report

IDENTIFICATION OF BARRIERS AND THEIR EFFECTS IN IMPLEMENTATION OF CONSTRUCTION SUPPLY CHAIN MANAGEMENT

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Statement of Originality

I, **Bhavinkumar Devjibhai Parmar**, Roll No. **22MCLT07**, give undertaking that the Major Project entitled **"Identification of Barriers and Their Effects in Implementation of Construction Supply Chain Management"** submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Construction Technology and Management** from Civil Engineering Department of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. It contains no material that is previously published or written, except where references have been made. I understand that in the event of similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action

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(Signature of Guide)

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This is to certify that the report of Major Project entitled **"IDENTIFICATION OF BARRIERS AND THEIR EFFECTS IN IMPLEMENTATION OF CONSTRUCTION SUPPLY CHAIN MANAGEMENT"** submitted by **"PARMAR BHAVINKUMAR D."**, towards the partial fulfillment of the requirements for the degree of Masters of Technology in Construction Technology and Management of Nirma University, Ahmedabad, is the record of work carried out by him/her under my supervision and guidance. In my opinion, the submitted work has reached the level required to be accepted for examination. The results embodied in this report, to the best of my knowledge, haven't been submitted to any other university or institution.

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Abstract

The construction industry is increasingly implementing supply chain management (SCM), yet various barriers hinder its effective implementation. Identifying and addressing these barriers may ensure the realization of expected benefits from Construction Supply Chain Management (CSCM). Therefore, this study aims to investigate the impact of barriers in implementing CSCM. Firstly, through an extensive literature review, 31 barrier attributes and 13 effect attributes were identified, and a questionnaire was prepared accordingly. Exploratory factor analysis (EFA) on a questionnaire survey of 110 industry experts grouped 29 barrier attributes into seven components. Similarly, 13 effect attributes were grouped into four components. Initially, two different three-level hierarchical structures were developed for barrier and effect components based on the factor analysis results. Subsequently, the two separate models of the barrier and effect components were created and confirmed using Confirmatory Factor Analysis (CFA) findings. A hypothesized model was developed using the Structural Equation Modelling (SEM) approach, indicating a relationship between barriers and effects. The model tested a positive relationship between five barrier components and four effect components. The findings of this study show a positive relationship between barriers and effects, indicating that "stakeholder's issue is the most important factor, followed by execution issue." This study contributes valuable insights to the existing body of knowledge on CSCM, enhancing practitioners' and researchers' understanding and fostering the evolution of SCM practices in the construction sector.

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Abbreviations and Acronyms

SC .... Supply Chain
SCM .... Supply Chain Management
CSCM .... Construction Supply Chain Management
EFA .... Exploratory Factor Analysis
CFA .... Confirmatory Factor Analysis
SEM .... Structural Equation Modeling
SPSS .... Statistical Package for Social Sciences
AMOS .... Analysis of Moment Structures

Chapter 1

INTRODUCTION

1.1 Prologue

Many stakeholders are crucial for the success of construction projects because they encourage integrated collaboration and teamwork at each phase. However, there are several additional varied concerns that impact the construction sector, such as a separation of design and construction, in addition to inadequate interaction and collaboration among the appropriate stakeholders Albaloushi & Skitmore (2008). The construction industry differs from other industries in that it is characterized by project-based work, quick organizational duration, stage interruptions, and a single design and set of material standards that are either nonexistent or extremely flexible. The construction industry continues to employ traditional project management techniques despite their drawbacks, which include the need for an individual point of contact for deals between channel groups, short-term endeavors, a shortage of exchange of data and monitoring, working independently, and a failure to communicate both risks and benefits Ahmed et al. (2002). The idea of supply chain management (SCM) is more appropriate and desirable in order to accomplish the previously mentioned characteristics and ensure the construction industry's continued growth. The coordination of different interactions along the supply chain is referred to as supply chain management. According to Ganeshan (1995), supply chain management is the process of procuring raw materials, converting them into intermediate and final products, and delivering the final products to customers via a network of facilities and distribution options. Instead of being a chain of companies with one-to-one business-to-business contacts, the supply chain is typically a network of several firms and relationships

(Lambert & Cooper 2000). In regard to this, SCM may be applied to manage upcoming construction problems and enhance the organization's efficiency and competitiveness (Giannakis & Croom 2004). O'brien et al. (2004) and Bankvall et al. (2010) suggest that SCM is a helpful tactic for addressing issues and boosting the competitiveness and profitability of the construction sector. Kim & Nguyen (2022) propose that construction supply chain management (CSCM) presents an opportunity to significantly enhance stakeholder and customer value while lowering overall costs. It also involves integrating important business processes related to the construction sector, such as demand management, environment management, construction flow management, supplier relationship management, owner service management, and research and development. Furthermore, according to Xue et al. (2007), CSCM includes owner-service management, construction process management, demand management, supply relationship management, environment management, and development and research. According to Dainty et al. (2001), the main contractor is positioned in the center of the hub of a typical construction supply chain (SC), with connections to both a number of suppliers and subcontractors on the one hand and customers and end users on the other.

Nevertheless, the construction sector in developing nations like India still struggles with the unsuccessful application of CSCM, exacerbating project failures associated with time, cost, and quality challenges (Doloi et al. 2012). The Ministry of Statistics and Programme Implementation (MoSPI 2023) study states that 756 of the 1476 infrastructure construction projects are under schedule, resulting in a 55 billion US dollar cost overrun. Understanding all of the barriers and their effects is necessary for a more effective implementation of CSCM, particularly in view of the current situation of the Indian construction industry. Through identification of the main barriers and their effects, professionals may develop appropriate strategies and solutions to accelerate SCM adoption in the construction sector. Furthermore, the anticipated benefits could not materialize if barriers to the adoption of CSCM are not removed.

1.2 Need of the Study

Barriers impeding the complete implementation of CSCM are the reason it is being adopted slowly. Furthermore, if barriers are not found and eliminated, the expected advantages of CSCM could not manifest as anticipated. It seems that prior research has not looked closely at and investigated the challenges associated with CSCM adoption. Furthermore, no other prior research has demonstrated the relationship model or hypothesized model for the barriers and their effects in terms of the implementation of construction supply chain management. This analysis pinpoints the barriers, and their effects unearth the underlying connections between them. Therefore, effectively avoiding these barriers might result in the implementation of CSCM.

1.3 Objectives of study

The principal objectives of this research are -

- To identify the barriers affecting the implementation of construction supply chain management and their effects.
- To test the hypothesis of identified barriers affecting the implementation of construction supply chain management.
- To explore the relative impact of the barriers and their effects on the implementation of the construction supply chain management.

1.4 Scope of work

1.5 Outline of the thesis:

Chapter 1 - Introduction: The research will focus on small, medium, and large-scale projects and will focus on the Gujarat region. This research will encompass residential, commercial, and infrastructure projects (roads, bridges, and railways).

Chapter 2: Literature Review: This section reviews the literature on construction supply chain management. Also, the different types of studies are reviewed in this section. This is also explained by the available studies on identifying the research gap. this section explains the applications of different factor analysis methods that will be used in this study

Chapter 3- Research methodology: This chapter describes the research methods used to meet the study's objectives. It begins with the identification of barriers and their effects based on significant literature analysis and expert interviews. The approach is divided into many stages, which include the formation of a questionnaire, a pilot survey, an expert survey, data collecting, and analysis. Validating the detected features and their interrelationships is accomplished using techniques such as Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modelling (SEM). This methodical methodology enables a thorough assessment of the barriers and their effects on the implementation of CSCM.

Chapter 4- Results and Discussion: This chapter presents and discusses the data collection and analysis outcomes in depth. The chapter delves into the ranking of barrier attributes and effect attributes. It highlights the results of the exploratory and confirmatory factor analyses, Confirmatory factor analysis, and the structural equation modeling. This section explains the hypothesized model obtained from the result of the analysis with an explanation of emerging barriers.

Chapter 5- Summary and Conclusion: The last chapter summarises the study's important results. It discusses the study's contributions to existing knowledge. The chapter also discusses the study's shortcomings and proposes topics for further research.

Chapter 2

LITERATURE REVIEW

2.1 Prologue

The literature review is essential to any research work since it discusses previously published information and identifies gaps in past research practices. The following sections in the chapter summarise the comprehensive review of construction supply chain management.

2.2 Summary of Construction Supply Chain Management

For several decades now, CSCM has attracted the interest of scholars and practitioners, acquiring significant and equal attention. For this reason, earlier research on SCM was examined to find potential barriers to the implementation of CSCM. The writers carried out a content analysis to identify terms related to "barriers," "obstacles," "difficulties," "problems," and "challenges" that might potentially hinder the implementation of CSCM. Although there have been studies on SCM in construction, the majority of them have not attempted to identify all barriers, especially those particular to Indian origin. As such, its content focused on just a few barriers to the widespread application of CSCM. According to Salami et al. (2013), there are barriers to SCM adoption among Turkish small and medium-sized contractors. They emphasize the need for customized approaches to CSCM implementation. In order to address barriers in the implementation of CSCM for environmental sustainability, Wibowo et al. (2018) investigated green supply chain management adoption variables in the construction sector. Costa et al.

(2019) evaluated customer-supplier relationships using the DEMATEL approach, providing information about barriers to the implementation of CSCM. Noorizadeh et al. (2019) investigation into supplier performance evaluation challenges within the construction industry provided light on implementation barriers for CSCM and offered mitigation methods. To shed light on the challenges associated with implementing CSCM, The influence of organizational ambidexterity and environmental unpredictability on supply chain integration, as well as the connection between SC agility and organizational flexibility in production enterprises, are examined by Shukor et al. (2021). The findings of this study indicate a robust correlation between supply chain integration, encompassing customer, supplier, and internal integration, and environmental unpredictability. The integration of the supply chain and organizational ambidexterity are significantly correlated. It was demonstrated that supply chain integration improved the company's organizational flexibility and supply chain agility. Arshad & Zayed (2022) looked at important aspects of supply chain management for modular integrated construction. In order to assist with removing barriers and streamlining the implementation of CSCM, Heaton et al. (2022) offered workable strategies for handling intricate supply chains in the field of construction material management. In their investigation of risk and success variables in building supply chains, Abas et al. (2022) identified obstacles and provided information relevant to the application of CSCM.

It is evident from the research conducted by Kim & Nguyen (2022), Ying et al. (2015), and Wong et al. (2004) that the barriers impeding the adoption of CSCM are frequently local in nature and can differ across different domains and countries. Therefore, it is crucial to recognize the barriers and their effects in the implementation of CSCM. However, identifying the potential barriers and their effects is tedious, as it is necessary to incorporate every possible barrier and ensure the interrelationship within the potential barriers. Also, it is necessary to evaluate the relationship between barriers and their effects on implementation of CSCM

2.3 Research Gap

The literature study makes it evident that the majority of the research that has been done thus far has focused on a certain area of the construction sector, such as contractors, environmental sustainability, customer-supplier relationships, supplier performance evaluation, modular integrated construction, materials management, and critical risk and success factors of CSCM. However, a holistic set of barriers and their effects on the overall industry is still lacking. Also, no previous studies were found to be focused on the model showing the relationship between barriers and their effects on the implementation of CSCM.

2.4 Application of Exploratory Factor Analysis (EFA)

CSCM is facing several problems in terms of its application in the Indian construction industry. Identification of barriers and their effects on the implementation of CSCM is also a tedious task. To guarantee the accuracy and comprehensiveness of an identified model and to heighten the need for enhancing the understanding of a structure with the interrelationships between its components, it is necessary to include every potential barrier and effect. It has recently been shown that the EFA approach works well for figuring out the basic structure or framework in the questionnaire questions without knowing the individual components beforehand Zhang, Liu, Wu & Skibniewski (2016). As per Hair et al. (2014), EFA is especially appropriate for analyzing intricate patterns and multidimensional relationships.

The EFA technique has been used by a number of researchers (Kim & Nguyen (2022); Amade (2016); Erik Eriksson et al. (2008)) to identify the obstacles to the implementation of CSCM in various contexts. The factor model or structure is identified by EFA based on attributes, according to Tabachnick et al. (2013). One statistical approach that is frequently used in EFA to identify factors is principal component analysis (PCA) (Iyer & Jha 2005).

According to Lam et al. (2008), PCA is a useful method for breaking down and organizing the underlying essential elements into smaller quantities by clearly applying factor scores. For the factorial analysis, EFA employs the following four steps: (1) sample size; (2) correlation matrix; (3) Kaiser-Meyer-Olkin (KMO) and Bartlett's tests; (4) factor extraction.

2.5 Application of Confirmatory Factor Analysis (CFA)

The construction industry faces various challenges in implementing effective supply chain management (CSCM). Identifying and understanding these barriers is crucial for developing strategies to mitigate their impact. CFA is a statistical technique that can be utilized to validate the factors or barriers affecting CSCM implementation, ensuring that the hypothesized model accurately represents the data. In a sense, CFA is a tool that enables us to either "confirm" or "reject" our preconceived theory. Validation of the measurement model through CFA is the first step in SEM. According to Mueller & Hancock (2008), the CFA enables the evaluation of the fit between the observed data and a theoretically grounded, previously developed model that outlines proposed causal relationships between constructs and their observable indicator variables.

CFA is a crucial statistical technique used to validate the factor structure identified by exploratory methods like Exploratory Factor Analysis (EFA) (Hair et al. 2014). CFA is instrumental in confirming whether the data fit a hypothesized measurement model based on theoretical and empirical foundations (Hair et al. 2014). This technique not only tests the hypothesized relationships between observed variables and their underlying latent constructs but also refines the model by assessing the adequacy of each construct's representation. CFA has been widely adopted in construction, management research domains to validate constructs and ensure model accuracy.

The application of CFA involves several steps. Firstly, a hypothesized model of barriers is developed based on the results from EFA and existing literature. Then, data is collected through a structured questionnaire targeting professionals in the construction industry. The model is then tested using CFA to determine the goodness-of-fit indices. By calculating the goodness of fit of the model, CFA is helpful in evaluating the scale's validity. An instrument's validity must be established by an acceptable fit, which can be assessed using a variety of indices, including the chi-square/df criteria, root mean square error approximation (RMSEA), normed fit index (NFI), Tucker Lewis index (TLI), goodness of fit index (GFI), comparative fit index (CFI), and root mean square error approximation (RMSEA) (Marsh et al. 2020). To ensure the validity and reliability of the constructs, CFA also involves assessing the convergent and discriminant validity of the factors. Convergent validity ensures that items intended to measure the same construct are highly correlated, while discriminant validity verifies that constructs intended to be distinct are indeed different (Fornell & Larcker 1981). By confirming these aspects, CFA strengthens the credibility of the model and its findings.

2.6 Application of Structural Equation Modeling (SEM)

Using multiple regressions and factor analysis, SEM is a confirmatory multivariate approach. Given that it works well for causal research, it has gained popularity as a research technique in the social sciences, including political science, economics, sociology, psychology, marketing, health, and education. In construction engineering and management research, SEM is not fully used, despite its many benefits (Molenaar et al. 2000). Chen et al. (2012) describe the SEM as an approach to multivariate statistics that includes two distinct model types; the first one is a structural model known as regression or path analysis, and another one is a measurement model known as confirmatory factor analysis. The causal connection between latent variables is ascertained using the structural model, according to Molenaar et al. (2000) and Wong & Cheung (2005)). One advantage of SEM is its ability to simultaneously model and analyze correlations between several independent and dependent components (Molwus et al. 2013). SEM takes measurement errors into consideration and offers a single model that captures the entire set of relationships, in contrast to other multivariate statistical techniques like regression analysis (Molwus et al. 2013). Covariance-based SEM (CB-SEM) and variance-based SEM (VB-SEM) are the two kinds of SEM. The partial least-square (PLS) approach is employed in the VB-SEM, whereas software is employed in the CB-SEM. The covariance matrices, which support the theoretical justification offered by the model and explain the relationship between observable and latent variables, serve as the foundation for the CB-SEM. According to S. Davcik (2014), the VB-SEM reports the amount of variation explained, which helps to establish a relationship between latent variables. While the VB-SEM functions similarly to multiple regression analysis, the CB-SEM seeks to validate theories by evaluating a model's ability to estimate a covariance matrix for the sample data (Hair et al. 2014). The maximum likelihood technique is the approach most frequently used to determine the covariance in the SEM (Cho et al. 2009)

Due to the aforementioned benefits, SEM has been utilized in different construction management domains, including determining success factors for a construction organization (Tripathi & Jha 2018*b*), determinants of safety performance in construction projects (Patel & Jha 2016), discovering success traits for a construction project (Tabish & Jha 2012), examining factors influencing delays in construction projects of India (Doloi et al. 2012), and investigating relationships between CSFs of construction projects (Chen et al. 2012). As a result, the extensive body of current research supports the validity and usefulness of SEM.

Chapter 3

Methodology

3.1 Prologue

The methodology of the study is formed based on several literature studies to discover various barriers and their effects in implementation of CSCM. To fulfill the objective of this study, the methodology of the study is defined in six steps as shown in Figure 3.1

Step 1: Identification of barriers and their effects

In the first step, 31 barrier attributes and 13 effect attributes were identified from the existing literature. These identified attributes are shown in Tables 3.1 and 3.2. Five professionals with over twenty years of experience confirmed this list. This validation was used to ensure the appropriateness of these attributes from the perspective of the CSCM. No more modifications were proposed since all of the experts had approved the list of attributes.

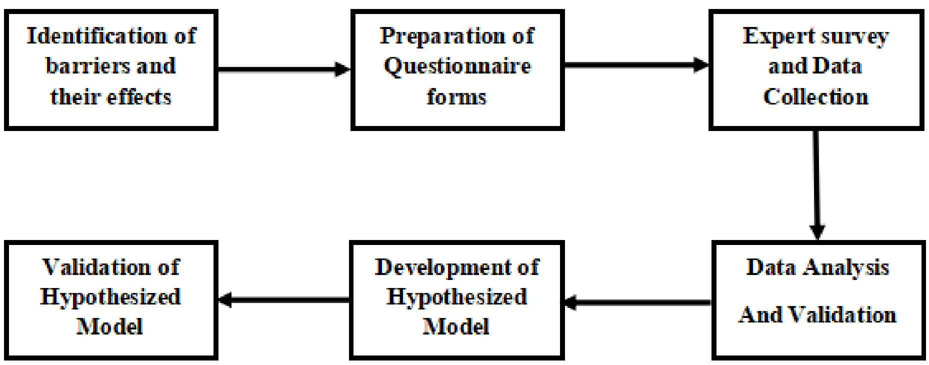

Figure 3.1: Research Methodology

Table 3.1: Identified Barrier attributes

ID	Barriers	References
B1	Lack of Funding	Abas et al. (2022), Meyer and Torres (2019)
B2	Inadequate performance of Procurement Team	Abas et al. (2022), Heaton et al. (2022), Ying et al. (2013) Wibowo et al. (2018), Wong et al. (2004), Meyer and Torres (2019)
B3	Inadequate performance of Management Team	Abas et al. (2022), Kim and Nguyen (2022), Heaton et al. (2022), Arshad and Zayed (2022), Wibowo et al. (2018), Wong et al. (2004), Meyer and Torres (2019)
B4	Lack of Communication b/w stakeholders	Abas et al. (2022), Kim and Nguyen 2021, Costa et al. (2019), Heaton et al. (2022) , Arshad and Zayed (2022), Salami et al. (2016), Wong et al. (2004), Amade (2016), Meyer and Torres (2019)
B5	Material Price Fluctuation	Abas et al. (2022), Arshad and Zayed (2022)
B6	Uncertainty in Cash Flow	Abas et al. (2022), Wong et al. (2004)
B7	Weather Condition	Abas et al. (2022), Heaton et al. (2022)
B8	Effect of Bureaucracy and political influence	Abas et al. (2022), Costa et al. (2019)
B9	Effect of Government policies	Abas et al. (2022), Costa et al. (2019), Eriksson et al. (2008), Wibowo et al. (2018)
B10	Effect of Standardization of activities	Abas et al. (2022), Noorizadeh et al. (2019), Arshad and Zayed (2022), Amade (2016)

B11	Effect of Law and order situation	Abas et al. (2022), Costa et al. (2019), Eriksson et al. (2008), Wibowo et al. (2018)
B12	Inappropriate tendering /bidding methods	Abas et al. (2022), Kim and Nguyen (2022), Costa et al. (2019), Noorizadeh et al. (2019), Heaton et al. (2022) , Wong et al. (2004), Olaniyi et al. (2015)
B3	Bad relations b/w Suppliers and contractors	Abas et al. (2022), Costa et al. (2019), Noorizadeh et al. (2019)
B4	Inadequate use of Information Technology	Arshad and Zayed (2022), Salami et al. (2016)
B15	Lack of Supplier's involvement	Kim and Nguyen (2022), Costa et al. (2019), Eriksson et al. (2008), Salami et al. (2016), Wong et al. (2004), Olaniyi et al. (2015)
B16	Diverse objective among stakeholders	Kim and Nguyen (2022), Costa et al 2019, Eriksson et al. (2008), Salami et al. (2016), Wong et al. (2004), Meyer and Torres (2019), Olaniyi et al. (2015)
B17	Lack of Top Management involvement	Costa et al 2019, Eriksson et al. (2008),Salami et al. (2016), Amade (2016), Meyer and Torres (2019)
B18	Difficulties in accessing resources	Wibowo et al. (2018), Salami et al. (2016)
B19	Complex Construction Process	Noorizadeh et al. (2019), Heaton et al. (2022), Arshad and Zayed (2022), Amade (2016)
B20	Improper Monitoring of Supply Chain	Arshad and Zayed (2022), Amade (2016)
B21	Construction Delays	Arshad and Zayed (2022)
B22	Decentralized Decision Making	Arshad and Zayed (2022)

B23	Improper Risk Sharing / risk allocation	Kim and Nguyen (2022), , Arshad and Zayed (2022), Wong et al. (2004), Olaniyi et al. (2015)
B24	Less Understanding of Supply Chain Management Concept	Kim and Nguyen (2022), Ying et al. (2013) Wong et al. (2004), Amade (2016), Olaniyi et al. (2015)
B25	Improper Organizational Structure to Support Supply Chain Management	Kim and Nguyen (2022), Noorizadeh et al. (2019),Ying et al. (2013) Amade (2016), Meyer and Torres (2019), Olaniyi et al. (2015)
B26	Lack of Training	Kim and Nguyen (2022), Olaniyi et al. (2015)
B27	Complexity of Supply Chain Management	Kim and Nguyen (2022), Heaton et al. (2022), Olaniyi et al. (2015)
B28	Lack of Appreciation	Eriksson et al. (2008), Amade (2016)
B29	Temporary or short term Supply Chain network	Kim and Nguyen (2022), Heaton et al. (2022), Olaniyi et al. (2015)
B30	Lack of commitment of firms (Client,Contractor, Supplier)	Costa et al. (2019), Eriksson et al. (2008)
B31	Geographic condition	Costa et al. (2019), Heaton et al. (2022)

Table 3.2: Identified Effect attributes

ID	**Effects**	**References**
E1	Cost Overrun	Costa et al. (2019), Ying et al. (2013), Heaton et al. (2022), Noorizadeh et al (2019), Kim and Nguyen (2022), abas et al. (2022)
E2	Time Overrun	Costa et al. (2019), Heaton et al. (2022), Noorizadeh et al. (2019), Abas et al. (2022)

E3	Reduce Productivity	Costa et al. (2019), Ying et al. (2013)
E4	Customer's Dissatisfaction	Costa et al. (2019)
E5	Poor Product/Service Delivery	Costa et al. (2019), Noorizadeh et al. (2019)
E6	Poor Quality of Product	Costa et al. (2019), Kim and Nguyen (2022), Abas et al. (2022)
E7	Poor Material Management	Ying et al. (2013), Heaton et al. (2022)
E8	Increased Waste	Ying et al. (2013)
E9	Disputes b/w Stakeholders	Heaton et al. (2022)
E10	Rework/Design Change	Heaton et al. (2022), Abas et al. (2020)
E11	Impact on Construction Process	Heaton et al. (2022)
E12	Impact on other supplier's delivery	Noorizadeh et al. (2019)
E13	Impact on the degree of commitment of other stakeholders	Kim and Nguyen (2020)

Step 2: Preparation of Questionnaire Forms and Pilot study

The following step was to create a questionnaire based on the 31 barrier attributes and 13 effect attributes discovered in the initial step. In this study, the questionnaire was created in two forms: Hard copy forms for in-person interviews and Google form for online/telephonic interviews. The questionnaire had four sections; where the first section included an evaluation of barrier attributes by respondents on a five-point Likert scale, with 1 indicating Very Low Impact, 2 low impact, 3 moderate Impact, 4 high Impact, and 5 very high impact. Five-point Likert scales are preferred over seven-point ones in this study because they increase response rate and quality while lowering respondents' irritation (Tripathi & Jha 2019). The second section included respondents' reviews of the effect attributes using the Likert scale which has five points: 1 for Very Low Effect, 2 for Low Effect, 3 for Moderate Effect, 4 for High Effect, and 5 for Very High Effect. The third portion included an area for feedback from respondents. The last section includes questions about the respondents' information. Then, a pilot survey was conducted to assess the questionnaire's comprehension and appropriateness.

Step 3: Data Collection

CSC is associated with all construction stakeholders, such as owners, consultants, designers, contractors, subcontractors, and suppliers. However, Considering the above criteria, a total of 99 respondents from various small, medium, and large-sized construction companies were contacted, and responses were collected over a period of 3 months (October to December of 2023). A total of 99 respondents from various small to large-sized construction companies were approached for the survey. Out of the 99 experts, 62 had five to ten years of expertise, and 26 had ten to twenty years. 9 of them had twenty to thirty years of expertise. 2 experts have over thirty years of expertise in the construction industry. Further, 39 respondents were senior site engineers, 22 were project managers, 14 were owners of companies or contractors, and the other 8 were assistant project managers. Additionally, there were 7 government engineers, 5 planning engineers, and 4 deputy project directors. Furthermore, 42 respondents were working on residential projects, 13 on commercial projects, and 44 on infrastructure projects such as the Mumbai Ahmedabad High-Speed Rail Project, Ahmedabad Metro Project, Surat Metro Project, and various road and bridge projects across the nation. The existence of these attributes in the construction company of India is based on all experts' responses.

Step 4: Data Analysis and Validation

In the fourth step of this study, EFA was used as a statistical method to determine the barrier components and effect components, utilizing the SPSS version 23 software. Before the EFA, the reliability test was performed using Cronbach's alpha test, one of the most common methods used to check reliability (Tripathi & Jha 2019). According to Gupta et al. (2024), Conducting a reliability test serves the objective of assessing the measurement's quality in the context of "consistency" and "repeatability." The most significant coefficient is Cronbach's alpha(α), which measures the attributes or barriers to internal consistency on the basis of the average correlation between the characteristics and the total number of attributes in the data (Giossi 2012). There are 0 to 1 reliability values. The level of internal consistency increases with the increasing value of α. Research indicates that when the α value is at least 0.7 times the reliability of the scale, it is deemed good; if not, it is not (George & Mallery 1999). Following the reliability test, the mean value and standard deviation (SD) of the barrier and effects attributes were used to rank them. The attributes with the lowest standard deviation were rated higher if more than one attribute had an equal value of mean. After that, a one-sample t-test is applied to check the significance between the population mean and the sample (Tripathi & Jha 2019). Then, to confirm the consistency of the findings and determine if the data was sufficient for factor analysis, the questionnaire validity was assessed using the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. If the KMO measure of sample adequacy values is close to 1, a correlation matrix is significant for the processes; values closer to 1 provide stronger evidence, as per Fellows & Liu (2021). The KMO and Bartlett tests were executed to confirm that the primary barrier showed high correlations. Specifically, the KMO test examines if the results are adequately dispersed throughout the test data used for the analysis. KMO correlations greater than 0.60 to 0.70 are deemed sufficient for evaluating the EFA result (Netemeyer et al. 2003). An output of chi-square that has to be significant is provided by Bartlett's test of sphericity (Tripathi & Jha 2019). The fact that it shows that the matrix is not an identity matrix means that factor analysis should only be appropriate if it is significant ($p<0.05$) (Hair et al. 2014). At last, factor analysis was performed to extract the barrier and effect components. The technique of factor analysis, including factor rotation, factor load estimations, data normalization, and other steps, was introduced by Hair et al. (2014). First, the correlation coefficient matrix underwent data normalization. Subsequently, principal component analysis (PCA) was employed to extract common components from the attributes, facilitating a reduction in dimensions while preserving essential trends and patterns. After that, varimax rotation was applied as a rotation technique since it maximizes the variance of the squared loading for each component, producing different factor loading (Hair et al. 2014). Attributes are then classified based on their maximum loading onto the component extracted, thereby concluding the factor analysis results.

Furthermore, CFA was employed to examine the validity of the constructs (Anderson & Gerbing 1988) by using SPSS AMOS 23 software. In the present study, the maximum likelihood approach of estimation was applied. Based on the CFA result, the construct's convergent validity and reliability are also evaluated. Standard factor loading (SFL), construct dependability, and average variance extracted (AVE) are the three indices used in this study to evaluate convergent validity.

Step 5: Development of Hypothesized Model

After the components were identified, a hypothesized model was generated to look at how barriers and effects relate to the use of CSCM, illustrated in Figure 4.8. A path diagram is commonly used to demonstrate this model. In this, relationships are shown by arrows, whereas observed variables are represented by rectangles, and latent constructs are represented by circles. The initial model outlines the relationships between the various constructs and which variables are predicted to affect which constructs. The software used for CB-SEM, SPSS AMOS 23, was utilized to examine the proposed model. Compared to VB-SEM, the covariance matrices provide significant statistical advantages (Schumacker & Lomax 2004). In the present study, the maximum likelihood method for the estimation was employed

The following tests were conducted based on the proposed model to determine whether or not barriers significantly influence the effects in CSCM implementation:

- Null hypothesis (H0): There is not a noticeable distinction between zero and the path coefficient between barriers and their effects.
- Alternate hypothesis (Ha): Barriers have a major positive impact on their effects in the implementation of CSCM.

Step 6: Validation of Hypothesized Model

By evaluating its suitability, the SEM model is tested. As evidenced by the goodness of fit (GOF) indices, the model's suitability is assessed based on the findings of the covariance structural analysis. It has to be revised if its appropriateness is poor. In the SEM literature, several researchers have put forth different standards for determining a model's GOF. Various GOF indices evaluate a model's suitability from various viewpoints. The present study aimed to validate the stated relationship between barriers and their effects in the application of CSCM by selecting the following GOF measures, which are also applicable to CFA, from among the various fit indices given in the SEM literature. (Tripathi & Jha (2018*b*); Chen et al. (2012); Doloi et al. (2012)).

1. The ratio of chi-square to the degree of freedom (χ^2/df): It makes the assumption that the tested model is valid and compares the observed covariance matrix with the estimated covariance matrix (Chen et al. 2012).
2. The goodness of fit index (GFI): The index of absolute fit is used to show how well the hypothesis being considered fits the available data. It goes from 0 to 1 and rises

with bigger samples, depending on the sample size. (Molwus et al. 2013).

3. Incremental fit index (IFI): As per Kline (2011), it displays the model's comparative fit enhancement as measured against the statistical baseline model.

4. Tucker-Lewis index (TLI): It takes into account a relationship between sample size and model complexity. (Patel & Jha 2016).

5. Comparative fit index (CFI): It displays the extent that the hypothesized model's fit has improved relative to the original (Chen et al. 2012). It works effectively even with small sample sizes since it considers sample size (Xiong et al. 2015).

6. The RMS error of approximation (RMSEA): The difference between the estimated and observable covariance matrices is measured in relation to the unit df., as per Chou & Yang (2012).

7. Expected cross-validation index (ECVI): It checks for confirmation whether the model's test results are stable. (Schreiber et al. 2006).

Table 3.3 provides a suggested level of these measurements.

Table 3.3: Level of Recommendations of GOF Measures

No.	**GOF measure**	**Recommended level of GOF measures**
1	Chi-square/degree of freedom (χ^2/df)	1 to 2
2	GFI	0 (no fit) to 1 (perfect fit)
3	IFI	0 (no fit) to 1 (perfect fit)
4	TLI	0 (no fit) to 1 (perfect fit)
5	CFI	0 (no fit) to 1 (perfect fit)
6	RMSEA	$\leq$0.05 (very good) to 0.1 (threshold)
7	ECVI	Lower value is better fit

(This table was adapted from (Tripathi & Jha 2018*b*))

Chapter 4

Result and Discussion

4.1 Reliability Test of Collected Data

In this study, the barrier attributes and effects attributes have Cronbach's alpha values of 0.763 and 0.744, respectively, for the whole data. It holds greater importance than 0.7. This number shows that all of the characteristics have great internal consistency and that the variables are suitable for additional research. According to the reliability study's results, the attributes' internal consistency is sufficient, and the value of an is therefore acceptable..

4.2 Ranking

Step 1 of the methodology outlined the identification of a total of 31 barrier attributes and their 13 effect attributes from the literature. The attributes were ranked using the mean and the standard deviation (SD), as shown in Tables 4.1 and 4.2. In analyzing the impacts between the midpoints of adjacent scales in the questionnaire, the mean value of the responses is not a whole number ((Tripathi & Jha 2019). Attributes were grouped according to the mean value, as Table 4.3 illustrates. Table 4.3 makes it very evident that 93% of the qualities fall between very high and moderate effect. However, attributes B11, B28, and B31 lie in the low impact range; therefore, they were eliminated from the further study. There was no removal of any effects that were found because their mean values were all more than 2.5.

Table 4.1: Ranking of Barriers

ID	Barrier	SD	Mean	Rank
B1	Lack of Funding	0.69	3.64	15
B2	Inadequate performance of Procurement Team	0.66	4.31	1
B3	Inadequate performance of Management Team	0.70	4.10	6
B4	Lack of Communication b/w stakeholders	0.52	4.02	7
B5	Material Price Fluctuation	0.64	3.62	16
B6	Uncertainty in Cash Flow	0.65	3.68	14
B7	Weather Condition	0.85	3.33	26
B8	Effect of Bureaucracy and political influence	0.64	3.62	17
B9	Effect of Government policies	0.54	3.48	21
B10	Effect of Standardization of activities	0.71	4.13	4
B11	Effect of Law and order situation	0.76	2.28	31
B12	Inappropriate tendering /bidding methods	0.64	3.39	22
B13	Bad relations b/w Suppliers and contractors	0.47	3.93	10
B14	Inadequate use of Information Technology	0.62	3.33	25
B15	Lack of Supplier's involvement	0.56	3.97	9
B16	Diverse objective among stakeholders	0.73	3.83	12
B17	Lack of Top Management involvement	0.50	3.61	18
B18	Difficulties in accessing resources	0.69	4.24	3
B19	Complex Construction Process	0.73	4.11	5
B20	Improper Monitoring of Supply Chain	0.64	4.29	2
B21	Construction Delays	0.76	3.89	11
B22	Decentralized Decision Making	0.50	3.60	19
B23	Improper Risk Sharing / risk allocation	0.56	3.75	13
B24	Less Understanding of Supply Chain Management Concept	0.66	3.36	24
B25	Improper Organizational Structure to Support Supply Chain Management	0.53	3.56	20
B26	Lack of Training	0.74	3.32	27
B27	Complexity of Supply Chain Management	0.71	3.29	28

B28	Lack of Appreciation	0.78	2.29	30
B29	Temporary or short term Supply Chain network	0.54	3.38	23
B30	Lack of commitment of firms (Client,Contractor, Supplier)	0.55	3.98	8
B31	Geographic condition	0.64	2.43	29

Table 4.2: Ranking of Effects

ID	**Effect**	**SD**	**Mean**	**Rank**
E1	Cost Overrun	0.67	4.06	1
E2	Time Overrun	0.68	4.04	2
E3	Reduce Productivity	0.58	3.69	3
E4	Customer's Dissatisfaction	0.52	3.39	7
E5	Poor Product/Service Delivery	0.56	3.41	6
E6	Poor Quality of Product	0.58	3.56	4
E7	Poor Material Management	0.56	3.46	5
E8	Increased Waste	0.64	3.36	8
E9	Disputes b/w Stakeholders	0.51	3.36	9
E10	Rework/Design Change	0.67	3.22	11
E11	Impact on Construction Process	0.63	3.15	13
E12	Impact on other supplier's delivery	0.74	3.20	12
E13	Impact on the degree of commitment of other stakeholders	0.58	3.26	10

Table 4.3: Categorization of barriers and effects based on the importance levels

Mean Value	**Level of Impact**	**Barriers and Effect**
$\mu \geq 4.5$	Very High	Nill
$4.5>\mu\geq3.5$	High	B1, B2, B3, B4, B5, B6, B7, B8, B10, B13, B15, B16, B17, B18, B19, B20, B21, B22, B23, B25, B30, E1, E2, E3, E6

3.5>$\mu \geq$2.5	Moderate	B7, B9, B12, B14, B24, B26, B27, B29, E4, E5,E7, E8, E9, E10, E11, E12, E13
2.5>$\mu \geq$1.5	Low	B11, B28, B31
1.5>μ	Very Low	Nill

4.3 Result of EFA

4.3.1 Questionnaire validity and significance test

The parametric one-sample t-test was run with a test value of three at a 95% confidence interval prior to the questionnaire validity and significance test, and it was discovered that the significance level was <0.05. According to Gupta et al. (2024), this suggests that the outcome of the remaining attributes was significant and rejected the null hypothesis, highlighting the lack of difference between the population mean and the sample. According to Netemeyer et al. (2003), the sample's computed KMO values for the barrier and effect attributes were both larger than 0.6, at 0.701 and 0.662, respectively. These findings corroborate the suitability of the data for factor analysis. The results of this research showed that the data were appropriate for factor analysis, with the corresponding Bartlett's test of sphericity significance threshold (Sig.) for barrier and effect characteristics being less than 0.01 (p <0.01), as suggested by Tripathi & Jha (2018*a*). The degree of freedom for the barrier and effect qualities was 378 and 78, respectively. This means that the degree of freedom indicates the number of independent values in the data that was studied. As per Saunders et al. (2009), The null hypothesis was shown to be rejected due to a significant correlation between the quality (barriers and effects). Consequently, the findings indicated that the size of the sample was enough for additional factor analysis of gathered information.

4.3.2 Factor Analysis

Afterwards, PCA, along with varimax rotation, was performed on the 28 barrier and 13 effect attributes in separate sequences. Two criteria, (1) factor loading >0.5 and (2) it should be loaded on only one extracted component, were used to understand the underlying characteristics. The findings showed that the original eigenvalues of 13 effect and

28 barrier qualities, demonstrating 100% variation, were cumulatively described by the proportion of variance before and after the varimax rotation. Each component's relative relevance is shown by the proportion of variation that it can explain. An eigenvalue larger than 1 is the default retention criteria, according to the Kaiser criterion. According to the findings, the first seven components have an eigenvalue of higher than one and a total percentage of 64.864. As a result, the first seven components are essential for understanding the initial barriers. In the same way, the effects' first four components—whose cumulative percentage is 56.859 and whose eigenvalue is greater than 1 are crucial to investigate. The research makes it abundantly obvious that the cumulative squared loading of the first four components for effects and the first seven components for barriers stay the same after rotation. Additionally, the cumulative percentage's variation is reallocated among the components, showing that the first four and the first seven components, respectively, for the barrier and effect attributes, are more projecting, while the other components are undetectable and tend to stabilize with time. (Tables 4.4 and 4.6).

Table 4.4: Total Variance Explained (Barriers)

A. Total Variance Explained (Pre Rotation) (Barriers)							
Components	Initial Eigenvalue			Components	Initial Eigenvalue		
	Total	% of variance	Cumulative %		Total	% of variance	Cumulative %
1	5.519	19.71	19.71	15	0.555	1.982	86.176
2	3.578	12.778	32.488	16	0.534	1.908	88.085
3	2.535	9.053	41.54	17	0.453	1.617	89.702
4	2.147	7.668	49.209	18	0.414	1.479	91.181
5	1.855	6.625	55.834	19	0.38	1.358	92.539
6	1.319	4.71	60.543	20	0.348	1.244	93.784
7	1.21	4.321	64.864	21	0.33	1.177	94.961
8	0.987	3.526	68.39	22	0.292	1.044	96.004
9	0.935	3.339	71.729	23	0.284	1.013	97.017
10	0.818	2.921	74.65	24	0.246	0.878	97.896
11	0.718	2.565	77.215	25	0.203	0.726	98.621
12	0.681	2.432	79.647	26	0.153	0.545	99.167
13	0.661	2.36	82.008	27	0.135	0.484	99.65
14	0.612	2.187	84.195	28	0.098	0.35	100

B. Total Variance Explained (Post Rotation)			
Components	**Total**	**% of variance**	**Cumulative %**
1	3.377	12.059	12.059
2	3.225	11.518	23.577
3	3.098	11.065	34.643
4	2.421	8.646	43.289
5	2.247	8.024	51.313
6	2.055	7.338	58.651
7	1.74	6.214	64.864

A factor load or component load is required in order to examine the relationship between the acquired common factor and the original variable. In this study, the initial component matrix is orthogonally rotated to increase variance and enhance the factors' capacity to characterize the attributes. Drawing on information pertaining to the before and after rotation component matrices, the authors identified the indices that conformed to each rotation component with a greater load. The varimax rotation was used for the factor rotation because it offers a maximum variation of each element's squared ladings and results in a unique division of the components (Hair et al. 2014). Factor loading of at least 0.5 was taken into account while grouping them.

The present study separated the 13 effect attributes into four components and the 28 barrier attributes into 7 components based on the data obtained, which will be discussed in a further section. The communities are the proportions of variance in a measured variable that are shared by the solution's retained components. It is considered that variables that have a communality larger than 0.5 are excellent in explaining shared variation Hair et al. (2014). According to Tripathi & Jha (2019), the variables must be deleted if the communality is less than 0.3. This is further supported by the fact that none of the factors variables appear in the rotated component matrix. The current study's communality values for barriers and impacts are more than 0.3, indicating the reliability of the chosen qualities. Table 4.7 presents the outcomes of communalities, rotated component matrix, and component matrix

Table 4.6: Total Variance Explained (Effects)

A. Total Variance Explained (Pre Rotation)							
Components	**Initial Eigenvalue**			**Components**	**Initial Eigenvalue**		
	Total	**% of variance**	**Cumulative %**		**Total**	**% of variance**	**Cumulative %**
1	2.789	21.455	21.455	8	0.698	5.372	83.487
2	2.046	15.741	37.196	9	0.573	4.404	87.892
3	1.531	11.775	48.972	10	0.478	3.676	91.568
4	1.025	7.887	56.859	11	0.457	3.513	95.081
5	0.985	7.578	64.436	12	0.371	2.852	97.933
6	0.969	7.451	71.888	13	0.269	2.067	100
7	0.81	6.228	78.115				

B. Total Variance Explained (Post Rotation)			
Components	**Total**	**% of variance**	**Cumulative %**
1	2.525	19.423	19.423
2	2.023	15.56	34.983
3	1.557	11.974	46.957
4	1.287	9.902	56.859

Table 4.7: Communalities

A. Communalities for barriers					
Barrier	Initial	Extraction	Barrier	Initial	Extraction
B1	1	0.59	B15	1	0.699
B2	1	0.844	B16	1	0.682
B3	1	0.813	B17	1	0.723
B4	1	0.546	B18	1	0.52
B5	1	0.611	B19	1	0.768
B6	1	0.704	B20	1	0.537
B7	1	0.609	B21	1	0.712
B8	1	0.359	B22	1	0.669
B9	1	0.562	B23	1	0.745
B10	1	0.682	B24	1	0.533
B11	1	0.689	B25	1	0.597
B12	1	0.61	B26	1	0.569
B13	1	0.756	B27	1	0.711
B14	1	0.628	B28	1	0.694
B. Communalities for effects					
Effect	Initial	Extraction	Effect	Initial	Extraction
E1	1	0.595	E8	1	0.38
E2	1	0.503	E9	1	0.434
E3	1	0.5	E10	1	0.491
E4	1	0.573	E11	1	0.698
E5	1	0.521	E12	1	0.637
E6	1	0.648	E13	1	0.768
E7	1	0.644			

Seven components of barrier attributes and four components of effect attributes are discussed as follows.

Barrier Component:

BC1: Performance, Monitoring and Resource Issues

This fourth component has attributes like the performance of the management team and procurement team, resource assessment, and SC monitoring, with a total variance of 12.059%. The procurement and management teams have vital and significant roles in the successful operation of CSCM. The procurement team is primarily in charge of SC monitoring, while the managerial team is in charge of resource access.

BC2: Stakeholder's Issues

The first component, accounting for 11.518% of the variance, includes attributes: Bad relations between suppliers and contractors, diverse objectives among stakeholders, lack of communication between stakeholders, lack of commitment of firms, and lack of supplier's involvement. These are related to issues of different stakeholders in CSCM. There are many communication gaps between stakeholders, and because of this, there may be diverse objectives among stakeholders. Communication problems and less involvement of suppliers can lead to bad relationships.

BC3: Top Management Issues

The second component has a variance of 11.065%, which includes attributes: Improper risk sharing/risk allocation, decentralized decision making, improper organizational structure to support SCM, lack of top management involvement, the effect of bureaucracy and political influence and, the effect of government policies. These are connected to decisions made by top management. For example, if top management takes sufficient action, decision-making will become more centralized. Similar to this, senior management is directly connected with risk sharing, organizational structures, government policies, and bureaucracy.

BC4: Awareness, Training, and complexity of SCM

This component of barrier attributes accounts for 8.646% variation. It includes attributes such as the complexity of the SC, lack of understanding of SCM concepts, and lack of training. Also, the weather conditions with low factor loading is included in this component. A lack of knowledge about SCM hinders its practical application and increases its complexity. The construction industry is not very familiar with this notion, so proper training is necessary.

BC5: Pre-Construction Issues

The last component accounted for 8.024% variation and comprises three attributes, Inappropriate tendering /bidding methods, temporary or short-term supply chain network, and inadequate use of information technology. The appropriateness of bidding or tendering must be determined before the execution stage, as this has an impact on the SC. The SC needs to be long-term or permanent. Establishing the supply chain should come before the execution. Additionally, the information technology (IT) tools must be chosen at an earlier stage of construction.

BC6: Financial Issues

This component has three attributes: Uncertainty in cash flow, material price fluctuation, and lack of funding. This component accounts for 7.338% of the variance. Cash flow uncertainty, material price fluctuations, and lack of funding are three financial attributes linked to project finance and economics. These attributes have an economic impact on the SC, and are crucial for the effective implementation of CSCM.

BC7: Execution Issues

This component of barrier attributes has a variance of 6.214% and includes barrier attributes like construction delays, the effect of activity standardization, and the complex construction process. The construction process and activity standardization are important aspects of execution that might have a detrimental impact on the whole supply chain. The CSCM system fails as a result of construction delays that arise during the construction or execution stage.

Effect Components

EC1: Execution, Commitment and Disputes Effect

The first component comprises four effect attributes: impact on the construction process, impact on the degree of commitment of other stakeholders, impact on other supplier's delivery, and disputes between stakeholders, with 19.423% of the total variance. It includes how barriers affect other stakeholders' commitment and the construction process. The poor or inadequate execution of CSCM would also lead to a high level of disputes. Every SC would be impacted if there was even a delay by any one stakeholder.

EC2: Quality and Service Effect

This component contains four attributes: Poor quality of product, customer dissatisfaction, poor product/service delivery, and increased waste, with a 15.560% variance. improper application of CSCM might result in poor quality. Additionally, low quality would make customers or end users dissatisfied. Thus, delays result in poor product or service delivery, and inadequate material management and reworking lead to an increase in waste.

EC3: Cost and Time Effect

The third component has three effect attributes: Time overrun, cost overrun, and reduced productivity, with an 11.974% variance. Delays and financial barriers would bring on time and cost overruns, which eventually might impact on productivity.

EC4: Material Management and Rework Effect

There are two effect attributes associated with the last component: Poor material management and rework/design change, with an 9.902% variation. Poor material management is a result of the unavailability of resources, delays, and performance-related barriers. Rework or redesign occurs due to communication and performance-related barriers.

In a nutshell, two different holistic three-level hierarchical frameworks (THF) were developed, as shown in Figures 4.1 and 4.2. These THFs consist of barrier and effect attributes and their corresponding components. Based on the variance explained, the first three barrier and effect components are the most significant components.

4.4 Result of CFA

Using SPSS Amos 23, two hypothesized models for barriers and effect components were developed based on the findings of the EFA. The maximum likelihood approach of estimation was applied to these models for CFA. After that, estimations of the model's goodness of fit (GOF) and construct reliability with convergent validity were calculated; these will be discussed in more detail in the next subsections. Figures 4.3 and 4.4 depict the initial CFA model.

4.4.1 Model fit

The recommended level of measure for model fit is same as SEM and it is shown in Table 3.3. Table 4.8 shows the model fit result for the initial model barriers and effects. The indices demonstrate that the model and the data have an excellent fit. Nevertheless, the maximum likelihood estimates indicate that two barrier attributes- B21, which addresses improper risk sharing and allocation, and B23, which addresses construction delays—have less critical ratios. Additionally, the regression weights for these two attributes do not significantly differ from zero at the 0.01 level. For these reasons, the two attributes were removed from further investigation; no effect components were removed. Convergent validity and construct reliability were then computed. The regression weight, standard

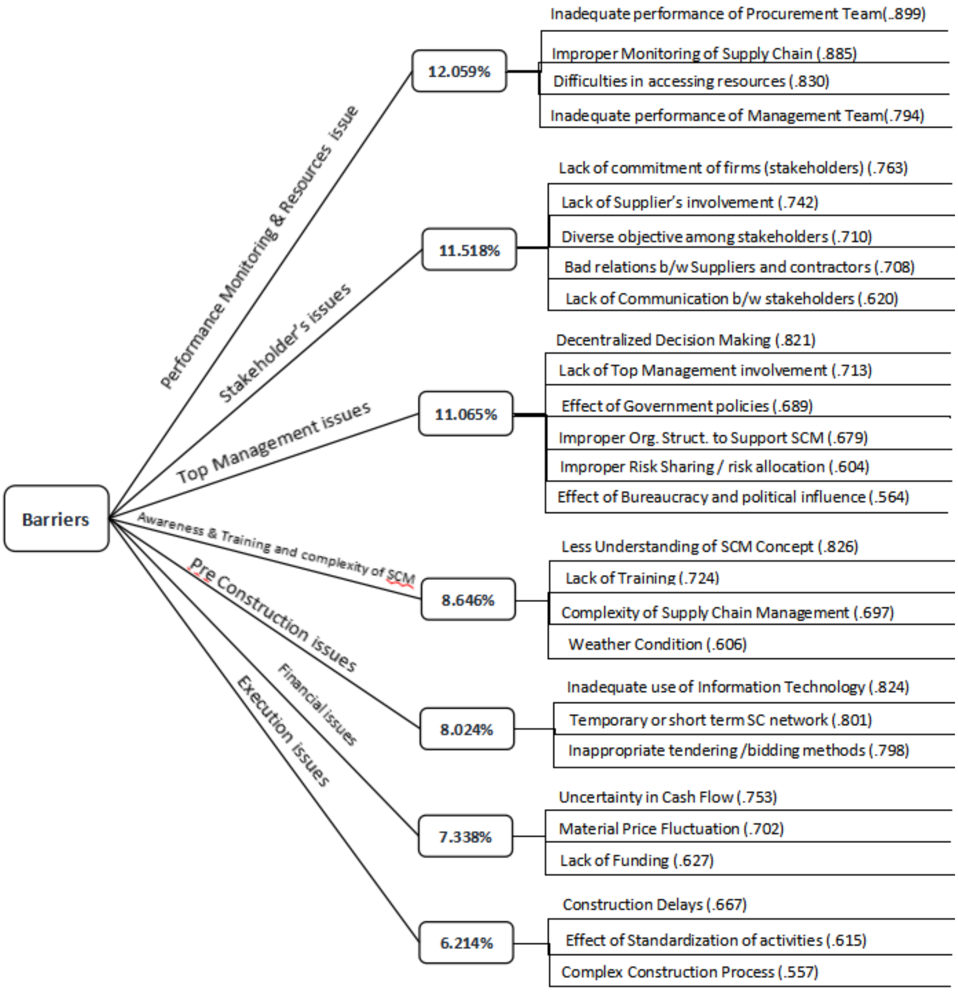

Figure 4.1: Framework for barriers in the implementation of CSCM

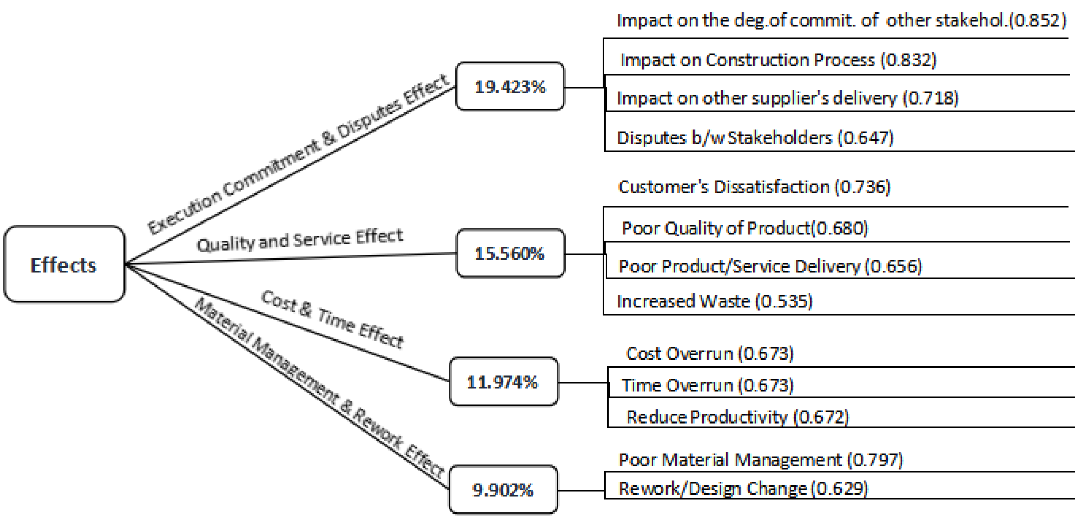

Figure 4.2: Framework for effects of barriers in the implementation of CSCM

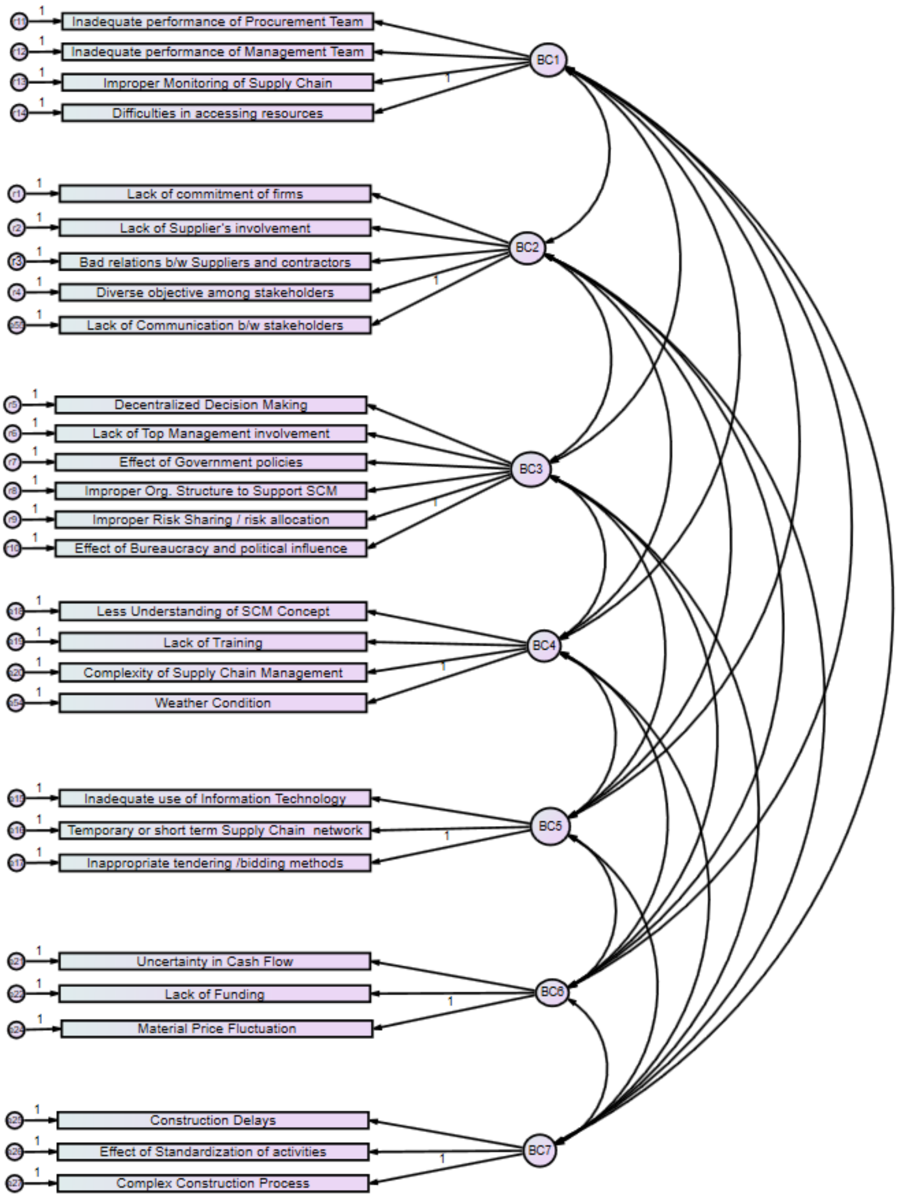

Figure 4.3: Initial CFA model for Barrier Components

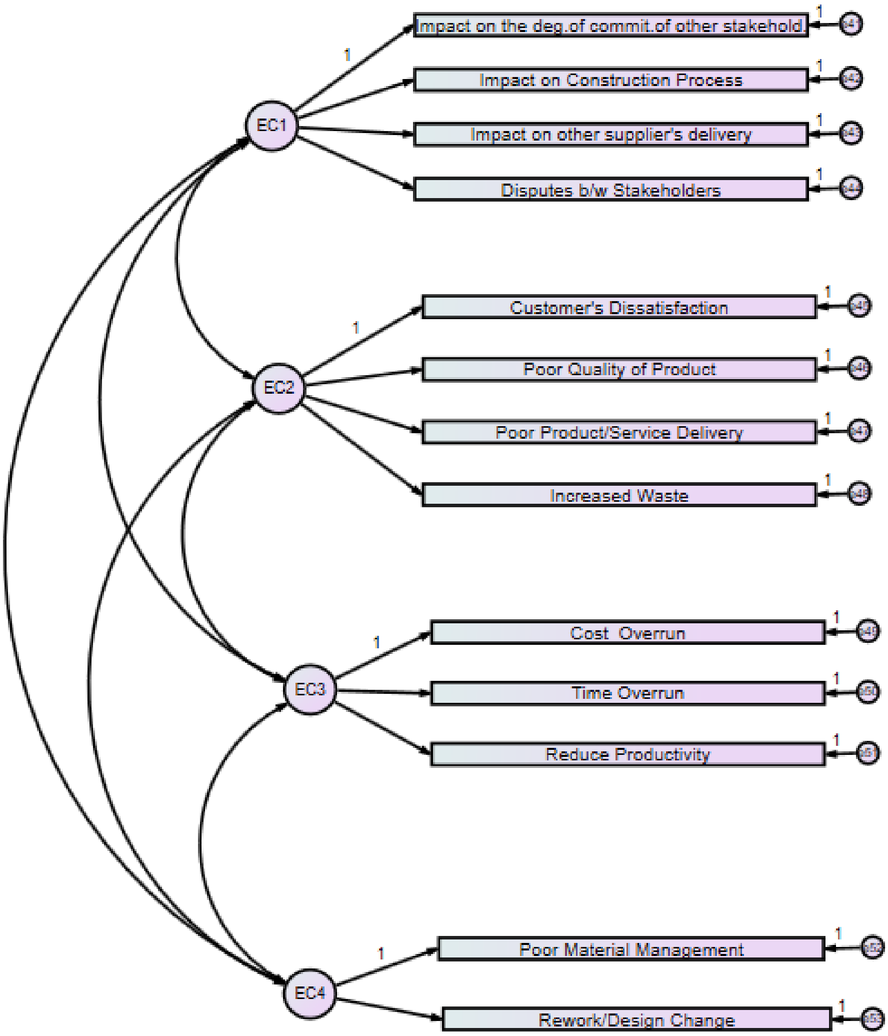

Figure 4.4: Initial CFA model for Effect Components

error, and critical ratio with significant levels are shown in Table 4.9

Table 4.8: GoF Measures of Initial models

No.	GOF measure	Barriers	Effects
1	Chi-square/degree of freedom (χ^2/df)	1.386	1.146
2	GFI	0.779	0.908
3	IFI	0.871	0.966
4	TLI	0.843	0.95
5	CFI	0.864	0.963
6	RMSEA	0.063	0.039
7	ECVI	6.223	1.343

Table 4.9: Regression weight , standard error, critical ratio with significant level

Path	Estimate	S.E.	C.R.	P
B27 FromBC4	.80626437	.16923239	4.76424373	***
B26 From BC4	.95434455	.18583750	5.13537123	***
B24 From BC4	.71445507	.15514699	4.60502050	***
B30 From BC1	1.29801611	.24378333	5.32446624	***
B16 From BC1	2.02830339	.34832024	5.82309942	***
B15 From BC1	1.15354302	.23718364	4.86350155	***
B13 From BC1	1.01968778	.20228398	5.04087267	***
B8 From BC2	1.00000000			
B23 From BC2	1.02530146	.31724138	3.23192850	.00122958
B25 From BC2	1.30439101	.35439477	3.68061580	***
B9 From BC2	1.48616835	.38869527	3.82347937	***
B17 From BC2	1.37439693	.35966945	3.82127793	***
B22 From BC2	1.50777885	.38532156	3.91304045	***
B12 From BC5	1.00000000			
B29 From BC5	.99890602	.17725046	5.63556237	***
B14 From BC5	1.40498761	.25421227	5.52682849	***

B3 From BC3	1.00000000			
B18 From BC3	1.96594170	.48347731	4.06625429	***
B20 From BC3	1.83125466	.44983945	4.07090720	***
B2 From BC3	1.95738328	.47707357	4.10289605	***
B19 From BC7	1.00000000			
B10 From BC7	1.41150363	.31303333	4.50911611	***
B21 From BC7	.67486619	.23365776	2.88826782	.00387370
B5 From BC6	1.27141102	.31944981	3.98000243	***
B6 From BC6	1.08962522	.28871089	3.77410495	***
B1 From BC6	1.00000000			
B7 From BC4	1.00000000			
B4 From BC1	1.00000000			

4.4.2 Construct's Reliability and Convergent Validity

Construct reliability is the measurement that makes it possible to determine how consistent a variable or group of variables is with the intended outcome (Straub et al. 2004). Convergent validity, on the other hand, refers to the extent to which many measurements of a concept ought to be connected theoretically Gefen & Straub (2000). Convergent validity is examined using Average Variance Extracted (AVE), while construct reliability is evaluated using Composite Reliability (CR) and Cronbach's Alpha. The latent unobserved variable's explanatory power (AVE) was used to calculate the indicator's variance. In this study, AVE was used to determine the convergent validity while Cronbach's Alpha(α) and Composite reliability were used to measure the construct's reliability. Tables 4.10 and 4.11 display the results of the construct's convergent validity and reliability. Tables 12 and 13 firstly show that the majority of SFL values are over the benchmark of 0.35, and the AVE for each construct was either above or around the 0.45 threshold (Zhang, Fu, Gao & Zheng 2016). B1, B3, B8, E3, and E8 were removed from additional studies because their SFL was less than0.0.35. Additionally, component BC6, which has a very low AVE, was removed from further study. following a revision in the construct's convergent validity and reliability.

Table 4.10: Result of Construct's reliability and convergent validity for Barriers

Result of CFA of Barriers	
Constructs and scale items	**SFL**
BC1: Performance Monitoring & Resources issues (α=0.814 , CR=0.83 , AVE=0.572)	
Inadequate performance of Procurement Team (B2)	0.740
Inadequate performance of Management Team (B3)	0.175
Improper Monitoring of Supply Chain (B20)	0.690
Difficulties in accessing resources (B18)	0.685
BC2: Stakeholders' issues (α=0.817 , CR=0.82 , AVE=0.480)	
Lack of commitment of firms (stakeholders) (B30)	0.513
Lack of Supplier's involvement (B15)	0.394
Diverse objective among stakeholders (B16)	0.721
Bad relations b/w Suppliers and contractors (B13)	0.430
Lack of Communication b/w stakeholders (B4)	0.343
BC3: Top Management issue (α=0.786 , CR=0.81 , AVE= 0.463)	
Decentralized Decision Making (B22)	0.640
Lack of Top Management involvement (B17)	0.559
Effect of Government policies (B9)	0.499
Improper Org. Struct. to Support SCM (B25)	0.447
Effect of Bureaucracy and political influence (B8)	0.169
BC4: Awareness, Training and Complexity of SCM (α=0.732 , CR=0.74 , AVE=0.415)	
Less Understanding of SCM Concept (B24)	0.358
Lack of Training (B26)	0.496
Complexity of Supply Chain Management (B27)	0.391
Weather Condition (B7)	0.416
BC5: Pre Construction issues (α=0.787 , CR= 0.80, AVE=0.574)	
Inadequate use of Information Technology (B14)	0.804
Temporary or short term SC network (B29)	0.541
Inappropriate tendering /bidding methods (B12)	0.377
BC6: Financial issues (α= 0.649, CR= 0.65, AVE=0.0.383)	
Uncertainty in Cash Flow (B6)	0.358

Material Price Fluctuation (B5)	0.521
Lack of Funding (B1)	0.270
BC7: Execution issues (α=0.613 , CR=0.62 , AVE= 0.458)	
Effect of Standardization of activities (B10)	0.580
Complex Construction Process (B19)	0.337

Table 4.11: Result of Construct's reliability and convergent validity for Effects

Result of Construct's reliability and convergent validity for Effects	
Constructs and scale items	**SFL**
EC1: Execution Commitment & Disputes Effect (α=0.817 , CR=0.82 , AVE=0.598)	
Impact on the degree of commitment of other stakeholders (E13)	0.817
Impact on construction Process (E11)	0.769
Impact on other supplier's delivery (E12)	0.350
Disputes b/w stakeholders (E9)	0.458
EC2: Quality and Service Effect (α=0.786 , CR=0.81 , AVE= 0.466)	
Customer's Dissatifaction (E4)	0.474
Poor Quality of Product (E6)	0.630
Poor Product/Service Delivery (E5)	0.450
Increased Waste (E8)	0.308
EC3: Cost & Time Effect (α=0.814 , CR=0.83 , AVE=0.509)	
Cost Overrun (E1)	1.023
Time Overrun (E2)	0.472
Reduce Productivity (E3)	0.032
EC4: Material Management & Rework Effect (α=0.732 , CR=0.74 , AVE=0.451)	
Poor Material management (E7)	0.403
Rework/Design Change (E10)	0.498

4.4.3 Revised Model Fit and Construct's reliability and convergent validity

The aforementioned suggestions served as a basis for the CFA model's modification. Table 4.12 displays the improved model's Model Fit outcome. The requirement of GoF measures is well achieved, as seen in Table 4.12, demonstrating the model's acceptable fit to the data. The GoF results indicate that every item in this section is in good alignment with the latent construct that was hypothesized, which is in line with the results and suggestions provided by Hair et al. (2014).

Table 4.13 and 4.14 display the updated outcomes for convergent validity and construct's reliability. The table illustrates that the CR results for barriers and effects vary from 0.62 to 0.89, indicating strong significance since they are higher than Hair et al. (2014)'s suggested threshold of 0.6. For both components, the average variance extracted ranged from 0.481 to 0.808. As seen by Fig. 6 and Fig. 7, the CFA result demonstrates that each component has positive associations. Strong relationships were found between the two barrier components, E2 and E4, and the three barrier components, B1, B2, and B7. The loading of the constructs for barrier attributes ranged from 0.55 to 0.91.

Table 4.12: Revised Model Fit

No.	**GOF measure**	**Barriers**	**Effects**
1	**Chi-square/degree of freedom (χ^2/df)**	1.189	1.318
2	**GFI**	0.848	0.920
3	**IFI**	0.956	0.946
4	**TLI**	0.945	0.916
5	**CFI**	0.954	0.942
6	**RMSEA**	**0.044**	**0.057**
7	**ECVI**	**3.274**	**1.082**

Table 4.13: Revised Result of Construct's reliability and convergent validity for Barriers

Revised Result of Construct's reliability and convergent validity for Barriers	
Constructs and scale items	**SFL**
BC1: Performance Monitoring & Resources issues (α=0.876 , CR=0.87 , AVE=0.704)	
Inadequate performance of Procurement Team (B2)	**0.723**
Improper Monitoring of Supply Chain (B20)	**0.692**
Difficulties in accessing resources (B18)	**0.697**
BC2: Stakeholders' issues (α=0.817 , CR=0.82, AVE=0.481)	

Lack of commitment of firms (stakeholders) (B30)	**0.517**
Lack of Supplier's involvement (B15)	0.397
Diverse objective among stakeholders (B16)	0.713
Bad relations b/w Suppliers and contractors (B13)	0.429
Lack of Communication b/w stakeholders (B4)	0.350
BC3: Top Management issue (α=0.804 , CR=0.88 , AVE= 0.536)	
Decentralized Decision Making (B22)	0.639
Lack of Top Management involvement (B17)	0.557
Effect of Government policies (B9)	0.498
Improper Org. Struct. to Support SCM (B25)	0.449
BC4: Awareness, Training and Complexity of SCM (α=0.732 , CR=0.74 , AVE=0.422)	
Less Understanding of SCM Concept (B24)	0.453
Lack of Training (B26)	0.541
Complexity of Supply Chain Management (B27)	0.405
Weather Condition (B7)	0.287
BC5: Pre Construction issues (α=0.787 , CR= 0.80, AVE=0.574)	
Inadequate use of Information Technology (B14)	0.823
Temporary or short term SC network (B29)	0.528
Inappropriate tendering /bidding methods (B12)	0.371
BC7: Execution issues (α=0.613 , CR=0.63 , AVE= 0.459)	
Effect of Standardization of activities (B10)	0.580
Complex Construction Process (B19)	0.337

Table 4.14: Revised Result of Construct's reliability and convergent validity for Effects

Result of Construct's reliability and convergent validity for Effects (Revised)	
Constructs and scale items	**SFL**
EC1 Execution Commitment & Disputes Effect : (α=0.781 , CR=0.85 , AVE=0.599)	
Impact on the degree of commitment of other stakeholders (E13)	0.902
Impact on construction Process (E11)	0.878
Impact on other supplier's delivery (E12)	0.591

Disputes b/w stakeholders (E9)	0.677
EC2: Quality and Service Effect (α=0.631 , CR=0.74 , AVE= 0.481)	
Customer's Dissatifaction (E4)	0.637
Poor Quality of Product (E6)	0.763
Poor Product/Service Delivery (E5)	0.675
EC3: Cost & Time Effect (α=0.783 , CR=0.89 , AVE=0.808)	
Cost Overrun (E1)	1.07
Time Overrun (E2)	0.685
EC4: Material Management & Rework Effect (α=0.667 , CR=0.68 , AVE=0.521)	
Poor Material management (E7)	0.644
Rework/Design Change (E10)	0.792

4.5 Result of SEM

The Hypothesized model was developed based on the components found from the factor analysis which is shown in Figure 4.8

The initial hypothesized model's GOF measure findings are displayed in Table 17. The values of χ^2/df is 1.444, RMSEA is 0.067, ECVI is 11.303, GFI is 0.686, IFI is 0.766, TLI is 0.740, and CFI is 0.757. This implies that the relationships between the barrier and effect components could not be well described by the proposed model. As a result, the initial model was updated. Typically, the model is revised using two approaches. Low path coefficients, or the path with a low causal relationship, are deleted in the first technique, and the causal relationship is added in the second. (Tripathi & Jha (2018*b*); Chen et al. (2012)). The model was revised in this study using the first method. The hypothesized model has undergone modifications until it was found to be in good alignment with both the theoretical expectation and the GOF Chen et al. (2012). To obtain a better-fit model, two components—BC4 and BC6—with low path coefficients were eliminated from the study. In Figure 4.7, the revised hypothesized model is displayed.

The results of the GOF measurements of the updated model are listed in Table 4.15 With value of 1.223, GFI at 0.765, IFI at 0.862, TLI at 0.842, CFI at 0.957, RMSEA at 0.060, and ECVI at 6.478, it shows that the revised model's level of appropriateness improved significantly. This shows that the relationship between barrier components and

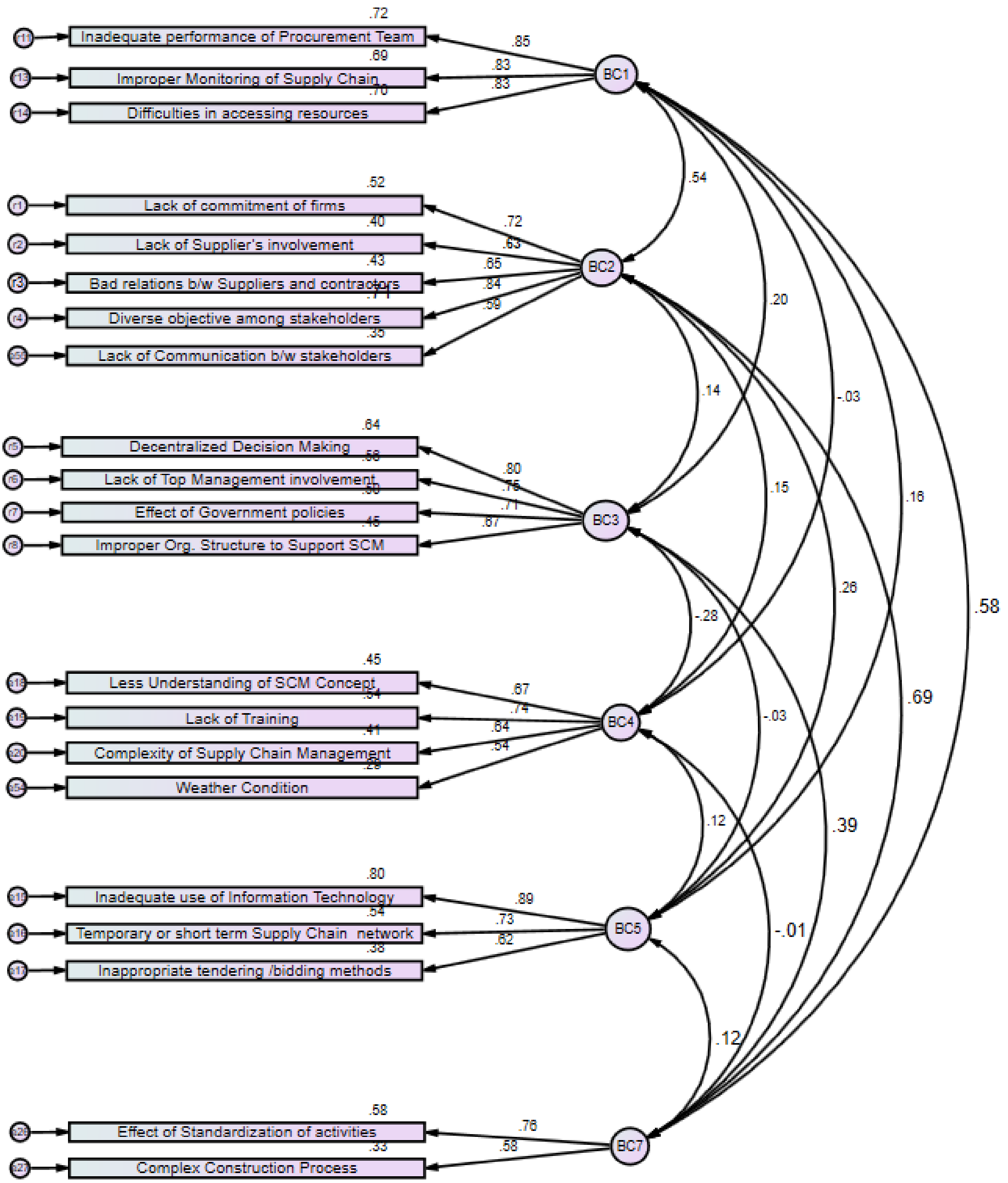

Figure 4.5: Revised CFA model for Barrier Components.

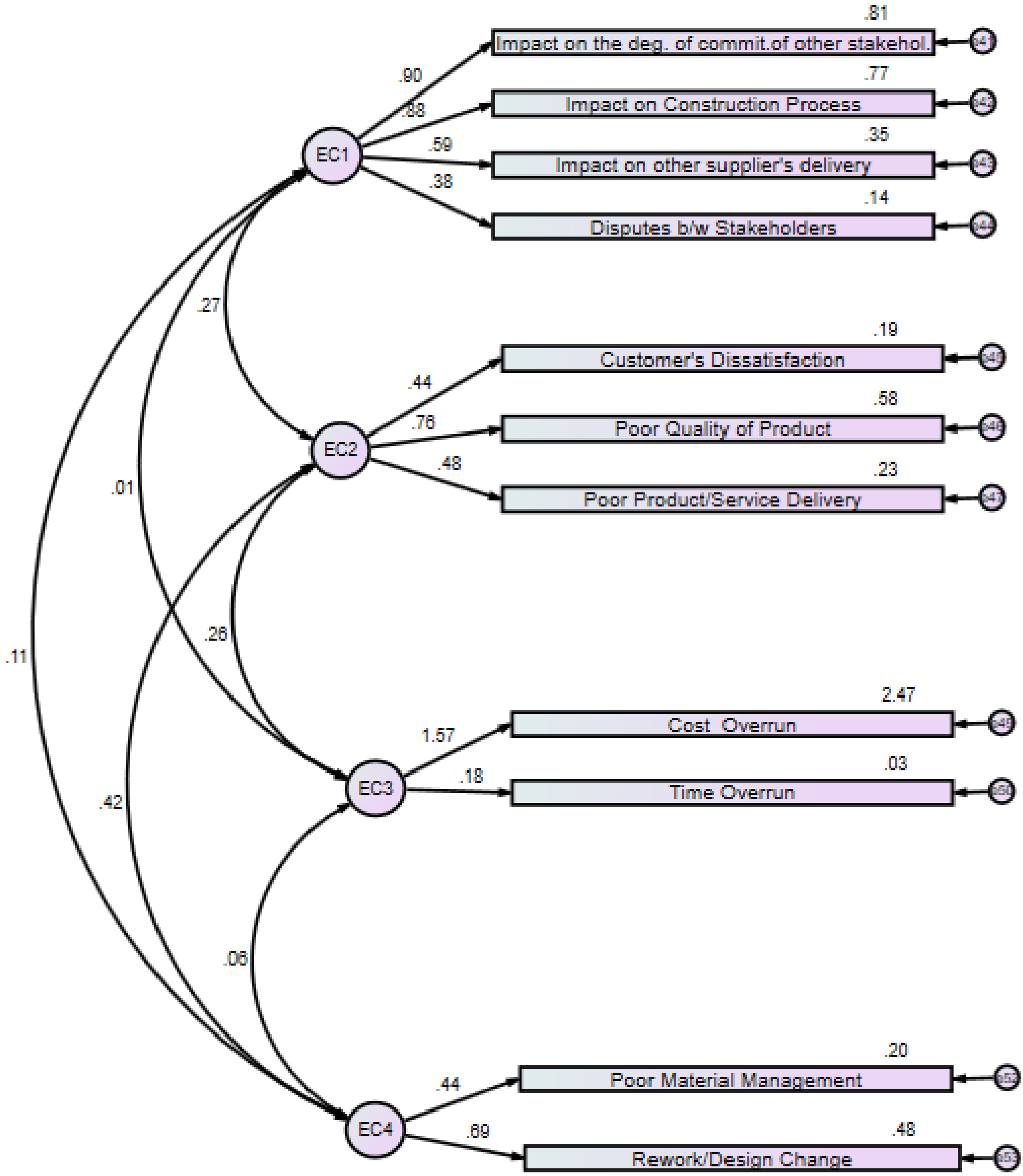

Figure 4.6: Revised CFA model for Effect Components

the effects in implementing CSCM can be better explained by the revised model. It is therefore acceptable to interpret the model.

The significant level, standard error, unstandardized path coefficient, and standardized path coefficients of the modified model are displayed in Table 4.16. The fact that every single standardized path coefficient is positive as well as significant in the desired direction serves as evidence for relationships. With a higher path coefficient, the attribute or component's significance as an impact indicator rises. Consequently, BC2 and BC7, with path coefficients of 0.83 and 0.82, stand out as the most significant Barrier Components. The path coefficient (0.76) is noteworthy at a 0.05 level of significance, supporting the hypothesis, which holds that barriers have a considerable beneficial impact on the effects in the implementation of CSCM. The next paragraphs provide a brief overview of the components that emerged from the SEM result.

BC2: Stakeholders' issues

At 0.80 path coefficient, BC2 is the most important barrier component. The qualities of this barrier component are as follows: (1)Lack of commitment of firms (stakeholders), (2)Lack of Suppliers' involvement, (3) Diverse objectives among stakeholders, (4) Bad relations between Suppliers and contractors (5)Lack of Communication b/w stakeholders.as the stakeholders are immediately impacted by these characteristics. Stakeholders' issues is the term for it. When firms and stakeholders are not fully committed, it undermines the trust necessary for effective collaboration. Trust is crucial for sharing sensitive information and aligning strategic goals. Lack of commitment can result in inconsistent participation in CSCM initiatives, leading to disruptions and inefficiencies in the supply chain processes. Firms not fully committed might prioritize short-term gains over long-term collaborative benefits, thereby hindering the implementation of sustainable and strategic CSCM practices. Suppliers who are not involved fully may not share critical data, which is necessary for optimizing supply chain operations.Suppliers often bring valuable insights and innovations. Their lack of involvement can mean missed opportunities for process improvements and cost savings.Without active supplier participation, coordinating activities and achieving synchronization across the supply chain becomes challenging, leading to inefficiencies.Different stakeholders might have conflicting objectives, such as cost reduction versus quality improvement, making it hard to align efforts towards a common goal.Diverse objectives can lead to conflicts in decision-making processes, slowing down the implementation of CSCM strategies.Stakeholders with differing priorities may resist allocating necessary resources (time, money, personnel) to CSCM initiatives, impeding progress.Poor relationships can lead to a lack of willingness to collaborate, share information, or invest in joint problem-solving.Bad relations often result in frequent disputes and conflicts, which can disrupt supply chain activities and delay projects.When relationships are strained, suppliers and contractors are less likely to be flexible and responsive to changing needs, leading to inefficiencies and increased costs.Poor communication creates information silos, preventing stakeholders from having a complete picture of the supply chain and making informed decisions.Effective CSCM relies on coordinated actions. Lack of communication leads to misunderstandings and coordination breakdowns, causing delays and errors.In dynamic markets, quick and effective communication is vital for adapting to changes. Lack of communication hinders the supply chain's ability to respond swiftly to new challenges or opportunities.

BC7: Execution issues

The second important barrier component, BC7, has a 0.82 path coefficient. These two attributes make up this barrier component: (1) Effect of Standardization of activities, and (2) Complex Construction Process. As execution is strongly correlated with those attributes. It's called Execution issues. Standardization involves creating uniform procedures and protocols across the supply chain. This can face resistance from various stakeholders who are accustomed to their established ways of working. Such resistance can slow down the adoption of CSCM practices.Construction projects are unique and often require customized solutions. Standardization can lead to a rigid framework that might not accommodate the specific needs of different projects, thereby reducing the effectiveness of CSCM. Different organizations within the supply chain might have varying levels of technological advancement and processes. Implementing standardized activities across all these organizations can be challenging due to differences in capabilities and resources.Standardizing activities necessitates training for all involved parties. This can be time-consuming and costly, acting as a deterrent to the swift implementation of CSCM. Standardized activities require a high level of coordination among various stakeholders. If not managed properly, this can lead to delays and inefficiencies. While standardization aims to ensure consistent quality, any deviation or non-compliance can result in significant issues, leading to rework and increased costs.A rigid standardization process can stifle innovation and the adoption of new methods or technologies that could benefit the construction process. Each construction project is distinct, with unique requirements and challenges. This variability complicates the application of uniform CSCM practices, as each project might need tailored supply chain solutions.Construction projects typically involve a wide range of stakeholders, including architects, contractors, suppliers, and clients. Coordinating between these parties within a unified CSCM framework is inherently complex.The construction environment is highly dynamic, with frequent changes in project scope, design modifications, and unexpected site conditions. This dynamic nature makes it difficult to establish and maintain a consistent supply chain management process.The construction industry is subject to stringent regulatory requirements and standards that can vary significantly across regions. Navigating these regulations while trying to implement a standardized CSCM system can be challenging.The complexity of construction processes often leads to communication gaps and coordination challenges, which can undermine CSCM efforts. In a complex construction process, any disruption or inefficiency in the supply chain can result in significant cost overruns and delays, making the management of the supply chain more difficult.The intricate nature of construction projects increases the risk of supply chain disruptions.

BC1: Performance Monitoring & Resources issues

With a path coefficient of 0.66, BC1 is the third component of the emerging barrier. The attributes of this barrier component are as follows: (1) Inadequate performance of Procurement Team, (2) Improper Monitoring of Supply Chain, and (3) Difficulties in accessing resources.Due to the fact that these attributes directly affect how well the management and procurement teams work and allocate resources. Performance Monitoring & Resources Issues is the name. A procurement team that performs inadequately may struggle to identify and collaborate with suppliers who align with CSCM principles. This can lead to sourcing from suppliers who do not prioritize sustainability or closed-loop practices, undermining the entire CSCM strategy. Poor performance can result in higher costs due to inefficient procurement processes. This can strain the budget and reduce the financial feasibility of implementing CSCM, which often requires upfront investment in sustainable practices and technologies. If the procurement team fails to ensure that suppliers meet required standards and regulations, the quality of materials and products can suffer. This affects the ability to reuse, re-manufacture, or recycle products effectively, which are key aspects of CSCM. Effective CSCM requires strong collaboration with internal and external stakeholders. A procurement team that lacks competence in stakeholder management can hinder the communication and coordination necessary for successful CSCM initiatives.

BC3: Top Management issue

BC3, with a path coefficient of 0.32, is the fourth major barrier component. The following attributes comprise this barrier component: (1) Decentralized Decision Making, (2) Lack of Top Management involvement, (3)Effect of government policies, (4) Improper Organization Structure to Support SCM.Since Top Management is closely associated with these attributes. Top management issues is the name of this component. In decentralized systems, decisions are often made independently across different units. This can lead to inconsistencies and misalignment in the supply chain strategy. Collaboration requires synchronized efforts. Decentralized decision-making can result in poor coordination, as various departments or units might prioritize their objectives over collective goals. Decentralization can slow down the decision-making process because of the need for extensive communication and negotiation among different units. The lack of a unified decision-making process can lead to fragmented operations, where different parts of the supply chain do not work in harmony. Inefficiencies arise due to redundant or conflicting activities, hampering the overall performance of the supply chain. The supply chain becomes less agile and responsive to market changes, impacting the ability to quickly adapt to new opportunities or threats. Top management provides the strategic vision and resources necessary for CSCM. Their absence can result in a lack of clear direction. Without top management support, obtaining the necessary resources (financial, technological, human) becomes challenging. Initiatives for CSCM might not be prioritized, leading to inadequate focus and attention from various organizational levels. Lack of top management involvement often translates into insufficient commitment across the organization, impeding collaborative efforts. Initiatives may suffer from poor implementation due to a lack of authoritative guidance and oversight. Top management has the influence to drive cultural and organizational changes needed for an effective CSCM. Their absence can limit the effectiveness of these changes. Constantly changing regulations can make it difficult to maintain consistent supply chain practices. Tariffs, quotas, and other trade restrictions can complicate cross-border collaboration. Adhering to these regulations may require significant changes in supply chain operations, adding complexity and cost. Government policies can impose constraints on supply chain operations, limiting flexibility and efficiency. Compliance with regulations often incurs additional costs, which can affect the overall profitability and viability of collaborative initiatives. The need to manage regulatory risks can divert resources and attention away from collaborative efforts, affecting their effectiveness. An improper organizational structure may lead to siloed departments that do not communicate or collaborate effectively. Processes may be inefficient and misaligned, making it difficult to implement streamlined and collaborative supply chain practices. Unclear roles and responsibilities can create confusion and hinder effective decision-making and execution. An improper structure often results in a fragmented supply chain, with different parts of the organization working at cross-purposes. Effective communication is crucial for CSCM. Structural issues can create barriers that impede the flow of information. Overall performance can be sub-optimal due to misaligned goals and objectives, leading to decreased competitiveness and customer satisfaction.

BC5: Pre-Construction issues

With a path coefficient of 0.21, barrier component BC5 comes fifth in importance. The attributes of this barrier component are as follows: (1) Inadequate use of Information Technology, (2) Temporary or short term SC network, (3) Inappropriate tendering /bidding methods. These attributes are directly related to the pre-construction stage. The name is Pre-Construction issues. Inadequate IT can lead to poor data management and insufficient sharing of critical information across the supply chain.This lack of visibility and real-time information can result in delays, errors, and inefficiencies. Effective CSCM relies on accurate and timely data to coordinate activities, forecast demand, and manage inventory. Without robust IT systems, integrating various parts of the supply chain becomes difficult. This lack of integration hampers collaboration between partners, making it challenging to synchronize operations, optimize processes, and respond swiftly to market changes. Poor IT infrastructure limits advanced analytic and decision-support systems. This affects the ability to make informed decisions based on comprehensive data analysis, leading to sub-optimal performance and missed opportunities for improvement.Temporary networks often lack the long-term relationships needed to build trust and cooperation.Trust is crucial for collaboration, as it encourages open communication and the sharing of sensitive information. Without it, partners may be reluctant to engage fully, reducing the effectiveness of CSCM. Short-term arrangements can lead to inconsistent practices and unreliable partnerships. This inconsistency can disrupt supply chain continuity and performance, as partners may not be fully committed to joint goals and standards, leading to frequent changes and adjustments. Short-term networks are less likely to invest in the necessary collaborative technologies and systems. This lack of investment can prevent the adoption of tools that facilitate CSCM, such as shared platforms for planning and communication, resulting in a fragmented and inefficient supply chain. Traditional tendering/bidding methods often prioritize cost reduction over collaborative potential. This approach can lead to selecting partners based on price alone, ignoring their ability to collaborate effectively, innovate, or provide long-term value. It can result in adversarial relationships rather than cooperative ones. Inappropriate tendering can lead to partnerships where the objectives and capabilities of the partners are not aligned. Misaligned objectives make it difficult to pursue common goals, optimize processes, and achieve mutual benefits, which are essential for CSCM's success.Tendering processes that favor short-term contracts discourage long-term collaboration. Short-term contracts do not incentive partners to invest in joint initiatives, shared technologies, or process improvements, all of which are crucial for effective CSCM.

Table 4.15: GoF Measures (SEM)

No.	**GOF measure**	**Value derived from the initial Model**	**Value derived from updated model**
1	**Chi-square/degree of freedom (χ^2/df)**	1..444	1.223
2	**GFI**	0.686	0.765
3	**IFI**	0.766	0.862
4	**TLI**	0.740	0.842
5	**CFI**	0.757	0.957
6	**RMSEA**	0.067	0.060
7	**ECVI**	11.303	6.478

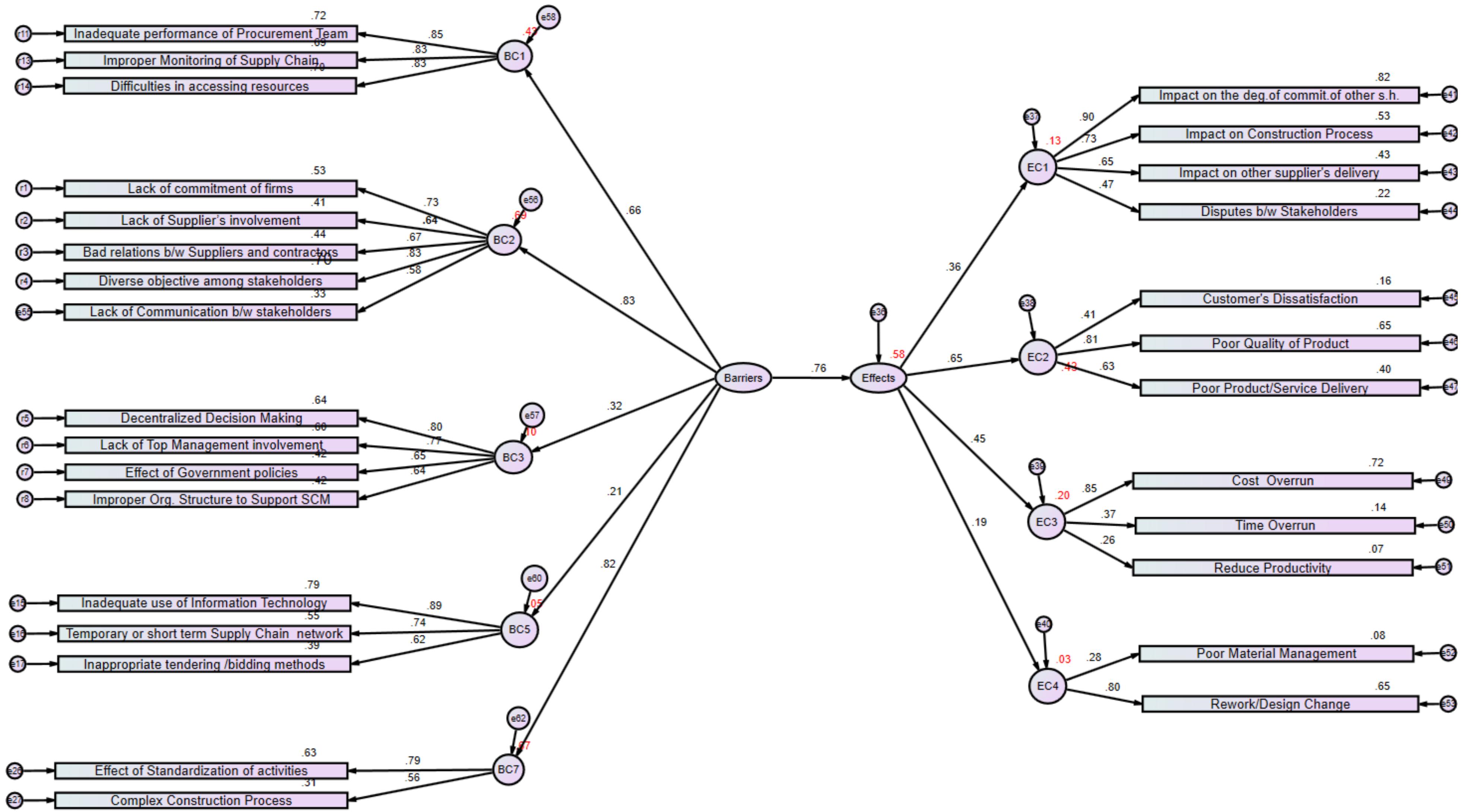

Figure 4.7: Revised Hypothesized Model

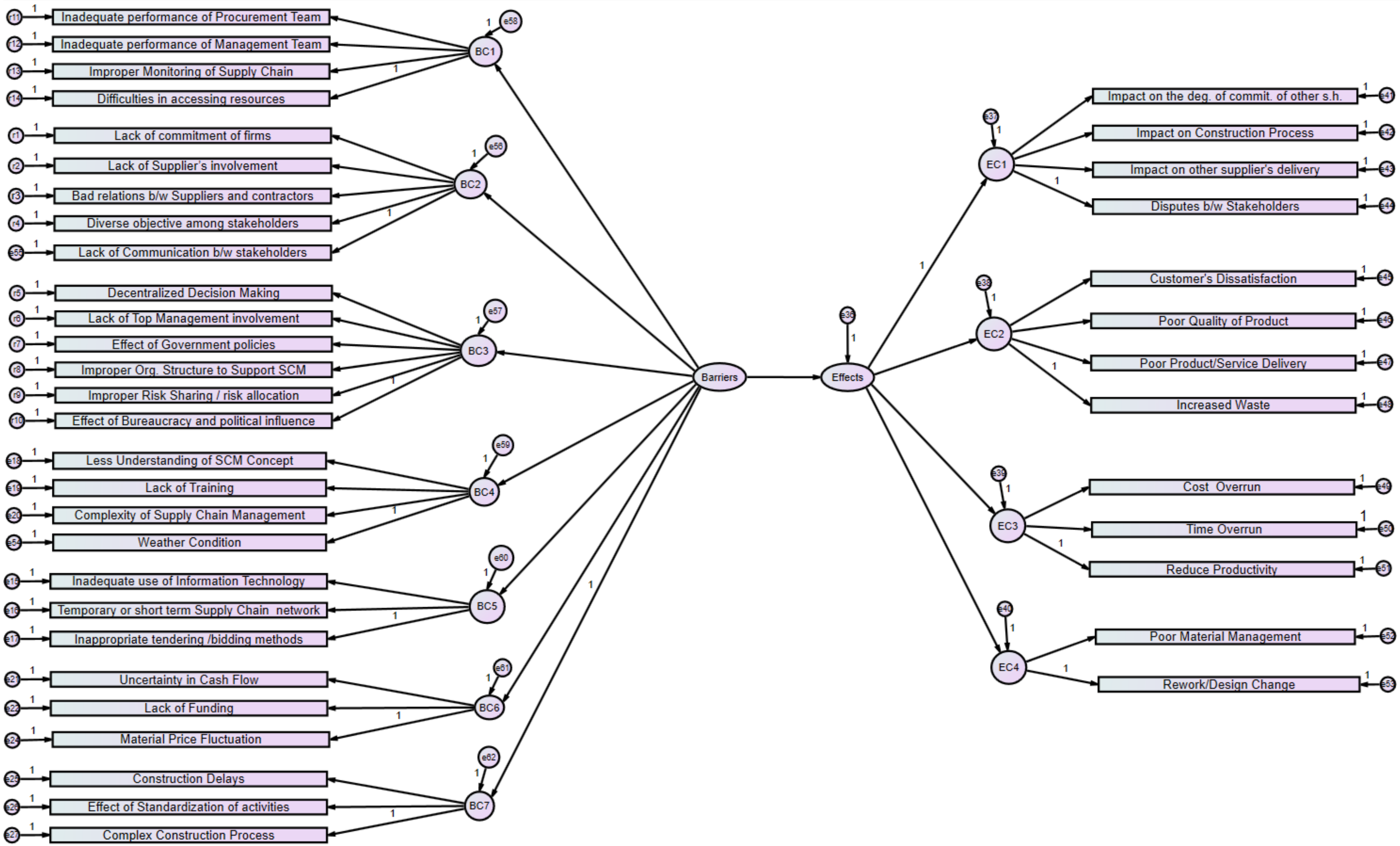

Figure 4.8: Initial Hypothesized Model

Table 4.16: Path Coefficient

Path	**Unstandardized estimate (B)**	**Standardized estimate (b)**	**Standard error (e)**	**C.R.**	**Sig. (p)**
Effects From Barriers	0.223	0.367	0.152	1.469	0.142
EC1 From Effects	1.000	0.469			
EC3 From Effects	0.791	0.656	0.669	1.183	0.237
EC2 From Effects	1.711	0.228	1.341	1.276	0.202
EC4 From Effects	1.243	0.842	1.331	0.934	0.350
BC2 From Barriers	0.849	0.286	0.316	2.686	0.007
BC3 From Barriers	0.253	0.609	0.139	1.818	0.069
BC1 From Barriers	1.106	0.061	0.367	3.013	0.003
BC4 From Barriers	0.091	0.226	0.211	0.433	0.665
BC5 From Barriers	0.302	0.150	0.201	1.508	0.132
BC6 From Barriers	0.212	0.771	0.240	0.884	0.377
BC7 From Barriers	1.000	0.300			
E7 From EC4	0.327	0.763	0.658	0.497	0.619
E10 From EC4	1.000	0.901			
E13 From EC1	2.392	0.729	0.555	4.309	***
E11 From EC1	1.798	0.655	0.406	4.429	***
E12 From EC1	1.985	0.476	0.475	4.179	***
E9 From EC1	1.000	0.821			

E1 From EC3	3.470	0.274	3.003	1.156	0.248
E3 From EC3	1.000	0.398			
E4 From EC2	0.856	0.845	0.348	2.460	0.014
E6 From EC2	1.939	0.598	0.649	2.986	0.003
E5 From EC2	1.372	0.358	0.478	2.872	0.004
E8 From EC2	1.000	0.643			
B27 From BC4	1.014	0.739	0.249	4.075	***
B26 From BC4	1.222	0.669	0.287	4.260	***
B24 From BC4	0.979	0.733	0.241	4.062	***
B30 From BC2	1.349	0.636	0.258	5.224	***
B15 From BC2	1.191	0.670	0.245	4.867	***
B13 From BC2	1.052	0.832	0.211	4.975	***
B16 From BC2	2.020	0.414	0.360	5.610	***
B8 From BC3	1.000	0.455			
B23 From BC3	0.963	0.640	0.312	3.089	0.002
B25 From BC3	1.291	0.654	0.360	3.586	***
B9 From BC3	1.339	0.761	0.373	3.591	***
B17 From BC3	1.448	0.810	0.383	3.778	***
B22 From BC3	1.550	0.621	0.405	3.829	***

B12 From BC5	1.000	0.739			
B29 From BC5	0.992	0.889	0.174	5.691	***
B14 From BC5	1.379	0.783	0.262	5.270	***

Chapter 5

Summary and Conclusion

Summary and Conclusion

This study investigates the barriers to Construction Supply Chain Management (CSCM) and their multifaceted effects. This research offers a comprehensive hypothesized model to address these barriers and effects within the Indian construction sector. First, from the literature, 31 barrier attributes and 13 effect attributes were found. A five-point Likert scale was used to develop the questionnaire, which was spread to experts representing the three primary stakeholders—the owner/client, consultancy, and contractor. A total of 110 expert answer samples were gathered. A satisfactory result was obtained when Cronbach's alpha was used to assess the reliability of the replies. The mean value of these barriers and their impacts was examined; nevertheless, the mean values of three barrier attributes, "Lack of Appreciation" (B28), " Geographic Condition (B31), and "Effect of Law and Order Situation" (B11), were less than 2.5. As a result, these three barriers were eliminated from the current study. Subsequently, a one-sample t-test was carried out on the data collected, revealing no evidence of a zero hypothesis and there is no distinction between the overall mean and sample. Barlett's test of sphericity and KMO were used to assess the validity and significance of the questionnaire. The sample's computed KMO values for barrier and effect attributes in this study were 0.701 and 0.662, respectively, both larger than 0.7, demonstrating that the data was appropriate for factor analysis. The related significance level (Sig.) for barrier attributes and effect attributes of Bartlett's test of sphericity was less than 0.01 ($p < 0.01$), according to the study findings, suggesting that the data was appropriate for factor analysis. 28 barrier attributes and 13 effects attributes were examined independently using the Principle component Method. Factor extraction was done using varimax rotation. Using factor analysis, a total of seven components from 28 barriers and four components from 13 effects were recovered. The names of the extracted components were assigned based on the attributes that each component included. A three-level hierarchical model was discovered for the barriers and the effects separately. Based on the outcomes of the EFA, CFA analysis was then conducted individually for the barrier and effect components. The model fit suggests that the model is adequately fit; nevertheless, the estimation reveals that two barriers—B23 and B21—have a low critical ratio and are not significant. As a result, they were excluded from further study. Convergent validity and construct reliability were computed for the initial model after removal. The majority of SFL values are over 0.35, according to the results of construct reliability and convergent validity, and the AVE for each component was above or around 0.45. However, the SFL values of B1, B3, B8, E3, and E8 were less than 3.5, which is why those attributes were excluded from additional studies. Moreover, BC6 was removed as well since its AVE score was very low. Convergent validity and construct reliability were computed for the revised model following the elimination. The findings and recommendations were validated by the improved model's model fit, which indicated that every item was in good alignment with the proposed latent construct. According to the outcomes of the construct reliability and convergent validity analyses, the CR values for the barrier and effect models ranged from 0.62 to 0.89, both of which were very significant. The range of AVE values for the barrier and effect components was 0.481 to 0.808. Overall, the CFA result demonstrated that there are positive relationships between each component. Two effect components, E2 and E4, and four barrier components, B1, B2, and B7, demonstrated significant interrelationships. Following the completion of the CFA, an SEM model was developed using the results of the EFA. The model fit and estimates of the initial model indicated that the proposed model was insufficient to explain the relationship between the effect and barrier components, so it was revised by removing paths with low path coefficients. Due to their poor path coefficients, BC4 and BC7 were excluded. With strong GoF scores and a positive and substantial path coefficient, the updated model functioned effectively. The two components with the highest path coefficients, BC2 and BC7, appear to be the most significant barrier components, according to the results.

Hypothesized models were developed to help construction professionals and policymakers overcome these challenges of the adoption of CSCM. This model provides a practical guide for implementing CSCM effectively. The findings of this research are not just relevant to India but can be applied to South Asian countries like Pakistan, Bangladesh, Nepal, Bhutan, etc., because of the similarity in their geographical conditions. This study is based on the barriers and effects mentioned in the available literature.Future work can be done by adding more barriers. Additionally, this study focused on all three types of projects, however, future studies can be done for specific types of projects with more details. Also, more comprehensive CSCM models can be developed. Furthermore, the case study-based model can be developed with the on-site data and validated with this model.

Overall, this research helps understand the challenges of CSCM adoptions and their effects and offers a practical solution to overcome them. By using this model and adopting a more collaborative approach, the construction industry can become more efficient, sustainable, and resilient.

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Annexure

Annexure A: Publications

- Parmar B. D., & Lad V.H. (2023). Application of Delphi Method for The Selection of Factor Influencing Construction Materials Order Quantity. First National Conference on Modern Construction Practices and Management (MCPM2023). SVNIT Surat, 02-03 June 2023 (Paper Presented)
- Parmar, B. D., Lad, V. H., & Tripathi, K. K. (2024). Identification of barriers and their effects in the implementation of construction supply chain management. In Proceedings of the 40th Annual ARCOM Conference (pp. XX-XX). Association of Researchers in Construction Management. 02-04 September 2024 (Paper Submitted and Accepted)

Annexure B: Questionnaire Survey Forms

NIRMA UNIVERSITY

INSTITUTE OF TECHNOLOGY
SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

IDENTIFICATION OF BARRIERS AND THEIR EFFECTS IN IMPLEMENTATION OF CONSTRUCTION SUPPLY CHAIN MANAGEMENT USING STRUCTURAL EQUATION MODELLING

PART 1 **Please put a tick mark(√) to rate the following barriers on a five-point Likert scale which affect the implementation of supply chain management in construction industry**

Sr No.	Barriers	Very Low Impact	Low Impact	Moderate Impact	High Impact	Very High Impact
		1	2	3	4	5
1	Lack of Funding					
2	Inadequate performance of Procurement Team					
3	Inadequate performance of Management Team					
4	Lack of Communication b/w stakeholders					
5	Material Price Fluctuation					
6	Uncertainty in Cash Flow					
7	Weather Condition					
8	Effect of Bureaucracy and political influence					
9	Effect of Government policies					
10	Effect of Standardization of activities					
11	Effect of Law and order situation					
12	Inappropriate tendering /bidding methods					
13	Bad relations b/w Suppliers and contractors					
14	Inadequate use of Information Technology					
15	Lack of Supplier's involvement					
16	Diverse objective among stakeholders					
17	Lack of Top Management involvement					
18	Difficulties in accessing resources					
19	Complex Construction Process					
20	Improper Monitoring of Supply Chain					
21	Construction Delays					
22	Decentralized Decision Making					
23	Improper Risk Sharing / risk allocation					
24	Less Understanding of Supply Chain Management Concept					
25	Improper Organizational Structure to Support Supply Chain Management					
26	Lack of Training					
27	Complexity of Supply Chain Management					
28	Lack of Appreciation					
29	Temporary or short term Supply Chain network					
30	Lack of commitment of firms (Client,Contractor, Supplier)					
31	Geographic condition					

PART 2	**Please put a tick mark(√) to rate the following effects of the barriers of the implementation of supply chain management in construction industry on a five point Likert scale**					
Sr No.	**Effect**	**Very Low effect**	**Low effect**	**Moderate effect**	**High effect**	**Very High effect**
		1	**2**	**3**	**4**	**5**
1	Cost Overrun					
2	Time Overrun					
3	Reduce Productivity					
4	Customer's Dissatisfaction					
5	Poor Product/Service Delivery					
6	Poor Quality of Product					
7	Poor Material Management					
8	Increased Waste					
9	Disputes b/w Stakeholders					
10	Rework/Design Change					
11	Impact on Construction Process					
12	Impact on other supplier's delivery					
13	Impact on the degree of commitment of other stakeholders					

PART 3	Please write any comments/feedback in the given space concerning barriers and their effects on implementation of supply chain management in the Indian construction industry. Please add any other barriers and effects if you feel that it is left in given list. Your feedback is the most valuable for our research work

PART 4	**Respondent's Information**	
1	Name	
2	Contact Number	
3	Email ID	
5	Designation	
6	Respondent's experience in the business (in years)	
7	Organization Name	
8	Organization Category	
9	Organization's experience in the business (in years)	

Note: This data will be used for academic purpose only, we will not reveal any personal details of the respondent

Date:

Sign:

Abas et al. (2022)Ahmed et al. (2002)Albaloushi & Skitmore (2008)Amade (2016)Anderson & Gerbing (1988)Arshad & Zayed (2022)Bankvall et al. (2010)Chen et al. (2012)Cho et al. (2009)Zhang, Liu, Wu & Skibniewski (2016)Zhang, Fu, Gao & Zheng (2016)Ying et al. (2015)Chou & Yang (2012)Dainty et al. (2001)Doloi et al. (2012)Erik Eriksson et al. (2008)Fellows & Liu (2021)Fornell & Larcker (1981)Ganeshan (1995)Gefen & Straub (2000)George & Mallery (1999)Giannakis & Croom (2004)Giossi (2012)Hair et al. (2014)Gupta et al. (2024)Heaton et al. (2022)Iyer & Jha (2005)Kim & Nguyen (2022)Kline (2023)Lam et al. (2008)Marsh et al. (2020)Meyer & Torres (2019)Molenaar et al. (2000)Molwus et al. (2013)Mueller & Hancock (2008)Netemeyer et al. (2003)Noorizadeh et al. (2019)O'brien et al. (2004)Patel & Jha (2016)S. Davcik (2014)Salami et al. (2013)Saunders et al. (2009)Schreiber et al. (2006)Schumacker & Lomax (2004)Shukor et al. (2021)Straub et al. (2004)Tabachnick et al. (2013)Tabish & Jha (2012)Tripathi & Jha (2018*b*)Tripathi & Jha (2018*a*)Tripathi & Jha (2019)Wibowo et al. (2018)Wong et al. (2004)Wong & Cheung (2005)Xiong et al. (2015)Xue et al. (2007)Ying et al. (2015) Costa et al. (2019) Lambert & Cooper (2000)