CHAPTER 01 – INTRODUCTION

1.1 Chapter Overview

The current chapter comprise of the introductory background to the research comprising description of working capital, working capital management, significance of working capital management efficiency, and the Indian manufacturing sector. Additionally, this chapter also highlights certain research aspects such as areas of research, research questions, rationale for the study, scope of the study, research objectives, methodology used, and significance of the research. Lastly, it offers the reader a brief overview of thesis and arrangement of various chapters along the thesis.

1.2 Background

1.2.1 Introduction

Changing business environment, deregulations and liberalization have altered the face of business competition. With the globalization of markets, none of the economies have remained untouched from fierce global competition and the developing economies are no exception. The global financial turbulence has significantly affected the business and has increased the demand for efficiency, efficacy, and productivity (Kumar and Vincent, 2011). Emerging economies are playing a vital role internationally due to globalization of economies in recent years (Arora, Jain and Das, 2009). Sound economic growth of any developing economy in general or for any firm in specific depends on efficient handling of limited resources. Limited funds are available to firms and thus success of a business depends on how efficiently these funds are utilized (Vashisht et al., 2011). This requires effective decision making by the management and involves analyses of all the financial choices that the firm faces and then deciding on the course of action that should be

taken. One of the critical issues in corporate financial decision making is efficient handling liquid assets i.e., management of working capital.

The overall objective of this study is to carry out a robust analysis of working capital management in terms of efficiency in the Indian manufacturing sector in the context of today's globalised Indian economy. To achieve this, the study attempts to develop a new measure for effective measurement of working capital management efficiency. The study aims to analyse the determinants influencing WCM efficiency and also examine the empirical association of WCM efficiency with these determinants. Moreover, this study also aims to validate the suggested working capital model and estimating the most vital predictors in influencing the WCM efficiency.

1.2.2 Working Capital

Working capital can be understood as a metric that measures a company's operating liquidity. It is the relation between resources in the form of cash or easily convertible into cash and liabilities for which cash will be required soon. A brief description of working capital, its classification along with notions and levels are presented in Figure 1.1 followed by its explanation.
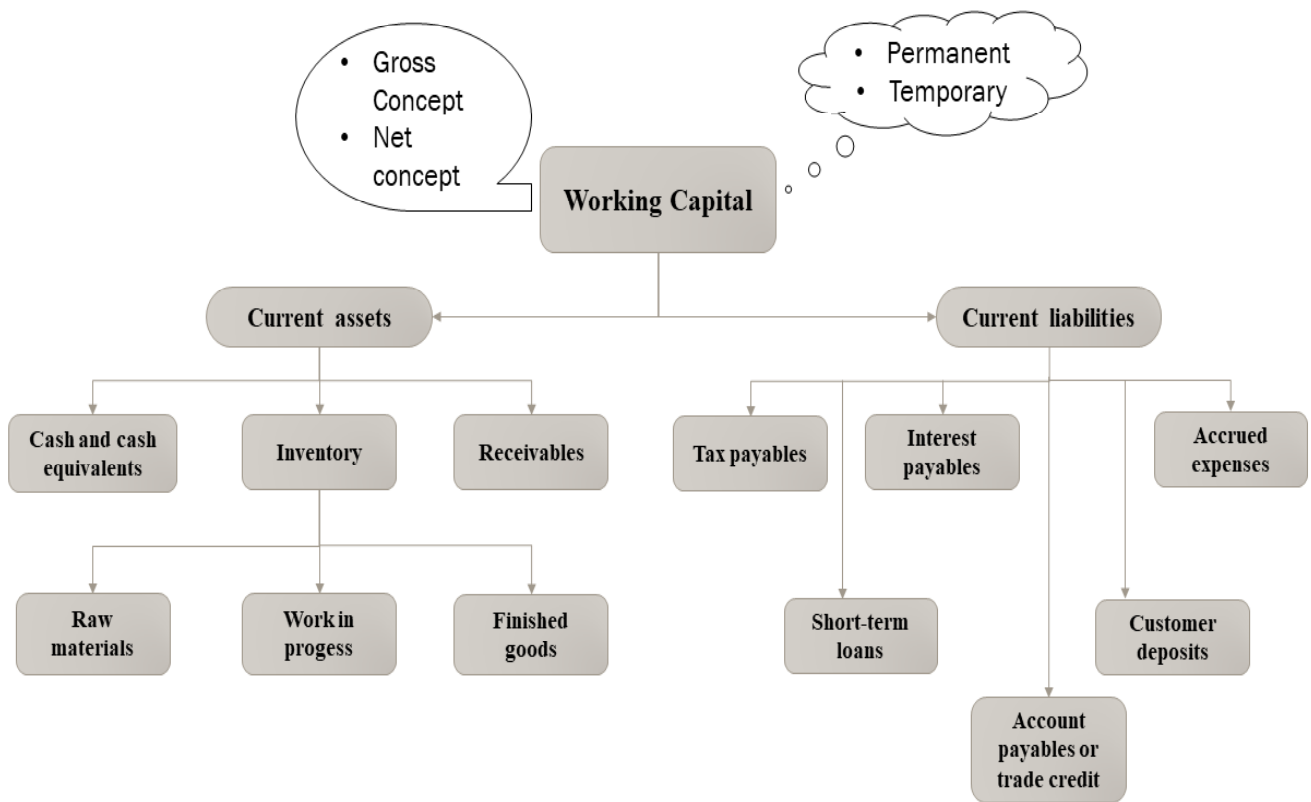
Figure 1.1: Working Capital Description

There are thus two constituents of working capital, namely current assets and current liabilities. Current assets are those assets or resources of firm which are held only for a short period of time. In general, all those assets which will be liquidated and converted into cash within one year or one operating cycle (whichever is longer) are called current assets. Current assets constitute:

(i)   Cash and cash equivalents: These constitute cash in the form of physical currency or bank deposits and also include cash equivalents which can be readily convertible into cash such as commercial paper, money market holdings, treasury bills etc.

(ii)   Inventory: These refer to stock of goods held by firms for further processing or sale. Inventory can be broadly of three types:

    a) Raw materials: These are items that have been procured by firm in order to convert them into semi-finished and finished goods through production process. Raw materials are unprocessed material waiting to be put into production process.

    b) Work in progress: These are semi-finished goods which are in the process of converting into finished or final product. All items from the raw materials that has just realized for processing up to the material that is almost completely processed come under this heading.

    c) Finished goods: These are items that have passed through all the stages of production and are now completely processed. Finished goods are items that are waiting for orders from customers. Receivables: If the goods are sold to customers on credit then the money owed by the customers to the firm is call receivables or accounts receivables. They are simply the rights to receive money from entities to whom goods have been sold or services have been provided.

Furthermore, there are a number of motives behind making investments in current assets. These include:

a) Transaction Motive: Firms keep cash in order to meet day to day expenses and to make payments. Raw material is held by firms to maintain smooth production as they may not be available as and when required. Finished goods are stored for uninterrupted sale as demands may not be able to keep pace with production at all times.

b) Precautionary Motive: Keeping cash helps firms in making payments for unexpected and unplanned expenses. While holding inventory helps in meeting unforeseen fluctuations in supply of raw materials due to strike, natural calamity etc, on the other hand holding finished goods helps in meeting variations in demand of goods.

c) Speculative Motive: Sometimes firms hold cash so that they are able to take advantage of favourable market conditions like bargain price for raw materials or favourable market exchange rates etc. Similarly, firms may hold inventory more than they require if they fear that there may be a steep rise in their prices in future.

Current liabilities are those liabilities or obligations that need to be settled within one year. In other words, the money owed by the firm for a short period that needs to be repaid through current assets or through creation of another current liability is called current liabilities. Current liabilities include tax payables: tax owed to government, interest payables: interest owed to lenders, accrued expenses: expenses that have been incurred but not paid, short term loans: loans that are to be repaid in a year, customer deposits: advance payments from customers and accounts payables. Accounts payables or trade credit is the most important part of current liability (García-teruel & Martínez-solano, 2010). It is the money payable to suppliers for the purchases made on credit. Thus, current liabilities are sources of short-term financing. They finance a portion of the

firm's current assets and hence reduce the amount of firm's own funds that need to be tied up in current assets.

There are two main notions of working capital viz. the gross concept and net concept. The gross concept measures the gross working capital by measuring the total amount of current assets held by the firm. On the other hand, the net concept measures net working capital by calculating the excess of current assets over current liabilities. It measures the portion of current assets financed from long term sources. Working capital can also be divided into permanent and temporary working capital. Permanent working capital is the minimum amount of current assets that always need to be maintained irrespective of the volume of sales. On the other hand, temporary working capital is the fluctuating or seasonal capital required over and above the permanent working capital. Overall, working capital characterizes the liquidity position of a firm and thus is also sometimes known as 'circulating capital or current capital'. Figure 1.2 shows the circulating/cyclical nature of working capital.
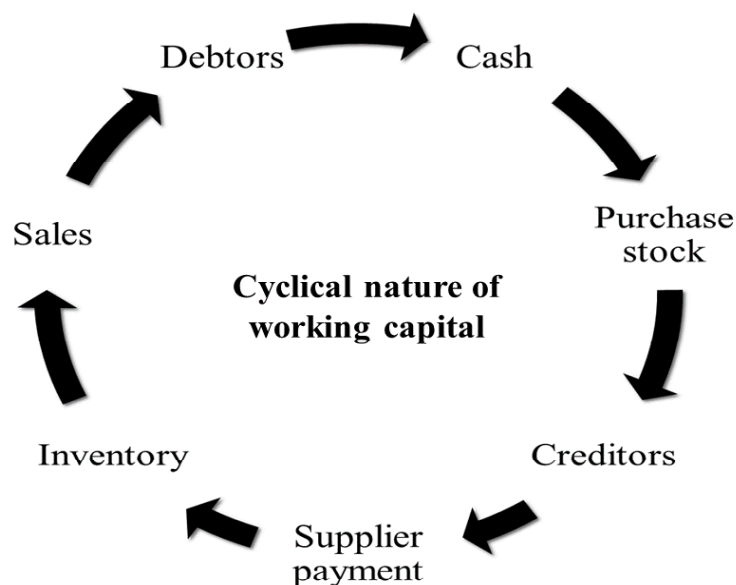

Figure 1.2: Cyclical Nature of Working Capital

1.2.3 Working Capital Management

Working Capital management (WCM) deals with managing short-term financing and short-term investment decisions of the firm (Sharma & Kumar, 2011). It is the management of current assets, current liabilities and the inter relationship between them. The objective of working capital management is to maintain balance among the working capital components (Filbeck & Krueger, 2005). There are two main facets of working capital management: first, to estimate the amount of various current assets to be held by the firms and second, to determine the extent of their financing through different current liabilities. There are two main objective of working capital management:

- To make sure that the firm has sufficient liquid resources to function smoothly.
- To minimise the investment in working capital in order to maximise the profitability.

The importance of trade-offs between the two goals of working capital management, i.e., liquidity and profitability has always been stressed in literature since both are essential for continuance of business. Here liquidity means whether or not a firm is able to meet its short-term obligations as and when they are due. The overall goal of working capital management is that a firm should be able to continue its operations by managing the inter-relationship between current assets and current liabilities. Figure 1.3 highlights the decision involved in managing the working capital and the approaches adopted by practitioners and financial managers in WCM.
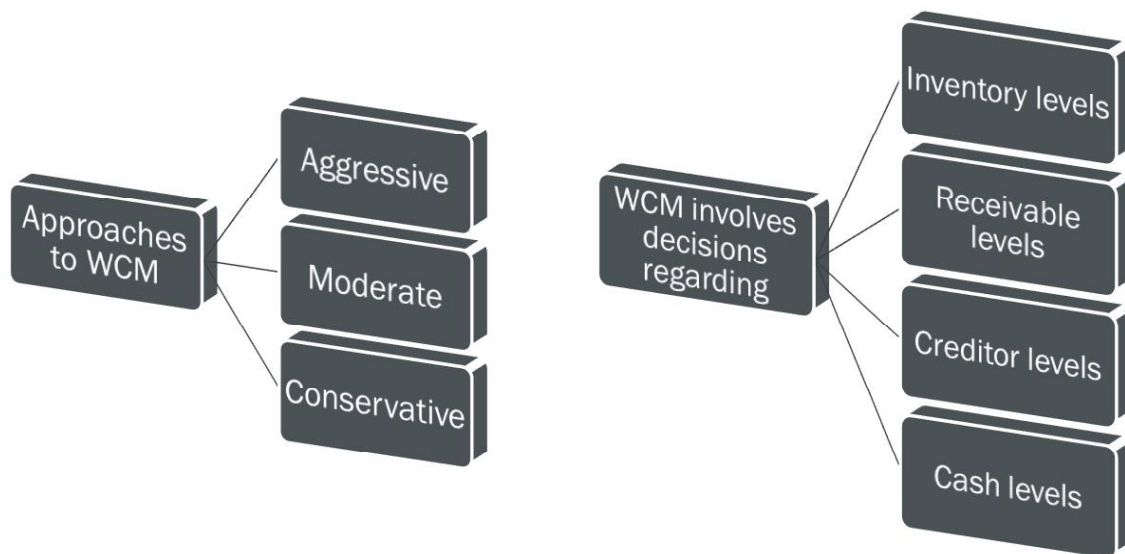
Figure 1.3: Approaches and decisions involved in Working Capital Management

Working capital management involves decisions regarding:

- Inventory levels: Deciding between high costs of stockholding due to inventory pile up vs. cost of stock outs as a result of keeping low inventory (Mishra and Raghunathan, 2004). Deciding between liquidity benefits of holding inventory vs. liquidity benefits of free funds.

- Receivable levels: Deciding between allowing high levels of receivables to promote sales vs. liquidity benefits of cash. Deciding between cost of slow cash inflow due to large and long receivables vs. cost of lower sales.

- Creditor levels: Deciding between availing liquidity benefits by delaying the payments of purchases vs. benefits of maintaining good reputation and better relations with the suppliers.

- Cash Levels: Deciding between liquidity benefit of holding cash vs. opportunity cost of idle cash.

There can be broadly three approaches to working capital management (Andrew and Gallaher,1968) namely aggressive, moderate and conservative. These three approaches differ from each other in their liquidity vs. risk characteristics. An aggressive approach involves keeping low level of current assets and high level of current liabilities. This results in low liquidity and high risk characteristics. However, it frees up more funds which can be invested more profitability elsewhere. On the other hand, conservative approach involves keeping high level of current assets and low level of current liabilities. This results in high liquidity and low risk characteristics. However, this also leads to higher blockage of funds in current assets and thus reduces the total returns on investment. In other words, in case of aggressive approach, a large portion of permanent current assets are financed from short term sources. This increases risk but improves profitability. On the other hand in conservative approach, permanent current assets and even some portion of temporary current assets are financed from long term sources of funds. This reduces risk but at the cost of profitability. The moderate approach follows amid-level path in between aggressive and conservative approach and tries to keep a balance among liquidity, risk and profitability. Here, long term sources finance permanent assets and short term sources finance temporary current assets. The WCM decisions affect number of other managerial decisions which in turn affect performance of firm (Mishra and Vaysman,2001) (Banker et al., 2002).

1.2.4 Significance of Working Capital Management Efficiency

Working capital management plays an important role in a firm's profitability, risk as well as in its value (Smith, 1980). Working capital is the circulating capital and therefore it has also been termed as the life blood of business. Its flow and circulation is essential for continuance of business. It is sometimes said that a firm can survive without being profitable but improper working capital management may result in bankruptcy and closing down of business. Even a profitable firm can fail and become bankrupt if there is mismanagement in working capital. Smith (1973) argues that a large number of business failures have occurred due to improper management of working capital. Berryman (1983) also states that improper working capital management is the primary reason for small business failures. There are two main reasons for the importance of working capital management:

a. A significant percentage of a firm's total investment is in the form of current assets.

b. The levels of both current assets and current liabilities change rapidly and suddenly.

The importance of working capital management also arises because of the two types of risks that are inherent in it viz. opportunity cost risk and liquidity risk. The opportunity cost risk is risk of unavailability of funds or assets to seize the opportunity when it arises. Liquidity risk is the risk of shortfall or unavailability of funds in case of any liability falling due. Both the risks can seriously affect the performance and in long run the existence of firm.

Improper cash management resulting from payment commitments without proper cash flow forecasts can lead to financial distress. Similarly, keeping large amount of slow-moving inventory or simply ineffective inventory management system can increase cost of holding, insurance, interests etc., ultimately leading to losses. Improper tracking of receivables can lead to costs of litigation and risk of serious bad debts. Again, ineffective management of payables can

lead to failure in meeting payment commitments and thus loss of supplier trust. Excessive working capital can have a number of fallouts like problem of overcapitalization, uncontrolled purchases of inventory leading to waste and theft, tendency to engage in speculative activities, too liberal credit resulting in delay of cash inflow and overall carelessness. Excessive working capital may have a negative effect on a firm's profitability, whereas a low level may lead difficulties in maintaining smooth operations (Van Horne and Wachowicz, 2008). An effective working capital management ensures that the firm is able to grasp all the profitable opportunities that arise in the business and helps in reducing liquidity risks.

The importance of efficiency of working capital management can be understood by the statement "Efficient working capital management is an integral component of the overall corporate strategy to create shareholder value" (Shin & Soenen, 1998). It is very important for working capital management to be effective because it affects the performance and liquidity of the firms (Taleb et al., 2010). The viability of business relies on the ability to effective manage receivables, inventory and payables (Filbeck & Krueger, 2005). Minimization of investments in the short term assets relative to the level of a firm's operations is a crucial element in the total management of operating funds (Helfert, 2004). To maintain competitiveness, companies should improve their performances in terms of WCM efficiency and it is important for firms to correctly measure the level of their efficiency and identify the benchmark firms.

Working capital management is somewhat similar to fixed asset management but for WCM there needs to be more active involvement since the strategy varies with sales. However, working capital management has often been ignored in financial decision making because it involves investment and financing for short term period whereas the concentration of managers are generally more on long term fund management. Short-term management is a difficult problem

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since usually companies do not employ working capital managers (Bolek, 2013). In today's competitive world of high capital costs (due to paucity of funds) and high costs attached to holding of funds, working capital management is gaining attention of managers. Increase in sales, declaration of dividends (Gupta et al., 2011), plants expansion, launch of new products, rising prices and hike in salaries and wages put addition pressure on firm's health and hence effective working capital management becomes critically important. Kulkarni (1985) says that working capital management is looked upon as the driving seat of a financial manager. The study of working capital management and its efficiency is thus vital for all stakeholders of the firms and is especially critical in manufacturing firms since they require large investments in short term assets.

1.2.5 Indian Manufacturing Sector

Over the years, Indian manufacturing sector has gone through several expansion phases. In 1947 since independence, the local manufacturing sector transformed towards 1950's industrial revolution and further to 1965-1980's license-permit Raj system. Going ahead, this manufacturing sector underwent liberalization in 1990 and currently observing global competitiveness phase. Currently, manufacturing sector has contributed nearly 16-17 percent in real gross domestic product (GDP) for financial year 2019, and accommodated nearly 12 percent of India's workforce, well below its true potential. Following United Nations Industrial Development Organization (UNIDO), India ranks one in terms of manufacturing of electrical machinery, general machinery, pharmaceuticals, chemical products, and textiles.

In accordance with the existing studies, manufacturing sector creates a multiplier effect stating that one job in manufacturing sector creates 2-3 service sector jobs. For a country such as India wherein generation of employment forms a part of key policy issues makes the

manufacturing sector crucial for inclusive growth. Recent years in India have observed lopsided development and substantial demographic growth. Additionally, a shift of focus from agriculture to manufacturing by people is witnessed. This renders manufacturing sector to be vital in India's advancement and employment of workforce. However, formulation of National Manufacturing Policy acts positively by envisaging manufacturing share in GDP to be 25 percent by 2022 accompanied by employing 100 million people, which is also a vision for Make in India (MII) initiative launched on September 25, 2014 by Hon'ble Prime Minister Narendra Modi. This policy aims at (a) enabling easy technology procurement and improvement of business environment; (b) skill development through private players; (c) easy capital access to small and medium size enterprises (SMEs). Additionally, MII campaign identified 25 strategic factors offering wide range of investment opportunities and policy reforms in the selected industries that would unify India towards a new holistically economic growth. These efforts are accompanied by evolving shift of public sector dominance towards a private enterprise management driven by global ambitions. Since the Indian manufacturing sector seems to go from strength to strength in the upcoming years, its future seems bright. Numerous factors such as young population, rising middle class, vigorous national demand, and high return on investment makes India an investment heaven and offers alluring prospects to manufacturers.

Despite these advantages, Indian manufacturing sector suffers in terms of capital availability, financing sources, right investment education, liquidity management, effectual workers, and high debt levels. Precisely, to cope with the changing dimensions and increasing requirements, it is imperative to emphasize on short-term operations and liquidity for building competitive manufacturing industries. This liquidity management, known as working capital management (WCM) would boost the growth in human centric manufacturing industries such as

electrical machinery, transport equipment, and petroleum, and in labor-intensive manufacturing industries like textiles, paper products and wood.

1.3 Areas of research

The current study is a quantitative research wherein the attempt is made to uncover the causes. By nature, this study forms a part of descriptive as well as analytical. The research initiated with the general understanding of Indian manufacturing firms, emphasizing prominently on prevailing WCM efficiency in these firms. Though the studies have tested WCM efficiency in Information technology sector (Chakraborty, 2020); automobile sector (Chellasamy and Ligy., 2019); and sugar industries (Dash, 2020), not much evidence prevails for the same in manufacturing industries (Seth *et al.*, 2020). Method of evaluating efficiency and several enablers influencing WCM efficiency were examined. In accordance with the reviewed literature, identification of research gaps was performed, and a WCM model was developed. A linear programming benchmarking technique, known as data envelopment analysis (DEA) was used for assessing the WCM efficiency in Indian manufacturing industries. A panel data fixed effects model was used to check the relationship of selected determinants with WCM efficiency. Further, a prediction model using artificial neural networks (ANN) and sensitivity analysis was developed which offered sequential normalized and individual importance of the significant determinants. The results were scrutinized on the basis of analysis and recommendations were suggested for improving the shortcomings.

1.4 Problem Statement

India has been highlighting its growth potential from past few decades and is even referred as the fastest growing economy and manufacturing superpower, after China (Deloitte, 2006). But, there are major aberrations. Though services contributed maximum in economic growth of India, several factors in China, such as low-cost labor, high availability of raw materials, favorable trade policies, superior governance, quicker adaptability to trends, knowledge experts, focused management strategies etc., owes to its capability of besting India (Deloitte, 2006).

The Indian government along with manufacturing firms have responded to this call and seemed to be working on various initiatives, namely Make in India campaign, Aatma Nirbhar Bharat, focusing on less imports, free technical education, higher funds allocation to the small and medium enterprises. But, in reality the manufacturing sector still lacks the expertise in term of allocation of funds, proper usage of funds, limited financing sources, costly materials from suppliers, improper management of cash conversion cycle which signifies the existence of a gap in the learning and outcome. Hence, a research primarily focusing on the extremely critical echelons of manufacturing firms i.e., working capital is warranted and this research drew focus on the subsequent research questions:

RQ1. How to assess the WCM efficiency in Indian manufacturing sector?

RQ2. What is the prevailing WCM efficiency condition in Indian manufacturing sector?

RQ3. Which are the foremost determinants influencing WCM efficiency?

RQ4. What is the relationship of selected determinants with WCM efficiency?

RQ5. What is the order of the significant determinants based on their importance while examining relationship with WCM efficiency?

RQ6. What are the recommendations drawn from the inferences of our research for enhancing the WCM efficiency?

In a quest to answer above questions, a meticulous study of several theoretical frameworks and models have been executed for gaining comprehension into the WCM and its efficiency.

1.5 Rationale for the Study

Working capital forms an important component for cash flow in firms that assists during economic downfall, price fluctuations, natural calamities, and uncertainties (Zeidan and Shapir, 2017). Efficient working capital models make the firms leaders in the whole supply chain by way of influencing payment cycles along with inventories in order to devote less investment in current assets (Farris and Hutchison, 2002). In the present scenario of uncertainties, managing liquidity for short-term operations and daily functioning has been a vital task for firms and financial managers. This phenomenon, known as WCM acts as an anchor for financing and investment decisions (Baños-Caballero *et al.*, 2012). In today's globalized economy, WCM is of extreme importance, specifically in a capital- and labor-intensive sector, like manufacturing, where the onus is on continual advancement of products and technologies. So, integrating a mix of firm-level as well as macro-economic determinants influencing efficiency would assess the WCM at its best. This would expand the performance dimensions and opportunities for the overall manufacturing sector. Additionally, a better management of working capital adds to the value, profitability, and other opportunities (Sharma and Kumar, 2011). Managing working capital efficiently saves the firms from facing financial constraints in the near future (Bodnaruk *et al.*, 2015) as well. However, its inefficient management has seen substantial business failures making management of working capital components of utmost importance. Hence, first the WCM efficiency needs to be evaluated

carefully to improve it. Second, the causes or factors behind inefficiency in managing the working capital needs focus. Lastly, a WCM efficiency prediction model would offer directions to focus on the most vital determinants simulating the effect on WCM efficiency and be a valued information source for promoting the existing knowledge body.

1.6 Scope of the Study

The overall study scope constitutes of analyzing the WCM efficiency of listed firms in the Indian manufacturing sector. The following extensive areas of research forms the scope of the study:

a) The current research is limited to the listed firms forming a part of manufacturing sector of India during the assessment period.

b) The time period of the study attempts to incorporate the after-effects of global financial crisis and the pre- and post-effects of demonetization in India, so the study period utilized is 2009-2020.

c) This study employed balanced panel data methodology and hence, comprises of same number of firms throughout the time period of the study used in the analysis.

d) The current study examines efficiency of managing the working capital in manufacturing firms of India by means of Data Envelopment Analysis technique.

e) This study delves into the comprehensive analysis of prevailing levels of WCM efficiency, its trend, and examination of the determinants influencing the WCM efficiency of Indian manufacturing sector.

f) This research is about offering a model comprising of the most vital predictors influencing WCM efficiency, hence, Artificial Neural Networks and sensitivity analysis is performed for validating our model and obtaining the normalized importance of the predictors.

1.7 Research Objectives

A comprehensive study of WCM and its practices would offer a prospective knowledge evidence for drawing inferences on assessment of efficiency, enhancement of efficiency, retrospective effect on the firm's profitability or performance and identification of the vital predictors influencing WCM efficiency. Few of the studies have been performed in the Information technology sector (Nilay *et al.*, 2020); automobile sector (Chellasamy and LigyV., 2019); and sugar industries (Dash, 2019), however not many such studies are available for the manufacturing sector.

To meet the stated challenge, a detailed study of WCM efficiency in the selected manufacturing industries along with examination of the relationship of determinants with WCM efficiency has to be performed. Furthermore, in order to validate the importance of the significant determinants, a ANN prediction model along with sensitivity analysis needs to be executed.

The current research implications could pave the way for better understanding of prevailing working capital levels, its efficient management, and policy formulation in Indian manufacturing firms, and also, clarity on reinforcing the working capital models. Hence, the implications drawn from this study could offer a better understanding of the current trends in manufacturing and working towards reinforcing the policies, and also to continue the research to further strengthen the working capital model, and hence, the objectives of this research are:

RO1. To identify a method for assessing WCM efficiency in Indian manufacturing sector.

RO2. To evaluate the current WCM efficiency in Indian manufacturing sector.

RO3. To identify the vital determinants that influence WCM efficiency in Indian manufacturing sector.

RO4. To develop a prediction model for obtaining sequential importance of significant determinants while examining their relationship with WCM efficiency.

1.8 Research Methodology

Complete description of several methods opted, and the research methodology is presented in Chapter 4. The purpose here is to give a brief outline of the main research methods and approaches. The current study has been conducted on a panel data of 1391 Indian manufacturing firms spread across nine industries i.e., chemicals & chemical products, construction materials, consumer goods, food & agro-based products, machinery, metals & metal products, miscellaneous manufacturing, textiles, and transport equipment. The time period taken for the study is 2009-2020. The secondary data for above mentioned industries were collected from CMIE Prowess database, which is a database of the financial performance of the companies. This database is managed by CMIE (Centre for Monitoring Indian Economy) which is headquartered in Mumbai, India.

This research adopted SBM-DEA model for assessing the WCM efficiency of selected manufacturing firms using MATLAB software. The inputs used in the DEA model comprised of receivables period, inventory period and payables period whereas outputs used were return on total assets. Variance Inflation Factor (VIF) was applied for establishing the existence of multicollinearity among the independent variables. Summary statistics (mean, median, standard deviation) signified considerable variability in the sample reflecting support for a better analysis and was calculated using EViews 9. Furthermore, this research scrutinizes the panel data regression namely Random Effect model (RE) or Fixed Effect model (FE) using EViews 9. Through application of the FE model for equation estimation, the impact of serial correlated error

is curtailed (Habib and Huang, 2018). Hausman test was performed for discovering the choice of suitability to RE or FE as it highlights the exogeneity in the unobserved errors (Goel and Sharma, 2015a).

Lastly, multi-layer perceptron (MLP) technique was used for computing ANN using IBM SPSS Statistics 20 along with sensitivity analysis for ascertaining the relative importance of significant predictors on WCM efficiency. MLP was employed wherein 90 per cent of the dataset was for network training and 10 per cent for network testing. ANN is applied for training and testing the models' precision and estimating the symmetric and asymmetric patterns in the data accurately (Abubakar *et al.*, 2018). Particularly, analysis for two layers was performed i.e. for input layer and output layer. The input layer comprises of five independent significant determinants from fixed effects model (i.e. CFLOW, LEV, GRT, TFA, PRD). The output layer encompasses one output determinant (i.e. EFF) with the standardized range [0, 1]. Further, applying sensitivity analysis provide us with the normalized importance of each significant predictors influencing the WCM efficiency.

1.9 Significance of the Research

The current research primarily features the prevailing levels of WCM efficiency in Indian manufacturing firms by focusing on the key components of working capital cycle. It also offers a holistic approach of dealing with WCM efficiency by combining firm-level as well as macro-economic determinants i.e. in order to determine their effect on efficiency. This holistic working capital approach could be applied directly by the financial managers and manufacturers for determining their firms' WCM efficiency along with focusing on the determinants of extreme value.

This research proposes a prediction model for WCM efficiency through ANN and sensitivity analysis applicable for the current workplace scenario signifying the level of importance among the significant determinants. Since no such prediction model have been developed earlier in the Indian context, the current research befits of extreme importance to the academicians, researchers, and managers.

1.10   Outline of the thesis

Chapter 01 – Introduction: This chapter provides a research background underlining working capital, its management, significance to WCM efficiency, Indian manufacturing sector and the problem statement. Research objectives along with rationale of the research and methods opted are offered. Furthermore, this chapter mentions the significance of the current research and finally, it outlines the thesis chapter-wise.

Chapter 02 – Literature Review: This chapter presents an introduction to WCM, its components, and measures of efficiency along with highlighting the need for WCM efficiency. The role of efficient WCM in Indian manufacturing firms and the contemporary research in WCM domain have been discussed. It also discusses the firm-level and macro-economic determinants selected for the current research to determine their expected relationship with WCM efficiency, thereby leading to hypotheses formulation. Finally, summary and conclusions of this chapter are shown.

Chapter 03 – Hypotheses Development: This chapter focusses on building the relationship of selected determinants with WCM efficiency and estimating their probable effect. The existing literature has highlighted several studies wherein various determinants have been investigated for their relationship with WCM efficiency. In line to this, this chapter offers a research that attempts

to accommodate the most vital determinants that might influence the WCM efficiency more than the remaining factors inclusive of a mix of firm-level as well as macro-economic determinants.

Chapter 04 – Research Methodology: This chapter converses on the research type applied and its components. The methods opted have been explicated concisely along with reasoning behind their usage. Research methodology have been described comprehensively, involving, rationale behind the selection of the sample and the time period as well. The reliability test and summary statistics along with their explanation have been listed in this chapter. This chapter moreover illuminates the DEA and ANN in detail.

Chapter 05: Results and Discussion: This chapter contend to statistical analysis and prediction results. The details of results obtained are provided in various tables. The results of the WCM efficiency in Indian manufacturing industries using DEA have been explained. Further, panel data FE model results are explained focusing on the significant determinants and the interpretations are derived by comparing with the framed hypotheses. Finally, this chapter states the sequence-wise importance of the significant determinant using ANN and sensitivity analysis.

Chapter 06: Conclusions, Implications, Limitations, and Future Work

Based on the findings, the current chapter provides suggestions and implications for managers, practitioners, investors, academicians, and other stakeholders to enhance the WCM efficiency in manufacturing firms. This chapter also briefs on the future scope of research and limitations of this research. Finally, the chapter culminates with this research's general conclusion.