Issues in large scale adoption of Supply Chain Management in Indian Construction Industry

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Abstract - *Supply Chain Management is the handling of the flow of the materials and services in the project, it includes extraction of raw components to delivering and commissioning of the final product. A company or an organization creates a network of service providers and suppliers for the efficient and reliable quality of service and goods. Using SCM in construction industry will help a lot to the companies in various ways, and many researches have also been done in adoption of SCM in the field of Construction. The Purpose od the research is to identifying the problems which are occurring while adoption of SCM in the construction field and the solution in form of methods and framework for wide spread adoption of SCM in Construction.*

Key Words: Supply Chain Management, Barriers in Implementation, AHP, Construction Industry, Strategies.

1. INTRODUCTION

Supply Chain Management is turned out to be very efficient and economical in various fields of industrial & bossiness sector, but in the Construction Industry the SCM has been adopted by very few companies and is not been very efficient in this field. In recent times some research works have been done on integration of supply chain management (SCM) in the field of Construction

As per the research done they have concluded that the construction industry is lagging behind when compared to other industries in India, even some of the very large construction firms with huge amount of work experience are still facing problems in having a collection of Consultants and Sub contactors, suppliers that can relied upon for quality and cost-effective completion of project within the stipulated time. This intended to say that the very few companies have long term linkages with their consultants or subcontractors etc., which is a major drawback in the industry (Madhukar, 2016).

The benefits of applying supply chain management principles in construction are, reduce real time cost escalations with on time ordering and supply of the materials, improvement in productivity, long term relation with the major contractor and suppliers, competitive advantages, repetitive type of work with increasing efficiency, more responsive and reliable workflow, anticipation of material requirement beforehand. (Papadopoulos, Zamer, Gayialis, & Tatsiopoulos, 2016).

When we think of SCM in construction recent works are there for the integration of SCM but even though its not been widely adopted in the field. There are lots of issues and constrains in the wide adoption of SCM principles in the construction for example one of the major reasons is the Fragmentation, individuality of project its becoming hard to keep the date updated for such large types of chains manually, the research done have shown the advantages of the integration of SCM in construction but there is no detail research on problems arising while adopting these principles of SCM and hindering the large scale adoption in the Indian Construction Industry.

1.2 Aim:

To improve the large-scale adoption of supply chain management in Indian Construction industry.

1.3 Objectives:

1. To identify the major barriers which are hindering the wide adoption of supply chain management in construction in Indian Context.
2. To Organize the identified issues in to major categories and analyze the interdependency of these issues.
3. Prioritize the issue rank wise and asses the importance of barriers.
4. To suggest the solution for any of the major identified barrier in the implementation of SCM

1.4 Methodology

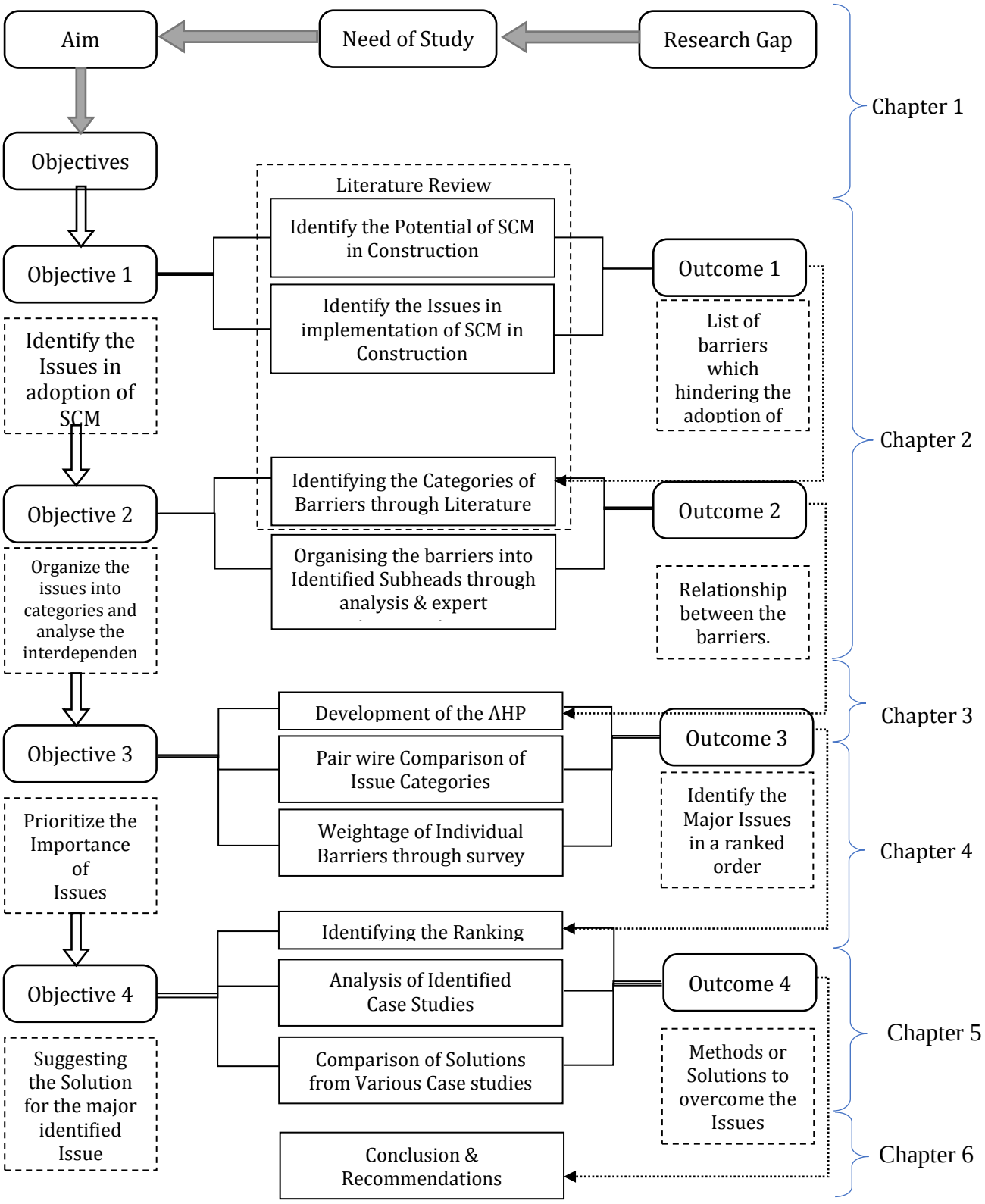

Figure 1: Research Methodology Flowchart

2. LITERATURE STUDY

2.1 Supply Chain Management in Construction

Supply Chain Management (SCM) is useful in achieving high level performance in the field and also provide significant benefits to the construction companies, it is very effective if there is a good integration, coordination and management of the chain, from suppliers to clients. (Rastogi R. P., 2022)

2.2 Benefits of SCM in Construction

There are lot benefits of using the supply chain management in the field of construction some of them are, reduce real time cost escalations with on time ordering and supply of the materials, improvement in productivity, long term relation with the major contractor and suppliers, competitive advantages, repetitive type of work with increasing efficiency, more responsive and reliable work flow, anticipation of material requirement beforehand. (Papadopoulos, Zamer, Gayialis, & Tatsiopoulos, 2016).Cost reduction and waste reduction, Risk reduction, with a more certain final project cost, Value for client, Enables long-term planning, Ongoing business or repeat business. (Al-Werikat, 2017)

- Subcontractors play a major role in supply chain management ensuring usage of minimum time, cost and material. (Durai & Sentamilselvan, 2016)

To apply SCM in construction it is necessary to distinguish some characteristics of the construction production system, as follows:

- The construction product is for a single client most of the times.
- The product changes for each project. Not all the parts and materials can be stored at site.
- The place, equipment and methods of production change for each project.
- Construction personnel have a high rotation index during construction time and between projects.

Although the construction process is different, SCM can be useful and effective in construction - (William J. O'Brien, 2009)

2.3 General Model of the supply chain in Construction - (Vrijhoef & Koskela, 1999)

This is a conceptual representation of construction supply chain and the participants involved and their mode of interaction. A construction company may have similar supply chain for different types of materials or goods.

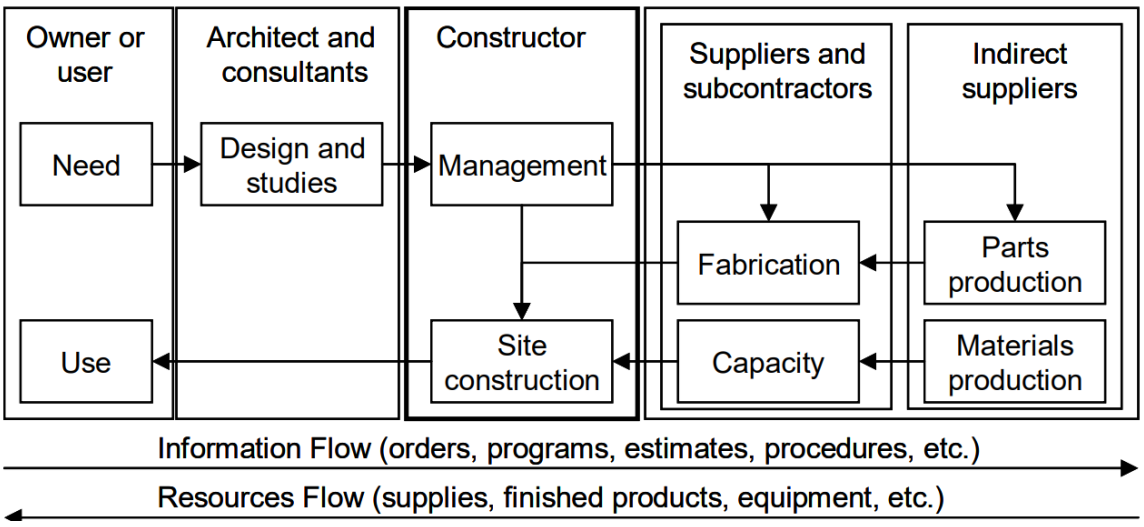

Figure 2: General Model of Supply Chain in Construction

The Construction Supply chain as per this model states that suppliers & subcontractors play a major role in the whole process, where as the main contractor or PMC has to organize and supervise the process w.r.t the quality & timely flow of work & Information.

2.4 Construction Supply Chain Management Techniques - (Papadopoulos, Zamer, Gayialis, & Tatsiopoulos, 2016)

- Suppliers' and Subcontractors' Development
- Performance Measurement
- Benchmarking
- Knowledge Management
- Waste Identification and Elimination
- Information Technology

S No	Subject Area	Elements
1	Strategic Management	• Global Strategy • Change Management • Capacity Development
2	Logistics	• Planning and control of material flows • Integration of materials and information flows.
3	Relationships	• Procurement, • Objectives alignment, • Top management support, • long term commitment, • Collaboration, • Communication, • Problem Solving, • Risk Sharing.
4	Best Practices	• Continuous Improvement • Lean thinking, • Just-in-time, • Offsite manufacturing, • Sustainability.
5	Organizational Behavior	Information and Communication Technology (ICT)

***Table 1**:Core Elements Underlaying in Construction SCM ((Puppo & Carlos, 2021)*

Element	Traditional Management	Supply chain management
Inventory management approach	Independent efforts	Joint reduction of channel Inventories
Total cost approach	Minimize firm costs	Channel wide cost efficiencies
Time horizon	Short term	Long term
Amount of information sharing and monitoring	Limited to needs of current transaction	As required for planning and monitoring Process
Amount of coordination of multiple levels in Channel	Single contact of the transaction between channel	Multiple contacts between levels in firms and levels of Channel
Joint Planning	Transaction based	Ongoing
Compatibility of Corporate philosophies	Not relevant	Compatible for atleast key relationships
Breadth of Supplier Base	Large to Increase competition and spread risks	Small to increase Coordination
Amount of sharing risks and rewards	Each on its own	Risks and rewards are shared over the long term
Speed of Operations, Information & Inventory Levels	"Warehouse" Orientation (Storage, safety stock) interrupted by barriers, localized to channel pairs	"Distribution Center" Orientation (Inventory Velocity) interconnecting flows; JIT, Quick response across channel

***Table 2:** Characteristic difference between traditional ways & SCM (Vrijhoef & Koskela, 1999)*

3. ANALYTIC HIERARCHY PROCESS (AHP)

The Analytic Hierarchy Process is a method for organizing & analyzing the complex decisions, it provides a rational frame work for a needed decision by Quantifying its criteria and alternative options, relating these options to overall goal.

It attempts to benefit from mathematic and expert knowledge to classify criteria and found knowledge. It is used in almost all domains and in various situations to help in decision-making. (Sael, Hamim, & Benabbou, 2019)

3.1 AHP Ranking Scale

Intensity (Importance)	Priority	Explanation
1	Equal	Same importance
3	Moderate	Element moderately favored than other
5	Strong	Element Strongly favored than other
7	Very Strong	Element Very strongly favored than other
9	Extreme	Element extreme important than other

Table 3: *AHP Importance intensity Satty's Scale*

Note: The Reciprocals are used for inverse Relation, 2,4,6,8 can be used for intermediate relationships.

4. IDENTIFICATION OF BARRIERS & CLASSIFICATION

4.1 Identified Barriers from literature & Interview

From Various Literature studies the Barriers for the large-scale implementation of SCM in construction are Identified are listed Below some of the barriers are repeated or may be similar all these will be refined and sub categorized in further process.

4.2 Classification of Various Issues into Major Subheads

As Per the Literature Studies these Issues Can be Classified into 6 Major subheads

1. **Administrative Issues**
2. **Financial Issues**
3. **Networking Issues**
4. **Technical Issues**
5. **Regulatory Issues**
6. **Socio – Cultural Issues**

Pair wise Matrix						
Categories	AI	FI	NI	TI	RI	SCI
Administrative Issues	1	1/3	2	1/4	2	3
Financial Issues	3	1	4	1/2	3	4
Networking Issues	1/2	1/4	1	1/5	2	2
Technical Issues	4	2	5	1	3	6
Regulatory Issues	1/2	1/3	1/2	1/3	1	2
Socio – Cultural Issues	1/3	1/4	1/2	1/6	1/2	1
Column Sum	9.33	4.17	13.00	2.45	11.50	18.00

Table 4: *Pairwise Comparison of Barrier Category*

4.3 Ranking of Barriers

Step 1: Pair-wise Barrier Category Weightage
Pairwise Comparison matrix done by comparing the weightage of each category with each other in the preference of their importance to adoption of SCM. To get Category weightage after identifying the pairwise matrix, divide each cell with column sum to get Normalized Matrix. The sum Average of each row will give the Category Weightage.

Check for the Consistency:
Multiply each Column with its category weight to get a matrix. Sum of each row gives the **weighted sum** of each category.λ_{max}
is obtained by Average of Weighted sub / Category weight

Consistancy Chech Multply Pairwise Comparisoon Matrix & Criteria Weight = PM * CW									
Categories	AI	FI	NI	TI	RI	SCI	WS	CW	WS/CW
Administrative Issues	0.1306	0.0865	0.1857	0.0956	0.1687	0.1506	0.8178	0.1306	6.261519
Financial Issues	0.3918	0.2594	0.3714	0.1913	0.2531	0.2008	1.6678	0.2594	6.429965
Networking Issues	0.0653	0.0648	0.0929	0.0765	0.1687	0.1004	0.5687	0.0929	6.123873
Technical Issues	0.5224	0.5188	0.4643	0.3826	0.2531	0.3012	2.4424	0.3826	6.383744
Regulatory Issues	0.0653	0.0865	0.0464	0.1275	0.0844	0.1004	0.5105	0.0844	6.051423
Socio – Cultural Issues	0.0435	0.0648	0.0464	0.0638	0.0422	0.0502	0.3110	0.0502	6.193661
Category Weight	0.1306	0.2594	0.0929	0.3826	0.0844	0.0502		**λ=**	**6.240697**

Table 5:*Normalized Pair wise Matrix with Consistency Check*

Consistency Index (CI) = λ_{max} -n / n-1 (Where 'n' is No. Categories)
= 6.2406 – 6 / 6 -1 = 0.0481

n	1	2	3	4	5	**6**	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	**1.24**	1.32	1.41	1.45	1.49

Consistency Ratio (CR) = CI / RI = 0.0481/1.24 =0.0388 < 0.1 (CR Should be less than 0.1 as per AHP)
Since CR <0.1; **Matrix is Consistent & can be used for Decision Making.**

Step 2: Scale of preference of Barrier Category using Survey data

Categories	Category Weightage	Survey Responces	Total Weightage	Factored Weight
Administrative Issues	**0.1306016**	3.8182	0.4987	**0.128516**
Financial Issues	**0.2593824**	4.0000	1.0375	**0.267395**
Networking Issues	**0.0928586**	3.6364	0.3377	**0.087025**
Technical Issues	**0.3825922**	3.9091	1.4956	**0.385447**
Regulatory Issues	**0.0843592**	3.7273	0.3144	**0.081036**
Socio – Cultural Issues	**0.0502061**	3.9091	0.1963	**0.050581**
	1		3.880135	1

Table 7: *Factored weightage of Barrier Category*

S No.	Level of Respondent	Profession Example	Weightage
1	First Level	Supply Chain Manager	1.2
2	Second Level	Procurement Manager	1.1
3	Third Level	Contractor, Supplier	1

Table 6: *Qualitative Importance table for Respondents*

Step 3: Qualitative ranking of importance of the Respondent.

The survey is conducted to analyze the Importance of the identified barriers.
The major focus of survey is to know the implementational issues for large scale SCM in construction field. The importance of respondent is based on their area of working, and according to this the order of Potential respondents.

1. **Supply chain Managers**

The next level of potential respondents are the employees who are dealing with only the procurement process of materials, they are managing only procurement service etc.

2. **Procurement Managers**

The third level of respondents are the Service providers themselves, they include Construction company representatives or Contractors/ Sub Contractors & Suppliers.They are least preferred but still their response is also a valid outcome.

3. **Contractor/Sub Contractor, Construction company representative, Suppliers**.

Depending on their area of influence the respondents are given weightage.

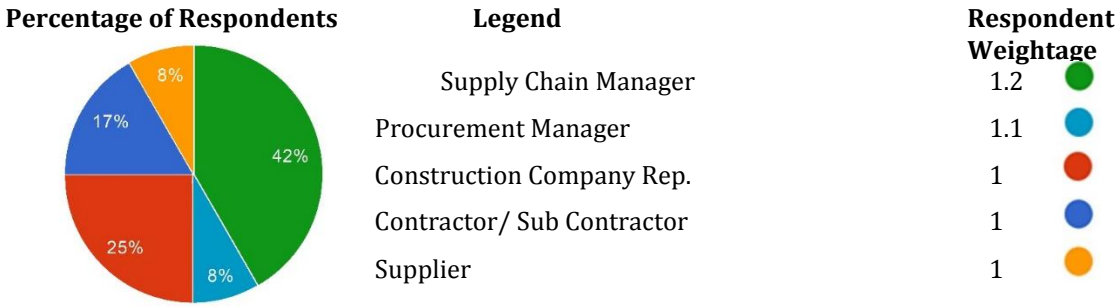

Figure 3: Respondents Survey Report

Step 4: Identification of Relatives Weights

To get the relative weights of importance of each barrier a survey is conducted among the above-mentioned respondent groups and the weightage is multiplied as per their respondent category to get the relative weightage.

Structure of Survey:

The Survey includes Each barrier category and Individual barrier in each section.

The scale of Importance as a **Potential Barrier**. [1 Least Important & 5 Most Important]

Potential Barrier in terms of Barrier for Adoption of SCM in their Organization.

Survey had 7 Section, out of which 1st is marking importance of Barrier Category, remaining 6 are marking importance of individual Barrier in each category.

Step 5: Calculating Global Weights - (Relative Weights x Category Weightage)

No.	Issue	Code	Relative Weight	C.W.	Global weight	Rank
	Administrative Issues	A				
1	Inconsistent operating goals	A1	0.027461	0.1285	0.01144	16
2	Organizational boundaries	A2	0.030613		0.00666	14
3	Lack of clear responsibility and difficulty in decision making	A3	0.032785		0.00499	13
4	Lack of top management commitment	A4	0.027531		0.00819	15
5	Lack of functional integration and cooperation	A5	0.032995		0.00518	12
	Financial Issue	F				
6	Shared risks & rewards	F1	0.028231	0.2673	0.00932	11
7	Measuring SC contribution	F2	0.031384		0.01350	10
8	Lack of performance measurement and incentives	F3	0.033625		0.00842	8
9	Cost of Implementation	F4	0.032224		0.00613	9
	Networking Issues	N				
10	Measuring customer demands	N1	0.032364	0.0870	0.00324	17
11	Lack of competitiveness	N2	0.031524		0.00606	18
12	Gap between design and implementation of technologies	N3	0.028651		0.00290	22
13	Poor and improper communication among suppliers	N4	0.029912		0.00347	19
14	Lack of effective leadership	N5	0.027881		0.00409	25
15	Temporary or short-term SC network	N6	0.028231		0.00355	24
	Technical Issues	T				
16	Inadequate information Sharing systems	T1			0.01154	**1**
17	Lack employee technical Expertise & Training	T2	0.035236		0.01654	4
18	Lack of communication	T3	0.032925		0.00857	5

19	Lack of technology to facilitate resource optimization	T4	0.032294	0.3854	0.00709	5
20	Lack of expert supply chain professionals	T5	0.031524		0.01093	2
21	Lack of understanding SC concept	T6	0.034606		0.00946	7
22	Ineffective problem-solving mechanism	T7	0.030543		0.00926	3
	Regulatory Issues	R	0.033765			
23	Lack clear alliance guidelines	R1		0.0810	0.00312	27
24	Lack willingness to share information	R2	0.028021		0.00433	21
25	Non-aligned Strategic and Operating Philosophies	R3	0.031173		0.00400	23
26	Inflexible Organizational Systems and Processes	R4	0.030683		0.00518	20
27	Cross-functional Conflicts and "Turf' Protection	R5	0.031524		0.00294	26
	Socio Cultural Issues	S	0.029212			
28	Risk-averse attitude	S1		0.0505	0.00168	32
29	Lack of Trust Among Supply Chain Members	S2	0.029912		0.00212	31
30	Resistance to Change	S3	0.030683		0.00374	29
31	Fear of extra workload and loss of flexibility	S4	0.034676		0.00320	30
32	Inadequate Training of SCM Principles in Institutional Level	S5	0.032294		0.00207	28

Table 8: *Factored global weightage of Identified Issues*

5. CASE STUDIES & ANALYSIS

5.1 Case Study 1: Kirby Building Systems, Hyderabad (Alghanim, 1999)

Organization Details : Established: 1999 in India
Type of Organization: PEB (Pre – Engineered Building) Company
Scale of Projects: Warehouses, Factories, Metro stations, Aircraft Hangers, Supermarkets, Steel Buildings, Sports stadiums, Auditoriums, etc.Other products include structural steel, sandwich panels, storage solutions etc.

Services Offered: i. Manufacturing of Steel Structures
ii. Steel Building Erection Services

To manage all these components & To provide Information sharing

Kirby is using various Techniques and Practices such as:

i. SAP-ERP (Implemented in 2014)
ii. Centre of Engineering Excellence (CEE)
iii. Integrated Enterprise landscape
iv. Sourcing of raw materials

Figure 4: *Gutter Installation work at site:*

Figure 5*: PEB Steel work at site*

Example Project – VEGA Production Unit, Hyderabad.

PMC: KPMA PMC
PEB Manufacturers: Kirby Building Solutions
Year of Construction: 2022
Typology: Industrial Structure
Client: Vega Automations
Location: Phase III Industrial sector, Hyderabad, Telangana.

EVM Report

The EVM report is on the date of 6 months from the start of the project which is the Half duration of the total project time.

S.No.	Activity	Planned %	Actual %
1	Columns & Rafters	97 %	97 %
2	Grits Fixing	5 %	3 %
3	Beam Alignment	73 %	83 %
4	Fascia stubs & Channels	15 %	8 %
	Cost of PEB	283.30 L	**217.84 L**

***Table 10**:Planned cost & planned amount of completion for PEB work*

S.No.	Activity	Planned %	Actual %
1	RCC Pedestal	100 %	50 %
2	Block Work	50 %	38 %
3	Mezzanine Pedestal RCC	72 %	36 %
	Cost of Civil	287.71 L	**47.53 L**

***Table 9:** Planned cost & amount of completion for Civil work.*

The project has faced lot of delay due to various factors but since Kirby was using SCM in their organization, they were able to decrease the impact when compared to the other Civil work in the same project.

Analysis:

- Using the above techniques, the Kirby is able to finish the project with minimum time and minimum wastage of material. The ability to share accurate and faster information helped in reducing the excess margins.
- They have their own Centre for Engineering & Excellence which is kind of R&D and training center which enables their staff to get trained in using these modern techniques like ERP systems which helps in improving the supply chain management system of the organization.
- Integration of all the data in the ERP helps in getting the real time data and which in tern helps in managing the process of SCM accurately.
- One more important practice used by this organization to achieve benefits of SCM are self-sourcing of the Raw materials from the trusted & Qualified suppliers, keeping ties with such suppliers instead of sourcing individually on time, and sharing of information how much to produce as per the requirement beforehand helps in avoiding shortage of raw material and decreases sudden fluctuation of material prices due to high demand & Shortage kind of issues.

5.2 Case Study 2: Infra.Market, Thane (Gowda, 2017)

Organization Details: Established: 2017
Type of Organization: Material Procurement Company
Range of Products: RMC, Flyash, Construction Chemicals, Aggregates, Cement, Light Weight Concrete, FRC, HSC, SCC, Pervious Concrete, Other products include structural steel, etc.
Services Offered: i. Cloud Manufacturing.
ii. Retail as a Service.
iii. Equipment Banking.

As per them the Larger companies are getting benefits of supply chain management, but smaller companies are unable to get this kind of benefits may be due to smaller order size or presence of multiple middle man in the tradition procurement chain or due to supply chain for various materials is fragmented and unorganized Infra.Market provides a solution for largely unorganized Construction Industry in the field of procurement, To achieve this, they are following Techniques & Practices such as: (Mathur, 2022)

- Taking the procurement process online.
- Bringing parity and transparency in pricing.
- Enhanced technology platform connecting client requirements directly to its supply chain
- Applying modern tools & approaches to remove unnecessary time and costs.
- Integrated national supply chain helps in quality, scale and efficiency.

Analysis:

- The Infra.market is a startup Organization established to provide the benefits of using the SCM in procurement systems, Inventory management & Equipment management even to the small-scale companies which were unable to get these benefits as large companies due **to smaller order size** or presence of **multiple middle man** in the **tradition procurement chain** or due to supply chain for various **materials is fragmented and unorganized.**
- This Case study provides many major solutions for the problems or issues identified above regarding the large-scale adoption of SCM in the industry of construction.
- The infra.market is able to this by various techniques and practices and is also mentioning that the companies are saving an amount if 5-7% of their initial input costs which is like quantifying the benefits of use of SCM which was one of the barrier identified in the above studies.

5.3 Case Study 3: Brick & Bolt, Bangalore (Bhattacharya, 2018)

Organization Details: Established: 2018
Type of Organization: Building Construction Company
Typology of Buildings: Residential Housing, Individual and Group Housing.
Services Offered: i. Residential Construction
ii. Commercial Construction.
iii. Construction **Material Sales.**

Brick and Bolt emphasis on simple model:

Plan - Build - Track - Settle in

They offer a kind of turn key solutions at a lower price compared to the market, they are able to do this without compromising in the quality due to some Techniques & Practices such as:

- Maintaining a Complete supply chain of Consultants to Suppliers.
- Providing real time Tracking by use of Technology.
- Maintaining clear transparency among the Supply chain.
- Providing simple tool for clients for calculation of overall cost to material requirement etc.
- Use of Escrow Model for money transactions.
- Quality assurance is one of their major practice, they have 340+ quality checks by in house team.
- They are also using a app to send the real time tracking & status of construction to the clients.

Analysis:

- The brick and Bolt have implemented technology as their basic strategy to offer clear transparency, real time tracking, and integration of their services through sharing of information etc., this helped them achieving Success in their field of construction and also SCM within it.
- They have their own set of consultants and contractors and suppliers with in the chain, even if contractor is making delays they are also penalizing them, it is like even with in the chain the are trying to keep discipline & transparency and confidence in their implementation process.
- Having the consultants in the supply chain is helping them in overcoming the issue of problem of risk in sharing of drawings which was one of the issues as mentioned above.
- Their main Strategy to get bulk order is they are ordering for themselves along with some of the local construction contractors, so they are acting as a supplier, by doing this they are increasing their amount of order from manufacturer to get the goods in lowest prices.

6 Comparison & Identifying the solutions of the ranked Barriers of solutions opted in the Case studies.

6.1 Comparison of Scope & Type of work.

S No.	Category	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Scope of Work as per SCM Model.	Management of a. Construction b. Supplier/ Sub-Contractor c. Indirect Supplier	Management of a. Supplier/ Sub-Contractor b. Indirect Supplier	Management of a. Designing b. Construction c. Supplier/ Sub-Contractor	There is distinct variation scope of work but all of these have Supplier/Sub Contractor in common and this also shows SCM can be implemented at various stages.
2	Type of Organization	PEB Manufacturer	Material Procurement	Design & Construction	This shows that SCM is helpful in all types of Organizations.
3.	Year of Establishment	2014	2017	2018	Implementation of modern technology is major key to success

Table 11: *Case studies organizational setup Comparison*

6.2 Comparison of Solution adopted in case studies w.r.t. to Identified Issues

S No.	Issues	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Inadequate information Sharing systems	Using SAP ERP System to share Information.	Uses web based online system for Information	App based real time sharing of information.	All companies are using technology-based IT tools to overcome this.
2	Lack of expert supply chain professionals	CEE is trying to train its employees.	They are connecting with SCM Experts	They are connecting with SCM Experts	Outsourcing of experts to train people about SCM is helping them.
3	Ineffective problem-solving mechanism	Through their R&D they have created a model for SCM in PEB	They have an effective SCM Model for Material management.	They have created a model for all types of SCM.	All organization have developed their own mechanism of SCM, so, these can be taken as example in India.

Table 12: *Table of Comparison of Technological Barrier Solutions*

S No.	Issues	Case Study 1	Case Study 2	Case Study 3	Remarks
1	Lack of performance measuring & incentive system	They don't have clear tool to measure it.	Using SCM, the saving is up to 5-7% cost, the performance can be measured	Provides a cost estimator to compare the benefits of using SCM.	Incentive system is not there but the benefits are clearly measured in Case studies.
2	Cost of Implementation	Initially to change, it had a cost, But the benefits are now more than Investment.	Because of clear commitment towards use of SCM, they have created a Cost-effective model	They also started with clear Idea of complete SCM solution, so it is profitable now.	The cost of implementation may be higher but in long term it is helping them & the industry with lot of intangible benefits.
3	Shared risks & rewards	They are accepting to share Risks & Rewards	They are accepting to share Risks & Rewards	They are accepting to share Risks & Rewards	Since the Rewards are less but consistent unlike Traditional, and also risk is decreasing.

Table 13: *Table of Comparison of Financial Barrier Solutions*

S No.	Issues	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Lack of functional integration and cooperation	They are using Integrated Enterprise landscape.	Web based integrated Supply chain to ensure Co-opt.	App based real time integration of functional operations.	The Organizations have adopted Tech based solution for Functional integration.
2	Lack of clear responsibility and difficulty in decision making	In 2014, while adopting SCM clear set of responsibilities are assigned.	The company started on basis of SCM have assigned SC managers etc.	The company started on basis of SCM have assigned SC managers etc.	The organizations have now clearly assigned the roles of decision making to SC managers etc., to overcome this Issue.
3	Organizational boundaries	Reframed the existing Organizational boundaries to adopt SCM.	They formed organizational principles on the basis of adopting SCM.	Their principles are to provide complete solution which includes SCM.	Reframing is the best solution for existing organization with the help of SCM expert, to gain benefits of SCM.

Table 14: *Table of Comparison of Administrative Barrier Solutions*

S No.	Issues	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Measuring demands	Demand to supplier is shared before itself with in SC.	Once the SC is connected, then the Demand is shared directly.	Consultants are directly involved so the demand estimation done.	The real time Sharing of info helps in demand estimation beforehand.
2	Lack of competitiveness	SCM helped in overpowering their rivals	Tech based model helped in their Success.	Complete solution model made it feasible	Competitiveness is now increased since there are new Startup emerging.
3	Poor & improper communication among suppliers	They have identified set of trusted Suppliers this helped in cooperation.	They have complete set of established SC till indirect Suppliers	They have own set of suppliers since they are also into material supply.	Having trusted limited set of suppliers will ensure proper communication among the suppliers.

***Table 15**: Table of Comparison of Networking Barrier Solutions*

S No.	Issues	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Inflexible Organizational Systems and Processes	In 2014, they have changed their System to adopt SCM	They had so such issue since they started with SCM itself.	They had so such issue since they started with SCM itself.	The Organizational system have to be changed to support SCM at some cost.
2	Lack willingness to share information	Since they are the designers of PEB, they have no issues in Sharing of Info.	This is one of the issues in this, but if BOQ are done early it can be avoided.	They have their own set of consultants, so sharing is not a major problem.	The sharing of info could be done either with in trusted suppliers or should quantify beforehand.
3	Non-aligned Strategic and Operating Philosophies	They have selected stakeholders with similar operating philosophies	They have developed an operating strategy to provide SC.	No such issue because of having all in stakeholders under one.	Selection of stakeholders & changing their operation procedure towards SCM can help in overcoming this issue.

***Table 16**: Table of Comparison of Regulatory Barrier Solutions*

S No.	Issues	Case Study 1 Kirby PEB	Case Study 2 Infra.Market	Case Study 3 Brick & Bolt	Remarks
1	Inadequate Training of SCM in Institutional Level	Out of their scope	Out of their scope	Out of their scope	They are trying train their professionals to improve SCM in Construction
2	Resistance to Change	Understanding benefits, and new tech helped in.	Easy of adoption as a startup made it possible.	Easy of adoption as a startup made it possible.	Understanding benefits and improved easy of adoption led use of SCM.
3	Fear of extra workload and loss of flexibility	Using of Tech compensated the extra work load SCM.	Using of Tech compensated the extra work load in SCM	Using of Tech compensated the extra work load in SCM	The work load which may increase is covered by the use of tech-based solution.

***Table 17:** Table of Comparison of Socio-Cultural Barrier Solutions*

The solutions these organizations have applied can be the inferred as the solution for large scale adoption of SCM, or even some solutions are different with respect to different case studies, so relevant solution can be preferred as per the suitability.

6.3 Analysis:

Even though these three models have given solution of major problems, but still there some issues which cannot be addressed by these models of solutions they are listed below:

1. Some of the model doesn't have clear tool to measure the benefit of SCM.
2. The operational extent or reachability of the material to remote places.
3. Availability of the required material as per the client at the required location.
4. It cannot be applicable to the fragmented orders which are very less in Quantity even in multiple order scenarios.

7 CONCLUSION & RECOMMENDATIONS

The previous studies include the advantages of using SCM in the construction industry but, it was not clear how to adopt the SCM, what were the major challenges occurring while adoption of supply chain and at which level SCM can be adopted, from the analysis of case studies, we can conclude that SCM can be adopted at various stages, it is not confined to only few type of construction such as PEB or Pre Cast, it can be used for traditional type of construction like cast in situ, The model of Supply chain can be of sub-contractor and Supplier, and this supply chain can be connected to various contractors, or in other case it could have a set of contractors, sub-contractor, supplier and they can be connected to various consultants, Similarly there could be a supply chain of Consultant, Contactor, sub-contractor and they can be engaged to a particular client. All these modes of SCM models are been implemented successfully in the case studies, and adopting this type of supply chains will help in keeping the supply chain for longer periods, and they can share risks and rewards throughout the life of supply chain. This method of supply chain will help in linking the fragmented supply chain in the industry of construction. By studying the above solutions how each issue has been addressed we can suggest them as the solution to adopt to implement Supply chain management in Construction even form small scale industries.

Some of the methods that could be adopted to overcome the Major challenges:

- Training of the employees regarding the SCM concepts.
- Technology based solution for information & communication system for real time sharing of the information.
- To reframe the organization structure to adopt SCM in their organization, since the benefits of the SCM can be gained.
- Outsourcing the experts in supply chain management to adopt to the SCM system.
- Identify a model of SCM, as per their type of operations & scope of work, or can follow tried and tested mechanism of the organizations using SCM.
- GPS based delivery system can help in avoiding delays of material due to traffic issues, especially for materials like RMC.
- Since the benefits of SCM are now been clearly measured, organization can change their goals to achieve the resource optimization, and reducing cost & wastage recycling using SCM.
- Contractors can connect with organization which can provide a supply chain including, sub-contractor, supplier and chain of manufactures etc. to gain the benefits of SCM even if he is working in small scale.
- Consultants can avail the organization who are providing whole supply chain including the contractors to the manufactures for the same.

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