

CHAPTER 02 - LITERATURE REVIEW

2.1 Chapter Overview

The continual emergence of globalization has burdened the economies with heavy usage of limited resources, utilization of costlier funding sources, and difficulty in economical mediation of funds. Every economic player in the market is obliged to handle its resources efficiently for long-term sustainability and hence, making it an essential criterion for nurturing individual as well as economic growth. Working capital being one of the crucial components of firm's resources necessitates its efficient management for ensuring funds availability, continuous operations, meeting customer orders, adequate cash supply, early profits from sales, and largely, wealth maximization. However, efficient management of working capital requires an accurate way of efficiency assessment method along with a better understanding of the determinants influencing the WCM efficiency and its effects. Earlier researchers have opted mainly ratios or cycle approach for estimating the WCM efficiency, but the shortcomings of these methods provide a basis for an improved efficiency measurement technique. Studies have investigated WCM efficiency and its determinants, however contradictory results, small size of the sample, ignorance of the industry effect, size of the firm and other related gaps remains which needs to be explored further. The current chapter delve into the existing research in WCM efficiency, measures of efficiency, influence on the determinants that precedes to gaps resting the basis of this study.

2.2 Working Capital Management and Its Efficiency

Managing working capital efficiently assist the firms in maintaining financial viability and liquidity across ever-changing business cycles. Aktas, Croci and Petmezas (2015) examined US

firms for a period from 1982-2011 for examining the WCM efficiency on firm's investment and performance. Their results indicated that investment levels effect the WCM efficiency which further leads to superior performance in firms. Particularly they suggested that redeployment of underutilized current assets into high value usage could be achieved through funding of cash acquisitions. Ding, Guariglia and Knight (2013) investigated relation of investment and financing constraints with WCM efficiency using a panel of 1,16,000 Chinese firms over a time period from 2000-2007. Their results signified that efficiency in managing the working capital assist the firms in alleviating the impact of financing constraints on fixed investments. Furthermore, idle funds are utilized by following efficient working capital strategies and hence, less funds are to be required for financing working capital components. This enhances the returns from working capital investments and augments firms' capacity to bear high borrowing costs. Such prospective scenario along with ample financing sources motivates the firms to enter new avenues and thereby leads to persistent growth.

De Almeida and Eid Jr. (2014) analyzed the influence of debt capacity on the association of firm's value and working capital on Brazilian firms from 1995-2009. They mentioned that a firm's dependence on external funding reduces due to WCM efficiency wherein the surplus cash can be utilized for diversification opportunities adding to financial flexibility. Besides firms need to incur less amount as financing costs due to fewer requirement for external funds further transforming into improved firms' performance. Kieschnick, Laplante and Moussawi (2013) studied the empirical relation between shareholder's wealth and WCM efficiency through examination of US firms from 1990-2006. They claimed that cumulative dollar in cash form is higher than the value of cumulative dollar invested in net operating working capital, thereby overall value of the firm is influenced. Ganesan (2007) studied WCM efficiency in 349

telecommunication equipment industries from 2001-2007. Their results indicated negative association among working capital days and firm's profitability. They suggested that working capital days can be reduced to improve WCM efficiency which elevates the profitability. Ghosh and Maji (2004) investigated WCM efficiency in Indian cement industry from 1993-2002 and found low levels of efficiency prevailing in the industry. Results underlined high degree of inconsistency in the efficiency values for which adoption of sound WCM policies was recommended. Similarly, Ramachandran and Janakiraman (2009) acknowledged WCM efficiency to be necessary for profitability as well as liquidity in firms as it utilizes the funds tied up in idle assets. Their results indicated good levels of WCM efficiency in Indian paper industry for a period from 1998-2006. They suggested that WCM efficiency must be comprised of planning and controlling of current assets and current liabilities in a way that minimize the excessive investment in these assets and eliminate the risk of inability of meeting financial obligations.

Prasad (2001) studied WCM in 21 Indian paper mills over a period of 10 years and revealed that although the top-level executives are aware of the vital role of efficient management of working capital for attaining better liquidity and profitability levels, but in practice it was unachievable for them. They mentioned sub-optimum utilization and budgetary method to be the reason behind inefficiency in managing the working capital. Saravanan (2001) studied efficient management of working capital in selected non-banking financial companies of India using ratios and suggested that more focus on the liquidity aspect would degrade the profitability. Hence, a better mix of liquidity and profitability approach would enhance the WCM efficiency. Strischek (2001) probed perspective of bankers on managing cash flow and working capital and stated WCM as the unsung hero of finance. He suggested that working capital must stay proportionate to sales and every dollar increase in sales must be aligned with incremental investment in working capital.

Furthermore, their study insinuates WCM efficiency to be essential for enhancement for investors wealth and responsible for high cash flows for repaying bankers.

Payne (2002) advocated the importance of WCM stating that inefficient management of working capital leads to failure in firms and since, WCM is the heart of any business, so its inefficiency would lead to suboptimal results and lead to lower performance by firms. Additionally, Payne (2002) indicated that values of financial statements such as profit and loss statement, balance sheet, cash flow statement and even growth prospects are driven by WCM. Steyn et al. (2002) scrutinized WCM in Johannesburg Stock Exchange listed firms having high growth and contended that rise in sales lead to growth in non-cash working capital base. Also, they claimed that this growth in non-cash working capital base leads to less cash availability for financing and hence, more current assets are to be consumed for financing purposes, which could negatively influence the firm's performance. Hence, making it imperative for firms to not only focus on sales growth but at the same time, managing working capital efficiently is required for adequate availability of cash for financing daily operations. Harris (2005) found WCM to be a tedious task and required human factor as a support for its effective implementation. Also, they claimed that WCM efficiency is achieved through equal concentration on internal as well as external constraints along with process improvement. They suggested, this can be achieved through empowering organization with an entrepreneurial mindset and enabling the employees to understand the vital role of working capital in achieving progress in firms.

Gundavelli (2006) discussed working capital as a hidden reservoir in achieving sales growth which further pushes the expansion in firms. He indicated that managing working capital components such as receivables and payables lead to surplus availability of cash that can add up to five to nine percent in net profits. Also, their results implied the adoption of latest technology

in improving the business processes so that better management of payables and receivables could take place leading to substantial gains to the firm. Sagner (2007) investigated role of WCM efficiency in sustainability of firms by studying United States firms. Their study highlighted that firms having huge amount of unused working capital are being targeted for mergers and acquisitions because the acquirer sees the unused working capital as a potential for productive use. They suggested measures for achieving WCM efficiency in firms that includes unified strategy for payables, receivable collateralization, and just in time inventory.

Smid (2008) delve into the WCM practices and found WCM efficiency of substantial value due to its capability of releasing funds for the operations and subsequently leading to continual savings. He stated that despite challenges in managing the working capital efficiently, the benefits it offers are huge and WCM hence must become a part of strategic objective in firms and the upper-level management must commit for WCM efficiency to survive the global competition successfully. Bittner et al. (2011) discovered WCM as an essential area to be focused in today's business era wherein for achieving its efficiency, firms must try to shorten the current assets investments and cut down inventories in order to have surplus cash which will make the firms in a better negotiation position with both suppliers and customers. Also, they implied the implementation of effective liquidity management strategies right from the base level (i.e., workers) till the enterprise level (i.e., Chief Executive Officer) along with flow of transparent communication among the stakeholders leading to healthier connections, lower carrying costs, degraded outmodedness, and consequently less requisite for working capital. This would offer new business prospects which were previously not present.

Ek and Guerin (2011) emphasized on the importance of efficient WCM stating that too much or too less investment in working capital would make the firms lose other growth prospects

or lead to shortage of inventories which will further impact the sales. However, lack of any specific formula for estimating adequate amount of working capital motivated them to suggest that focus must be on purchase-to-pay payables, order-to-cash receivables, and forecast-to-fulfill inventories lead to WCM efficiency. Their results implied that working capital levels vary in terms of nature and size of the industry so firms must benchmark the practices of peers in upper quartile and readjust their working capital levels for achieving right WCM and in a way tackling deficit. Tagaduan and Nicolaescu (2011) examined WCM in firms of Romania and revealed that adverse impact of financial crisis or uncertainties can be reduced through WCM efficiency. This adds to the liquidity levels and provide more cash flows to the firms.

Bahhouth et al. (2014) used a sample of 1474 United States firms for estimating the influence of technology on working capital requirements wherein they indicated a substantial downfall in the working capital owing to technology advancement. The also stated that proportional change in working capital came out to be less than the increase in sales and its cost. Their study focused on adoption of efficient WCM strategies with consideration to size and nature of the industry. Furthermore, the authors concluded that high WCM efficiency will make the markets efficient due to less requirements for financing. Banham (2013) claimed that traditional ways of managing working capital needs to be ignored wherein large credit is prolonged for enlarging the customer base. Also, they mentioned that firms carefully manage the working capital only during times of uncertainties, hardships or high volatility in markets and otherwise, not much attention is paid towards it. Hence, the author suggested a mix of liquidity and profitability approach to maintain a stable and efficient WCM throughout the life cycle of firm.

Seth et al. (2020) investigated 563 Indian manufacturing exporters over a period from 2008-2018 for assessing the WCM efficiency. They identified WCM efficiency vital for firm's

survival and growth. Additionally, their results indicated a need for an improved working capital model that could balance among the losses and gains emerging from lower or excess investment in current assets to maintain WCM efficiency. Maina and Ishmail (2014) examined firms listed on Nairobi Stock Exchange for assessing the economic consequences of WCM efficiency on value and profitability of the firm. Their findings discovered that CCC, inventory conversion period, receivable days were substantial to the firm's value and profitability. The author also suggested WCM efficiency to be considered as pre-requisite for enhancing shareholder's value and directly impacts the profits of firms.

Chellasamy and Ligy (2019) studied Indian automobile sector and defined working capital as the management of short-term assets and liabilities wherein achieving its efficiency is one of the pre-conditions for achieving success in any firm. The results indicated the improvement in the WCM efficiency of some sample firms. However, elevated levels of inconsistency clearly point out the need to adapt to a sound policy management system for achieving WCM efficiency. Ma and Yao (2020) examined state controlled and non-state controlled manufacturing firms in China over a period from 2001-2008 for assessing the relationship between WCM efficiency and value of the firm. Their results indicated positive relation among WCM efficiency and firm value, and they suggested that reduction in CCC influence the return on assets positively. Seth, Chadha and Sharma (2020) evaluated WCM efficiency of 1391 Indian manufacturing industries using DEA technique over a period from 2008-2019. The authors revealed that the efficiency levels of managing the working capital is consistent in manufacturing industries throughout the time period of the study. Also, they suggested that WCM efficiency could be achieved inconsideration to each component of CCC i.e. receivable days, payable days, and inventory days, which in turn would enhance the firm's performance in terms of earnings and cash flows.

Kasiran, Mohamad and Chin (2016) argued WCM efficiency as one of the most essential segments in financing decisions acting as a stimulus to firm's performance. They signaled that WCM efficiency forms a fundamental part of the global corporate strategy and adds positively to value of the firm. Hence, the irrefutable importance of efficient WCM in certifying each working capital components to be operating at its best effect is desirable to the sustainable growth and development in firms.

The literature reviewed underscored the significance of WCM and its efficiency. As per the literature, managing working capital efficiently enhances the chances of firms in getting successful and disregarding WCM efficiency might cause failures in firms. Varied results in the studies suggest that managing working capital differs in terms of country, type, size, operating region etc. Also, the results have varied in terms of development wherein results from developed economies might not be applicable directly in developing economies, however, every study have focused on the need to enhance the WCM efficiency for achieving maximum performance. Considering the huge importance of WCM, non-applicability of results from developed economies to developing economies, and negligence in efficiently managing the working capital leads to an emergence of need for an extensive research on WCM. India being a developing economy incur huge potential but needs to work on enhancing the global performance, which makes WCM efficiency a vital area of study. This comprehensive research would highlight the prevailing WCM efficiency levels, its pattern, and comparative growth over the selected period and industries.

2.3 Measures of Working Capital Management Efficiency

Looking at the complexity in determining optimum working capital levels in firms, the point arises whether firms are capable enough in managing their working capital efficiently or not. Various

statistics have been advocated, namely CCC (Smith 1980); optimal CCC (Nobanee and Al Hajjar, 2014); adjusted CCC (Viskari et al., 2012); weighted CCC (Gentry et al., 1990); working capital requirement (Hill et al., 2010); net trade cycle (NTC) (Shin and Soenen, 1998); optimal NTC (Nobanee and Al Hajjar, 2014); total cash cycle (Gitman, 1974); operating cycle (Gill et al., 2010); optimal operating cycle (Nobanee and Al Hajjar, 2014); wherein widely used measure for assessing WCM efficiency is CCC (Kieschnick et al., 2006; Deloof, 2003; Garcia Teruel and Martinez-Solano, 2007). Traditionally, quick ratio and current ratio were utilized for analyzing the financial strength of firms and these ratios signified working capital levels by measuring current assets over current liabilities in ratio or percentage. These ratios indicated the firm's capability of meeting the short-term financial obligations for the current year. Though, some researchers have doubted the appropriateness of these ratios and preferred CCC over them (Smith, 1980; Seth et al. 2020).

CCC comprises of mainly managing three components, i.e. accounts receivables, accounts payables, and inventory. This includes the time period since the raw material purchase till the amount is received from sales of finished goods wherein the customer's credit policies are emulated along with inventory decisions and selection of suppliers (Pais and Gama, 2015). Mathematically, CCC is calculated by adding days inventory outstanding to the days receivable outstanding and further days payables outstanding is subtracted from it (Maheshwari, 2014). Fundamentally, managing CCC efficiently offers a restored command to the management over short-term decision-making including investment prospects. This in turn influence the ability of firms in managing its internal resources, financing constraints, sales capabilities, and funds generation capabilities along with profit and firm's value (Ebben and Johnson, 2011).

Shin and Soenen (1998) found negative relation of CCC (proxy for WCM efficiency) in listed American firms with profitability spread across period 1975-1994. Their results signified reduction of CCC to a reasonable minimum adds to the overall profits.

Deloof (2003) used cash conversion cycle (CCC) as a proxy for WCM efficiency in examining 1,009 non-financial firms in Belgian for a period across 1992-1996. Their study investigated the relation of WCM efficiency with profitability using several components such as inventory days, payable days, and receivable days. Their results signified that firms earning less profits delay their payment to the suppliers or creditors. They suggested that managers must focus on reducing the receivables and inventories days for enhancing shareholder's value.

Seth et al. (2020) examined 563 manufacturing firms of India involved in export activities for estimating WCM efficiency, which was measured by CCC. The authors revealed significant influence of total assets growth rate, profitability, asset turnover ratio, leverage, and productivity on CCC. Their results indicated a need for an improved working capital model that could balance among the losses and gains emerging from lower or excess investment in current assets to maintain WCM efficiency.

Other than CCC, researchers have studied WCM efficiency using index values such as, Ghosh and Maji (2004) investigated WCM efficiency in Indian cement industry from 1993-2002 using three index values- utilization index, performance index and overall efficiency index. Utilization index implies utilizing ability of the firm regarding overall current assets for generation of sales. It reflects the firm's operating cycle. Ultimately, shortening the operating cycle through increasing the utilization rate is desirable. Numerically, utilization index greater than one indicates WCM efficiency. Performance index signifies mean performance of current assets components. In other words, during a particular period if proportional increase in sales is higher than proportional

increase in current assets, then that firm is managing its working capital efficiently. Numerically, performance index greater than one implies presence of WCM efficiency. Overall efficiency index comprises of product of the utilization and performance index. It gauges the ultimate WCM efficiency of firms.

Similarly, Ramachandran and Janakiraman (2009) used three index values- utilization index, performance index and overall efficiency index for measuring WCM efficiency. This study acknowledged WCM efficiency to be necessary for profitability as well as liquidity in firms as it utilizes the funds tied up in idle assets. Their results indicated good levels of WCM efficiency in Indian paper industry for a period from 1998-2006. They also stated that firms with lower earnings wait longer to clear their dues and follow a decline in CCC.

Kasiran, Mohamad and Chin (2016) investigated WCM efficiency of small and medium enterprises (SMEs) in Malaysia using efficiency index of WCM, utilization index of WCM, and performance index of WCM. The results revealed low levels of efficiency in managing the working capital in Malaysian SMEs. The results held responsible lower WCM levels for degrading profitability.

Chellasamy and Ligy (2019) studied WCM efficiency in Indian automobile sector using three index values- utilization index, performance index and overall efficiency index. The results indicated the improvement in the WCM efficiency of some sample firms. However, elevated levels of inconsistency clearly point out the need to adapt to a sound policy management system for achieving WCM efficiency.

Few researchers have also studied efficiency in firms by adopting ratio methodology such as Saravanan (2001) performed ratio analysis using current ratio, liquidity ratio, debt-equity ratio,

fixed asset ratio, capital gearing ratio, return on investment, return on shareholder's funds, fixed charges coverage ratio, proprietary ratio, net working capital to bank credit, and shareholder's funds to bank credit for examining the liquidity and profitability in the selected non-banking financial companies.

The existing literature signified that although several measures are available for assessing the WCM efficiency, but, the most appropriate and popular measure came out to be CCC. The results signified that although CCC is effective measure for efficiency assessment, but it is not free from its own flaws inclusive of mathematical inaccuracy and other limitations. Measures other than CCC have also been questioned for their appropriateness and other shortcomings. Hence, a gap emerges in the literature in terms of an effective technique for assessing efficiency that can eradicate the flaws of earlier measures.

2.4 Data Envelopment Analysis as Efficiency Measure

The concept of data envelopment analysis (DEA) was introduced by Charnes, Cooper and Rhodes (1978) for estimating the efficiency of decision-making units (DMUs) relative to other units using multiple inputs and outputs. This model of Charnes, Cooper and Rhodes (1978), named as CCR, followed constant returns to scale (CRS) assumption wherein the efficiency was estimated assuming proportionate change in inputs and outputs to be the same. However, since the real scenario does not behave in the same manner, Banker, Charnes and Cooper (1984), named as BCC, adopted variable returns to scale (VRS) assumption for efficiency assessment by making a convex hull frontier to make the technique suitable in practical conditions. Thereafter the researchers have been applying DEA for gauging the efficiency in several areas, sectors, domain, and firms.

Mukherjee et al. (2001) estimated efficiency of commercial banks in United States of America (USA) using two-stage DEA wherein first stage comprised of efficiency assessment and the next stage explored the influence of exogenous determinants on the efficiency of banks. Staub et al. (2010) utilized DEA for measuring Brazilian banks efficiency along with their comparison with their counterparts in Europe and USA. Furthermore, the authors assessed the pure and technical efficiency wherein the technical efficiency formed for the reason for inefficiency in Brazilian banks. Additionally, the bank size and activity type were examined for their effect on the efficiency. Parameshwaran et al. (2009) measured automobile repair shop's efficiency using DEA for enhancing the shop's performance. The authors utilized both qualitative and quantitative measures for estimating relative efficiency for each shop and input/output efficient targets for them. Hoff (2007) performed two-stage DEA on Danish Fishery wherein the second stage results were compared using Tobit regression and Ordinary Least Squares (OLS) regression. These two alternative approaches to second stage DEA presented that OLS regression provide better results in comparison to Tobit regression and OLS regression can well replace the Tobit regression sufficiently for assessing the relationship of various determinants with the efficiency.

Simar and Wilson (2007) utilized DEA technique using bootstrapping method resulting into an improved reliability of the efficiency scores. They contended that since efficiencies calculated through DEA are relative to other DMUs, hence omission of some firms might alter the output which leads to a sample sensitive result. Consequently, carrying a bootstrapping of over 2000 iterations offers a result close to the outcome that would have been attained when the sample would consist of all DMUs of the population. Tsekeris (2011) adopted CCR and BCC model following CRS and VRS assumption for estimating Greek airport's efficiency along with bootstrapping DEA. Additionally, the author projected regression analysis for examining the effect

of various influencers on the efficiency and resulted into size and location to be significantly influencing the efficiency. Similarly, Medin et al. (2011) performed bootstrapped two-stage DEA for examining the cost efficiency of Nordic country's university hospitals. The authors performed CCR and BCC model of DEA wherein first stage comprised of cost efficiency estimation and second stage involves analyzing the effect of determinants on the efficiency scores using OLS regression.

Marschall and Flessa (2011) adopted two-stage DEA for calculating African's primary care efficiency in Burkina Faso and identified the factors impacting primary care efficiency. Noh (2011) performed scale and pure efficiency using CCR and BCC DEA models for assessing the resource utilization efficiency of university libraries. Likewise, Sharma and Raina (2013) analyzed the performance of automobile industry of India through several efficiency measures of DEA. Their results demonstrated technical inefficiency in automobile firms highlighting the need for potential saving in inputs through benchmarking targets. Krishna and Sai (2016) performed DEA analysis along with TOPSIS approach for estimating the Indian public sector bank's financial efficiency. Agasisti et al. (2014) measured Italian public school's managerial efficiency wherein two-stage DEA was employed. First stage involved bootstrapped BCC DEA scores highlighting the efficiency of public schools and second stage stated the influence of exogenous variables on efficiency using Tobit regression.

Li, Wang and Lee (2019) investigated the recycling and waste treatment efficiency for waste processing industries using two-stage DEA with undesirable inputs for obtaining an environment friendly and resource-conserving supply chain in Chinese industries. Zeng et al. (2020) evaluated renewable energy development efficiency using two-stage DEA for a better renewable energy planning. The inputs used by the authors included different scheme's

performances and energy structure's optimal design. Dutta, Jain and Gupta (2020) underwent performance analysis of non-banking finance companies (NBFCs) through two-stage DEA. The first stage included calculation of super-efficiency and next stage involved examination of the influence of exogenous determinants on the NBFC efficiency using Tobit regression. Ouenniche and Carrales (2018) adopted DEA and regression-based feedback for examining efficiency in United Kingdom banking sector. Their results signified huge improvement prospects in terms of technical and scale size to be attained in UK's commercial banks.

A two-stage network DEA was adopted by Gulati and Kumar (2017) for assessing the operating and intermediate efficiencies in Indian banks. Further, the authors utilized bootstrapped truncated regression algorithm for examining the influence of selected determinants on the efficiencies. Their results stated that determinants such as income diversification, profitability, liquidity position, and size influence the operating and intermediation efficiency.

The literature clearly signifies the use of DEA in numerous areas, sectors, and aspects for gauging the DMU's efficiency using multiple inputs and outputs. Authors have utilized two-stage DEA which in addition to including efficiency assessment involves estimation of the relationship of certain determinants with the required efficiency. Moreover, using bootstrapping in DEA have provided better results by reducing the sample bias issue of DEA. Other than this, authors have stated various advantages of DEA which makes it a better prospect to achieve the desired target efficiency level. Literature highlighted extensive focus on the developed economies with an emphasis on the efficiency assessment of schools, banks and transport authorities. However, analysis of manufacturing sector of developing economy, such as India, is relatively limited. The count and quality of literature concerning WCM is sparse and especially, the short-term components which are vital for any manufacturing firm's existence are uncertain. Hence, a multi-

stage DEA is a suitable technique for estimating the WCM efficiency for Indian manufacturing firms and further assessing the relationship of various determinants with WCM efficiency.

2.5 Artificial Neural Networks as a Prediction Technique

Artificial neural networks (ANN) is termed as a processor of analogous scattered nature comprising of plain administering units with natural predisposition for storing investigational knowledge and rendering it for usage (Haykin, 2007). ANN operates in akin to the human brain as in this learning process occurs through knowledge gained from the surrounding environment. Further, the knowledge obtained is stored via neurons or nodes, which is also termed as synaptic weights (Haykin, 2007). Commonly, there are three layers, such as input, hidden, and output layer in a neural network wherein input layer consumes the data using the synaptic weights assigned to each input. Then via hidden layer, the input values generate the output information using applied weights in a nonlinear activation function (Agarwal, 2016). ANN can be grouped into four distinct clusters: (a) radial basis functional networks; (b) recurrent networks; (c) multi-layer perceptron networks; (d) feed forward neural networks (Sim *et al.*, 2014).

The current study employs a multi-explanatory approach by combining DEA and artificial neural network analysis. Detection of even non-linear connections in complex problems, makes neural network the most standout artificial intelligence technique. In this comparison, multiple regression analysis and structural equation modeling comes behind ANN, as they over-simplifies complex decision process (Tan *et al.*, 2010). Additionally, ANN provides more robust results than conventional tools due to its high accuracy order and is capable to learn complex associations among predictors and the adoption decision (Chan and Chong, 2012).

Wu, Yang and Liang (2006) used a combination of DEA and ANN for assessing the Canadian bank branches' efficiency. Likewise, Emrouznejad and Shale (2009) efficiency of large data sets was measured through combined DEA and ANN approach. Tsai *et al.* (2009) developed a model for consumer loan default prediction by applying DEA, discriminant analysis and neural network. Shabanpour, Yousefi and Saen (2017) examined the green suppliers' efficiency by dynamic DEA and ANN. Lately, influence of operational efficiency and R&D on performance was investigated using DEA, neural network, and sequential regression approach (Lee *et al.*, 2019).

Note that previous researchers in WCM domain have focused on basic DEA models that lacks translational invariant property for examining efficiency. Further, the focus has just been on assessing the individual effect of factors on WCM efficiency and not on the relative importance of these factors, which requires a predictive analysis technique. Hence, the current study performs a combined approach of DEA and ANN, wherein (a) WCM efficiency is calculated using SBM-DEA method which provided a non-radial measure allowing non-proportional augmentations in outputs or reductions in inputs; (b) panel data fixed effects model is applied for examining the individual effect of selected determinants on WCM efficiency; (c) ANN is employed for checking the relative importance of selected determinants on WCM efficiency. This would further act as a validation to our proposed WCM efficiency model in the context of manufacturing firms.

The literature suggested several measures for assessing the WCM efficiency, however, the widely used measure came out to be CCC. Additionally, other measures such as net trade cycle and index values are gaining importance. Existing studies have signified the effectiveness of CCC in terms of measuring WCM efficiency but the same has been criticized for its mathematical correctness

and other drawbacks. Other measures also suffer from some or the other drawbacks. Hence, there exists a gap in the literature for an appropriate and effective measure of WCM efficiency that can fulfill the shortcomings of previous measures. The DEA methodology suffice the requirement and has been praised for its accuracy, appropriateness, and applicability for gauging the WCM efficiency. Furthermore, lack of studies on identification of the most vital determinants influencing the WCM efficiency persists. In line to this, a need emerges for a prediction tool that can offer variable wise importance to enhance the WCM efficiency. Adopting ANN technique, hence, fulfills the need of the hour resulting into shift of focus from least important to the most important variables.

2.6 Research Gaps

Despite focus on the emerging need for WCM at the industry level and consequent support from the government, Indian manufacturing sector is still lacking in terms of efficiency in order to match with the global trends starting at the execution level. Further, lack of any adequate efficiency measurement method persists that can assess the WCM efficiency of Indian manufacturing sector at the national level and also to contend with its foreign counterparts. Although studies have been performed in the developed economy for assessing relationship of WCM efficiency with various determinants but the contradiction in their relationships lacks adequacy and generalization to the developing economies, such as India. Also, limited availability of studies pertaining to holistic examination of WCM, measures of efficiency, its vital determinants and importance wise classification of the significant determinants in the Indian manufacturing sector prevails and hence, offers a curious field of study. In line to this, ANN can be applied for validation of the proposed model and sensitivity analysis can be used for predicting the most vital determinants influencing

WCM efficiency. Table 1.1 presents a brief of the research area used, previous research signifying existing work, and current study presenting the addition to the existing work fulfilling the emerged gaps in the literature.

Table 1.1: Research Gaps

Research Area	Previous Research	Current Study
Vital role of WCM efficiency	<ul style="list-style-type: none"> • WCM efficiency being one of the foremost financial decisions in firms. • However, its negligence leads to failure and bankruptcy. • Practices and policies of managing the working capital differs widely among the developing and developed economies. • WCM being a lifeline for manufacturing industries have not been investigated exhaustively. 	<ul style="list-style-type: none"> • Comprehensive research on WCM efficiency in India. • Prevailing levels of WCM efficiency in India. • Understanding of the components behind WCM efficiency. • Better understanding of liquidity management in Indian manufacturing industries.
WCM efficiency measure	<ul style="list-style-type: none"> • Numerous measures for estimating WCM efficiency have been proposed. • None of the measure is free from drawbacks or have been questioned for their adequacy. • A need emerges for an improved efficiency measurement model that can 	<ul style="list-style-type: none"> • Proposed a new efficiency measure incorporating the working capital components wherein previous drawbacks have been taken care off and several advantages have been provided.

	offer a real picture of WCM without any flaws.	
Determinants of WCM	<ul style="list-style-type: none"> • Determinants influencing WCM efficiency range from firm-level to macro-economic level. • Lack of studies investigating a mix of firm-level and macro-economic factors that impact WCM efficiency. • The influencers vary in terms of country, economy, type, scale etc. • Existing researchers have utilized small sample and short period that might not provide accurate results. 	<ul style="list-style-type: none"> • A combination of most vital determinants including firm-level and macro-economic determinants in the Indian context have been utilized. • Big sample size covering a larger time period extracted from nine industries of Indian manufacturing sector. • An improved measure of WCM efficiency of DEA is proposed for examining the influence of determinants.
Validation and importance of the significant determinants	<ul style="list-style-type: none"> • Studies have analyzed determinants of WCM efficiency. • Lack of studies on prediction of an efficient WCM model. • No studies on importance-wise classification of the significant determinants. 	<ul style="list-style-type: none"> • Utilized ANN approach for validation of the WCM model. • Performed sensitivity analysis for extracting the average importance of predictors in the model

Source: Existing Studies in Literature