T. (2018). Fuzzy AHP-TOPSIS approaches to prioritizing solutions for reverse logistics barriers. Computers and Industrial Engineering, 117(January), 303–318. https://doi.org/10.1016/j.cie.2018.01.015

286. Slotnick, S. A., & Morton, T. E. (2007). Order acceptance with weighted tardiness. Computers & Operations Research 34, 34, 3029–3042. https://doi.org/10.1016/j.cor.2005.11.012

287. Soman, C. A., Van Donk, D. P., & Gaalman, G. (2004). Combined make-to-order and make-to-stock in a food production system SOM-theme A: Primary processes within firms. Int. J. Production Economics, 90, 223–235.

288. Stephany, F., Neuhäuser, L., Braesemann, F., Stoehr, N., Darius, P., & Teutloff, O. (2022). to Covid-19. Humanities and Social SciencesCommunications. https://doi.org/10.1057/s41599-022-01039-1

289. Stevenson, M., Hendry, L. C., & Kingsman, B. G. (2005). A review of production planning and control: The applicability of key concepts to the make-to-order industry. International Journal of Production Research, 43(5), 869–898. https://doi.org/10.1080/0020754042000298520

290. Stevenson, Mark. (2006). Refining a Workload Control (WLC) concept: A case study. International Journal of Production Research, 44(4), 767–790. https://doi.org/10.1080/00207540500338070

291. Streukens, S., & Leroi-Werelds, S. (2016). Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. European Management Journal, 34(6), 618–632. https://doi.org/10.1016/j.emj.2016.06.003

292. Sudarshan, B., & Rao, D. N. (2014). Modular Manufacturing in Garment Industries. International Journal of Engineering Science and Innovative Technology (IJESIT), 2(5).

293. Sukdeo, N. (2017). The effect of the working environment on employee satisfaction and productivity : a case study in a clothing manufacturing factory. International Conference on Industrial Engineering and Operations Management Bogota, 1112–1121.

294. Sun, Q., & Sun, X. (2021). Research on the Technology of Mass Customization of Clothing. International Journal of Modeling and Optimization, 11(3). https://doi.org/10.7763/IJMO.2021.V11.783

295. Sun, X. Y., Ji, P., Sun, L. Y., & Wang, Y. L. (2008). Positioning multiple decoupling points in a supply network. International Journal of Production Economics, 113(2), 943–956. https://doi.org/10.1016/j.ijpe.2007.11.012

296. Švančara, J., & Králová, Z. (2010). Case study on simulation analysis of a multiple product manufacturing system. IFAC Proceedings Volumes (IFAC-PapersOnline), 43(17), 172–177. https://doi.org/10.3182/20100908-3-PT-3007.00033

297. Swain, B., Priyadarshini, M., Mohapatra, S. S., Gupta, R. K., & Behera, A. (2021). Parametric optimization of atmospheric plasma spray coating using fuzzy TOPSIS hybrid technique. Journal of Alloys and Compounds, 867, 159074. https://doi.org/10.1016/j.jallcom.2021.159074

298. Tang, L., & Chen, F. L. (2019). Integrated Scheduling of Production and Two-Stage Delivery of Make-to-Order Products : Offline and Online Algorithms. INFORMS Journal on Computing, 31(3), 493–514. https://doi.org/10.1287/ijoc.2018.0842%0AFull

299. Taylor, P., Emmatty, F. J., & Sarmah, S. P. (2012). Modular product development through platform-based design and DFMA. Journal of Engineering Design, December 2014, 37–41. https://doi.org/10.1080/09544828.2011.653330

300. Taylor, P., Land, M. J., & Gaalman, G. J. C. (2009). Production Planning & Control : The Management of Operations Production planning and control in SMEs : time for change. November 2014, 37–41. https://doi.org/10.1080/09537280903034230

301. Taylor, P., Li, Y., Lin, Q., & Ye, F. (2014). Pricing and promised delivery lead time decisions with a risk-averse agent. International Journal of Production Research, 12(October), 37–41. https://doi.org/10.1080/00207543.2013.871592

302. Teimoury, E., Modarres, M., Khondabi, I. G., & Fathi, M. (2012). A queuing approach for making decisions about order penetration point in multiechelon supply chains. International Journal of Advanced Manufacturing Technology, 63(1–4), 359–371. https://doi.org/10.1007/s00170-012-3913-x

303. Tian, H., Iqbal, S., Akhtar, S., Qalati, S. A., & Anwar, F. (2020). The Impact of Transformational Leadership on Employee Retention : Mediation and Moderation Through Organizational Citizenship Behavior and Communication. Frontiers in Psychology |, 11(March), 1–11. https://doi.org/10.3389/fpsyg.2020.00314

304. Towers, N., Perry, P., & Chen, R. (2013). Corporate social responsibility in luxury manufacturer supply chains An exploratory investigation of a Scottish cashmere garment manufacturer. International Journal of Retail & Distribution Management, 41(11/12), 961–972. https://doi.org/10.1108/IJRDM-05-2013-0100

305. Tripathi, S., & Talukder, B. (2020). Supply Chain Performance and Profitability in Indian Automobile Industry: Evidence of Segmental Difference. Global Business Review. https://doi.org/10.1177/0972150919898302

306. Tseng, M., & Bernard, A. (2013). Product variety management. CIRP Annals - Manufacturing Technology, 62, 629–652. https://doi.org/10.1016/j.cirp.2013.05.007

307. Umer, R., Touqeer, M., Omar, A. H., Ahmadian, A., Salahshour, S., & Ferrara, M. (2021). Selection of solar tracking system using extended TOPSIS technique with interval type-2 pythagorean fuzzy numbers. Optimization and Engineering, 22(4), 2205–2231. https://doi.org/10.1007/s11081-021-09623-1

308. Valase, K., & Raut, D. N. (2019). Mediation analysis of multiple constructs in the relationship between manufacturing and technology and environmental constructs in structural equation model for sustainable manufacturing. International Journal of Advanced Manufacturing Technology, 101(5–8), 1887–1901. https://doi.org/10.1007/s00170-018-2979-5

309. Vavrek, R., & Chovancová, J. (2019). Assessment of economic and environmental energy performance of EU countries using CV-TOPSIS technique. Ecological

Indicators, 106(July), 105519. https://doi.org/10.1016/j.ecolind.2019.105519

310. Vidyarthi, N., Elhedhli, S., & Jewkes, E. (2009). Response time reduction in make-to-order and assemble-to-order supply chain design. IIE Transactions (Institute of Industrial Engineers), 41(5), 448–466. https://doi.org/10.1080/07408170802382741

311. Vinodh, S., Sundararaj, G., Devadasan, S. R., Kuttalingam, D., & Rajanayagam, D. (2010). Amalgamation of mass customisation and agile manufacturing concepts: The theory and implementation study in an electronics switches manufacturing company. International Journal of Production Research, 48(7), 2141–2164. https://doi.org/10.1080/00207540802456257

312. Wadhwa, S., Ducq, Y., Ali, M., & Prakash, A. (2009). Performance analysis of a flexible manufacturing system. Global Journal of Flexible Systems Management, 10(3), 23–34. https://doi.org/10.1007/BF03396564

313. Wan, J., Chen, B., Imran, M., Tao, F., Li, D., Liu, C., & Ahmad, S. (2018). Toward dynamic resources management for IoT-based manufacturing. IEEE Communications Magazine, 56(2), 52–59. https://doi.org/10.1109/MCOM.2018.1700629

314. Wang, S., Wan, J., Zhang, D., Li, D., Zhang, C., Wan, J., Zhang, D., Li, D., & Zhang, C. (2016). Towards Smart Factory for Industry 4.0: A Self-organized Multi-agent System with Big Data Based Feedback and Coordination. Computer Networks: The International Journal of Computer and Telecommunications Networking, 101(C), 158–168. https://doi.org/10.1016/j.comnet.2015.12.017

315. Wang, Zhen, Qi, Y., Cui, H., & Zhang, J. (2019). A hybrid algorithm for order acceptance and scheduling problem in make-to-stock/make-to-order industries. Computers and Industrial Engineering, 127(February), 841–852. https://doi.org/10.1016/j.cie.2018.11.021

316. Wang, Zhichao, Ran, Y., Yu, H., Zhang, S., & Zhang, G. (2020). Precision analysis for five-axis CNC milling machine based on meta-action units and integrated weights with Shannon entropy and AHP. International Journal of Advanced Manufacturing Technology, 107(5–6), 2767–2782. https://doi.org/10.1007/s00170-020-05168-2

317. Wegner, D., Zarpelon, M., Verschoore, J. R., & Balestrin, A. (2017). management practices of small-firm networks and the performance of member firms. verslas: teorija ir praktika / business: theory and practice, 18, 197–207. https://doi.org/10.3846/btp.2017.021

318. Wei, C. C., Chien, C. F., & Wang, M. J. J. (2005). An AHP-based approach to ERP system selection. International Journal of Production Economics, 96(1), 47–62. https://doi.org/10.1016/j.ijpe.2004.03.004

319. Wejnert, B. (2002). Integrating models of diffusion of i nnovations : A Conceptual Framework. Rogers 1995, 297–326. https://doi.org/10.1146/annurev.soc.28.110601.141051

320. Wu, C., Hsu, P., & Lai, K. (2011). Simulated-annealing heuristics for the single-machine scheduling problem with learning and unequal job release times. Journal of Manufacturing Systems, 30(1), 54–62. https://doi.org/10.1016/j.jmsy.2011.03.004

321. Xiao, T., Choi, T., & Cheng, T. C. E. (2016). Delivery leadtime and channel structure decisions for make-to-order duopoly under different game scenarios. e transportation research part, 87, 113–129. https://doi.org/10.1016/j.tre.2016.01.003

322. Yildirim, V., Yomralioglu, T., Nisanci, R., Çolak, H. E., Bediroğlu, Ş., & Saralioglu, E. (2017). A spatial multicriteria decision-making method for natural gas transmission pipeline routing. Structure and Infrastructure Engineering, 13(5), 567–580. https://doi.org/10.1080/15732479.2016.1173071

323. Yin, R. K. (2023). Case Study Research and Applications: Design and Methods. A Book Review: Case Study Research and Applications, 11(1), 319.

324. Younas, M., Jaffery, S. H. I., Khan, M., Khan, M. A., Ahmad, R., Mubashar, A., & Ali, L. (2019). Multi-objective optimization for sustainable turning Ti6Al4V alloy using grey relational analysis (GRA) based on analytic hierarchy process (AHP). International Journal of Advanced Manufacturing Technology, 105(1–4), 1175–1188. https://doi.org/10.1007/s00170-019-04299-5

325. Yuan, M. L., Ong, S. K., & Nee, A. Y. C. (2005). A generalized registration method for augmented reality systems. Computers and Graphics (Pergamon), 29(6), 980–997. https://doi.org/10.1016/j.cag.2005.09.014

326. Yücenur, G. N., Vayvay, Ö., & Demirel, N. Ç. (2011). Supplier selection problem in global supply chains by AHP and ANP approaches under fuzzy environment. International Journal of Advanced Manufacturing Technology, 56(5–8), 823–833. https://doi.org/10.1007/s00170-011-3220-y

327. Yue, Z., & Jia, Y. (2015). A group decision making model with hybrid intuitionistic

fuzzy information. Computers and Industrial Engineering, 87(May), 202–212. https://doi.org/10.1016/j.cie.2015.05.016

328. Zaabar, I., Arango-miranda, R., Beauregard, Y., & Paquet, M. (2021). A Sustainable Multicriteria Decision Framework for Obsolescence Resolution Strategy Selection. Sustainability (Switzerland), 13, 1–16. https://doi.org/10.3390/su13158601

329. Zaerpour, N., Rabbani, M., Gharehgozli, A. H., & Tavakkoli-Moghaddam, R. (2009). A comprehensive decision making structure for partitioning of make-to-order, make-to-stock and hybrid products. Soft Computing, 13(11), 1035–1054. https://doi.org/10.1007/s00500-008-0377-x

330. Zennaro, I., Finco, S., Battini, D., & Persona, A. (2019). Big size highly customised product manufacturing systems : a literature review and future research agenda. International Journal of Production Research, 0(0), 1–24. https://doi.org/10.1080/00207543.2019.1582819

331. Zhai, Y., & Cheng, T. C. E. (2022). Lead-time quotation and hedging coordination in make-to-order supply chain. European Journal of Operational Research, 300(2), 449–460. https://doi.org/10.1016/j.ejor.2021.07.045

332. Zhang, J., Ong, S. K., & Nee, A. Y. C. (2012). Design and development of an in situ machining simulation system using augmented reality technology. Procedia CIRP, 3(1), 185–190. https://doi.org/10.1016/j.procir.2012.07.033

333. Zhang, M., Qi, Y., Zhao, X., & Duray, R. (2015). Mass customisation systems: complementarities and performance consequences. International Journal of Logistics Research and Applications, 18(6), 459–475. https://doi.org/10.1080/13675567.2015.1015507

334. Zhong, R. Y., Xu, X., Klotz, E., & Newman, S. T. (2017). Intelligent Manufacturing in the Context of Industry 4 . 0 : A Review. Engineering, 3(5), 616–630. https://doi.org/10.1016/J.ENG.2017.05.015

335. Zhou, F., Hu, M., & Zhao, Y. (2020). Study on the Influence of Modular Design of Garment on Market Innovation. Journal of Textile Science & Fashion Technology, 6–7. https://doi.org/10.33552/JTSFT.2020.06.000640

336. Zorzini, M. Ã., Corti, D., & Pozzetti, A. (2008). Due date (DD) quotation and capacity planning in make-to- order companies : Results from an empirical analysis. International Journal of Production Economics, 112, 919–933.

https://doi.org/10.1016/j.ijpe.2007.08.005

Appendix 1: Questionnaire for Hypothesis Testing

Delhi Technological University, Delhi
Department of Mechanical Engineering
Shahbad-Daulatpur, Bawana Road,
Delhi – 110042

Research Supervisors: Prof. S K Garg

Dr. Rishu Sharma

Subject: To study the impact of various factors on Make To Order (MTO) manufacturing of passenger cars.

Dear Sir/Madam,

Make-to-order refers to a situation where the product is customized through a variety of offerings or engineering designs and cannot be built without a customer order. MTO systems can provide highly customized products, but customers must wait for their orders to be filled. In MTO Company, when an order is placed, the basic design is available and the remainder of the work is in manufacturing and assembly.

A research to study the impact of various factors on 'Make to Order' manufacturing of passenger cars. A small questionnaire has been prepared where it is needed to rate different factors which can later be used as an assessment tool for prioritizing factors for implementing Make to Order in automobile manufacturing organizations. The survey should take 10 to 15 minutes and you response will be confidential.

Please respond genuinely and in case you are uncertain, you may answer with your first intuitive response. A definition of various production strategies has been provided below for clarity. This research is based on Make To Order, and not to be confused with other strategies.

Make To Order: Make to Order (MTO) is a production technique in which producers start manufacturing a product only after the customer places an order for it. When an order is placed, the basic design is available and the remainder of the work is in manufacturing and assembly

Make to Stock: MTS systems can respond to customer demand quickly, but they are not suited for markets where customers require high variety in finished products for which inventory holding costs can be considerable. Make to stock (MTS) is a traditional production strategy that is used by businesses to match inventory with anticipated consumer demand.

Mass Customisation: It refers to the capability to reliably offer a large volume of different product categories in a relatively large market that demands customization, without substantial trade-offs in cost, delivery, quality and user experience.

SECTION A

Kindly provide the information regarding your background details.

- Name (Optional)

- Level of Education

Post Doctorate	☐	Doctorate	☐	Masters	☐
Graduate	☐	Diploma	☐		

- Designation

Top Management	☐	Middle Management	☐	Technical Staff	☐
Administrative personnel	☐	Academician	☐		

- Department

Marketing/Sales	☐	Production	☐	Procurement	☐
Logistics	☐	R & D	☐	Retailer	☐
Project Management	☐				

- Years of Experience

More than 20	☐	15 – 20	☐	10 – 15	☐
5 – 10	☐	0 – 5	☐		

Kindly provide the information regarding organizational details

- Organization name (optional)

- Type of Industry

Automotive	☐	Furniture	☐	Footwear	☐
Apparels	☐	Food	☐	Electronics	☐
College/University	☐	others	☐		

- No. of workers

More than 1000	☐	500 – 1000	☐	200 – 500	☐
100 – 200	☐	Less than 100	☐		

- Annual Turnover (In Rupees crores)

Less than 10	☐	10 – 50	☐	50 – 100	☐
100 – 500	☐	More than 500	☐		

- Location of Organisation

North India	☐	South India	☐	East India	☐
West India	☐	outside India	☐		

- Type of Business

Government	☐	PSU	☐	Private Listed	☐
Private unlisted	☐	MSME	☐	Start ups	☐

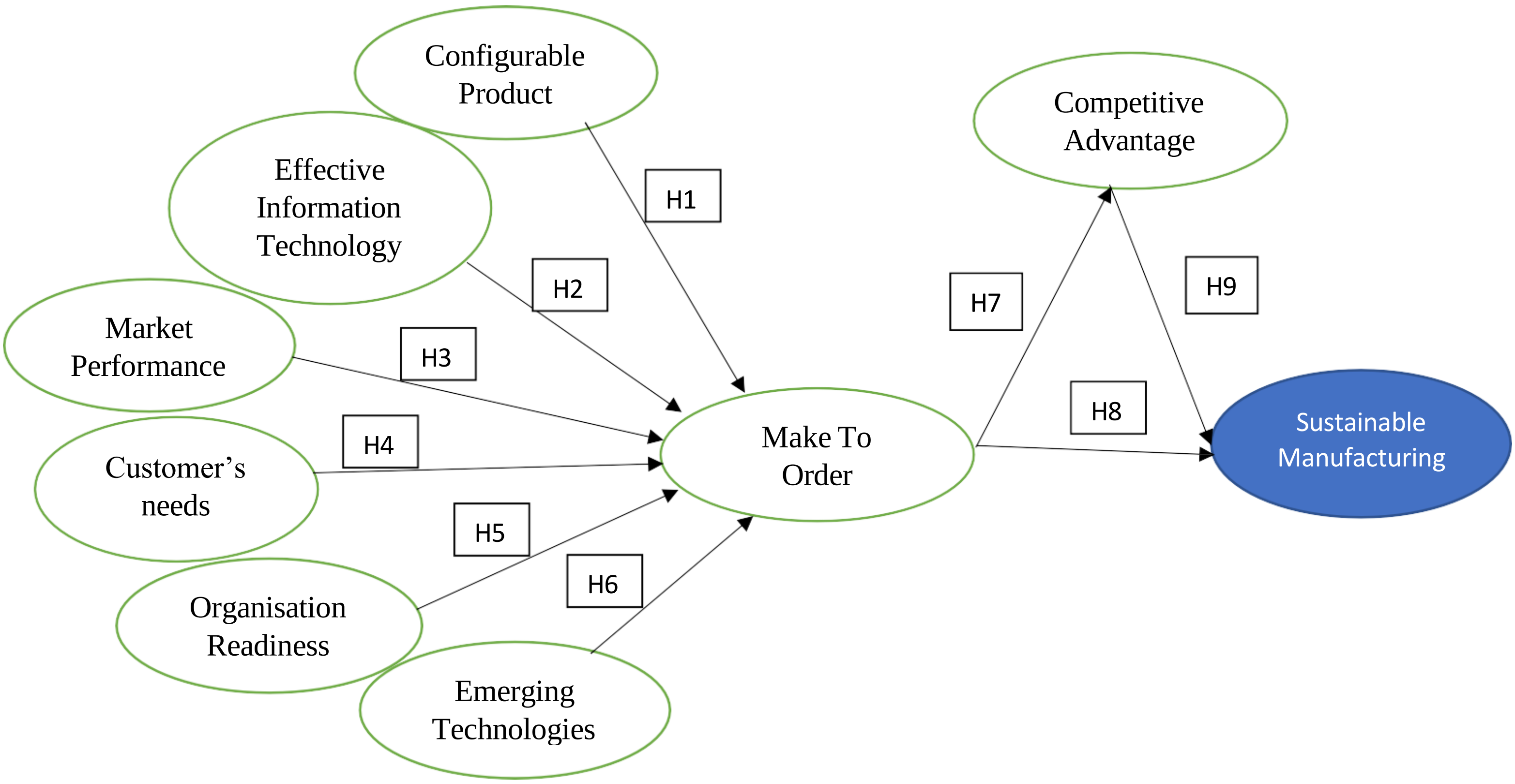


Fig. 1: Model for Hypothesis Testing

SECTION B

Following are various factors that will affect the successful Implementation of Make To Order in manufacturing passenger cars. Indicate the extent to which you agree with each statement.

1. Please rate the role of the following characteristics of the Configurable Product in MTO manufacturing.

		Very High	High	Medium	Low	Very Low
A	High choice of Products to customer					
B	Product Innovation					
C	Short Lead time of suppliers					
D	Modular product design					
E	Ability to produce in small quantities					
F	Promised in place in stipulated time					

2. Please rate the role of following factors of Information Technology in making MTO manufacturing effective.

		Very High	High	Medium	Low	Very Low
A	Accessibility to flexible and real time information technology to keep the customer updated					
B	Information system (online system) to receive order and payments					
C	Information Technology based coordination among different departments					

3. Please rate the impact of following factors on Market Performance of MTO products.

		Very High	High	Medium	Low	Very Low
A	Improved Competitiveness					
B	Reduced Risk of obsolescence and perishability					
C	Enhanced Market Penetration					
D	Improved Image of brand in market					

4. Please rate the impact of following factors on Customer Need for MTO product.

		Very High	High	Medium	Low	Very Low
A	Fulfilment of Customer's passion for unique product					
B	Online real time information to customer					
C	Ability to customize the product					

5. Please rate the effect of following factors on Organisation Readiness for MTO manufacturing

		Very High	High	Medium	Low	Very Low
A	Flexible manufacturing processes					
B	Multi skilled employees for manufacturing					
C	Flat organization structure					
D	Ability of MTO without increasing cost of manufacturing					
E	Reduced cost of carrying inventory					

6. Please rate the role of following Emerging Technologies in MTO manufacturing.

		Very High	High	Medium	Low	Very Low
A	Adoption of Industry 4.0					
B	Effective intervention of 3D Printing					
C	Adoption of IOT enabled manufacturing					
D	New possibilities by using AR (Augmented Reality) and VR (Virtual Reality)					

7. Please rate the following factors to measure firm’s capability to implement MTO and deliver products.

		Very High	High	Medium	Low	Very Low
A	Reduction in delivery time					
B	Increase in varieties					
C	Better customer experience					
D	High variety at reduced cost of providing MTO delivery					

8. Please evaluate Competitive Advantage on account of Make To Order as compared to other strategies.

		Very High	High	Medium	Low	Very Low
A	Better customer satisfaction					
B	Acquiring new customers					
C	High employee satisfaction					
D	Increased Sales volume and revenue					

9. Please rate following Sustainable Performance factors

		Very High	High	Medium	Low	Very Low
A	Avoidance of waste					
B	Sustainable Supply Chain Management					
C	Economical Sustainability					
D	Sustainable Business					

SECTION C

<u>Please provide the information as per your expertise</u>

1) What are the major reasons that encourage you to implement Make To Order in your esteemed organization?

2) What were the major challenges you faced or you may face during the implementation phase?

3) What were the major measures adopted by your organization to move from Make To Stock to Make To Order?

List of Publications

International Journals:

1. Upadhyay, S.; Garg, S.K.; Sharma, R. Analyzing the Factors for Implementing Make-to-Order Manufacturing System. Sustainability 2023, 15, 10312. https://doi.org/10.3390/su151310312
2. Upadhyay, S., Garg, S.K.; Sharma, R. 'Unlocking competitive edge and sustainability through Make to Order manufacturing : an empirical investigation', Environment, Development and Sustainability, (0123456789) (2023) . doi: 10.1007/s10668-023-04255-0.

International Conferences:

1. Upadhyay, S., Garg, S. K. and Sharma, R. (2022) 'Improving Competitiveness through MTO Systems', 3rd International Conference on Recent Advances in Materials Manufacturing and Thermal Engineering (RAMMTE-2022), July 8-9, 2022 by Delhi Technological University (Formerly Delhi College of Engineering), Delhi, India.
2. Upadhyay, S., Garg, S. K. and Sharma, R. (2024) 'Study of design issues in MTO and MTS systems in Automobile sector', at the International Conference on Green Technology and Sustainability (ICGTS – 2024), January 30 – 31 January' 2024 by Maharaja Agrasen Institute of Technology, Delhi, India.