PUNE RESEARCH DISCOVERY ISSN 2455-9202
AN INTERNATIONAL JOURNAL OF ADVANCED STUDIES VOL 5, ISSUE 3

CONSTRUCTION SUPPLY CHAIN MANAGEMENT

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Abstract: The construction industry, faces a lot of challenges ranging from behavioral attitudes among partners to lack of trust between clients and industry practitioners. A review of construction activities has revealed that these challenges are informed by the lack of collaboration and performance within the supply chain (SC). The various literature reviewed showed that the construction supply chain (CSC) needs to be adaptive by applying the principles of supply chain management (SCM) to utilize systemwide costs to attain system -wide services no matter how broad the value chain. This paper presents the elements of the adaptive CSC as a network that defines relationships, roles, networking capabilities and technological infrastructure. The adaptive CSC enhances relationships, promotes trust between the partners in the value chain but it operates based on partners' performance. The next step of the research work is also enumerated.

Key words – Adaptive Network, Construction Supply Chain, Simulation, Supply Chain Management, Technological Infrastructure, Linear Supply Chain.

I. INTRODUCTION

Supply chain frame work: Here various definitions of Supply chain framework are being given:

"A supply chain is a network of supplier, manufacturing, assembly distribution and logistics facilities that perform the functions of procurement of materials, transformation of these material into intermediate and finished products and the distribution of these products to customers"

"Supply Chain Management as the integration of business process from the end user through original supplier who provide products, services and information that adds value for the customers"

However, this requires an integrative planning process that involves suppliers and subcontractors early in the construction project. This thesis is to find how supply chain planning can integrate the supply process and the construction process in order to facilitate improvements of logistics in construction.

So, SCM can be defined as network of different organizations, linked upstream and downstream in a chain, aiming to produce quality and value in the services and products for the end consumers through integrated processes and activities.

Aim:

- To study and develop framework for effective supply chain management for residential projects in Baramati region.

Research Questions:

1. What are the important parameters of SCM?
2. How to develop effective SCM for given cases?

Objectives:

1. To study and analyze overall supply chain management in given project.
2. To study & analyze challenges of supply chain management.
3. To recommend solutions for the challenges in supply chain network.

Scope:

- Mainly focused on of supply chain management of residential projects Baramati region.

Limitation:

- Limited to supply chain management of selected project in Baramati region only.

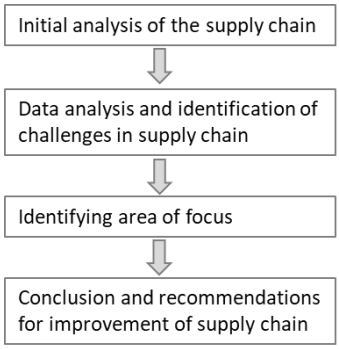
II. METHODOLOGY

The questionnaire is the main tool used here.
Questionnaire template is prepared comprising two components. -

A. First part consists of demographic details, company details and project details.
B. Second part consists of Critical issues affecting Supply Chain Management in Construction projects.

The survey was conducted on 3 different sites of Baramati area. Questionnaires is given to various respondents such as construction manager, suppliers, contractors, project engineers, etc.

Data was collected from different experts involved in the project as mentioned above.



III. LITERATURE REVIEW

Research paper 1: **Supply Chain Management in the Construction Industry**

A Literature Review Conference Paper • April 2016

The importance of supply chain management (SCM) has been discussed extensively, especially in the context of improving companies' performance.

Since the construction industry is a key social and economic activity of every country, the application of SCM strategies is considered helpful in achieving higher competitiveness of construction firms and construction sector as a whole.

Although the existing literature suggests that the generic supply chains should be simple and linear, the reality in the construction sector is quiet.

Research paper 2: **Construction material supply chain process analysis and optimization**

Article by Nai-Hsin Pan, Ming-Li Lee, in Journal of civil engineering and management, October- 2010

This paper provides a systematic approach for the analysis and design of construction supply models.

This research studies supply and demand behavior, using a bridge superstructure construction process as a case study.

This study primarily investigated the supply chain behavior of a bridge construction project, from procurement and processing to field installation.

It focused on key points of supply chain model design and analysis; the conclusions of this study were as follows:

Construction supply chains have huge structures covering many complicated industries, and no supply chain operation model has been built up to now.

Research paper 3: **Supply Chain Improvement in Construction Industry**

Article by Georgios A. Papadopoulos, Nadia Zamer, Sector of Industrial Management and Operational Research, School of Mechanical Engineering, National Technical University of Athens, Greece, June 2016

The aim of this research study report is to provide a set of propositions for improving construction supply chain management such as benchmarking, improvement of suppliers/subcontractor's performance, elimination of waste, training and information sharing between parts of the supply chain.

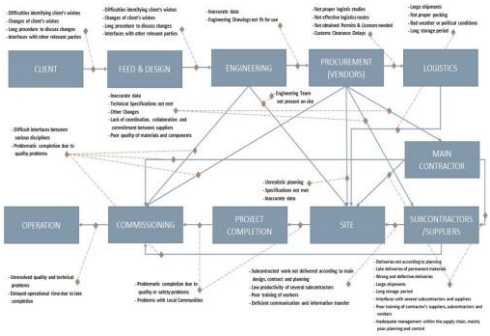


Figure1.Supply Chain in Construction Industry

Book Review 1: **Construction Supply Chain Management - Concepts and Case Studies**

Mark Gannon. "Construction Supply Chain Management - Concepts and Case Studies." *ICE publishing*, November 2012.

This book is well organized and written, bringing together the theory and practice of SCM.

Construction supply chain management is organized into two main sections: Part A covering the theoretical concepts of SCM in construction; and Part B covering the application of SCM to the United Kingdom (UK) construction industry.

Part B, the practice, comprises the chapters on supply chains applied to private finance initiative projects and supply chain risk, supply chains used and developed from a client's perspective by two of the largest UK clients, Slough Estates and British Airport Authorities, and a contractor's perspective on the way they exploit supply chains. The final chapter is on the use of franchising in construction and its application to contractors and sub-contractors.

Book Review 2: **Successful Construction Supply Chain Management: Concepts and Case Studies**

Stephen Pryk. "Successful Construction Supply Chain Management: Concepts and Case Studies." John Wiley and Sons Ltd, 25 Feb 2020.

Provides a unique overview of supply chain management (SCM) concepts, illustrating how the methodology can help enhance construction industry project success. This book provides a unique appraisal of supply chain management (SCM) concepts brought together with lessons from industry and analysis gathered from extensive research on how supply chains are managed in the construction industry.

The research from leading international academics has been drawn together with the experience from some of the industry's foremost SCM practitioners to provide both the experienced researcher and the industry practitioner a thorough grounding in its principles, as well as an illustration of SCM as a methodology for enhancing construction industry project success.

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The research from leading international academics has been drawn together with the experience from some of the industry's foremost SCM practitioners to provide both the experienced researcher and the industry practitioner a thorough grounding in its principles, as well as an illustration of SCM as a methodology for enhancing construction industry project success.

IV. DATA COLLECTION

Case studies: A case study research can therefore be a valid method for fulfilling parts of objective

Case study 1: URBANGRAM, JALOCHI, BARAMATI

No.	Description	Case study 1
1	Project by	'VASTUSHOD'
2	Name of the project	'URBANGRAM'
3	Location	JALOCHI, BARAMATI
4	Site area	5 Acre
5	Total no. of blocks	4
6	Total no. of floors	P+6
7	No. of flats on every floor	6
8	Constructed area/ plinth area	3150 sq. m
9	Block consists	Residential Apartments (1,2,3 BHK)
10	Zoning as per corporation by laws	Residential
11	Land use	Residential
12	Starting of the project	Feb, 2017
13	Duration of the project	4 years
14	Delay in the construction	Expected in 2021
15	Completion of the project	13 months

Urbangram offers spacious and skillfully designed, well-ventilated 1BHK, 2BHK and 3BHK flats in Baramati, Pune, bringing elevated lifestyle in the town.

This RERA registered project is well equipped with basic modern amenities and is blessed with green surroundings. Structures are with parking plus 7 floors.

Located just 500m from Bhigwan Road in close vicinity of MIDC Baramati. Excellent connectivity with schools, colleges and railway station. Easily accessible by local transport.

This residential property of 252 flats is spread across 6.5 acres of land.

On site Scenario

a. Construction material management

Material management is defined as planning, identification, procuring, storage, Receiving and distribution of materials.

The purpose of material management is to assure that the right materials are in the right place, in the right quantize when needed.

The responsibility of material management department for the flow of materials from the time the materials are ordered, received, and stored until they are used in the basis of material management.

b. Process of construction material management

Material planning

All the requirements of material and equipment's is calculated after the finalizing the drawings and scope and time of the project.

Then, accordingly the time period the cash flow is calculated and, cash flow chart is finalizing accordingly.

Schedule of the work is prepared accordingly, to calculate exact time period.

Duration and mile stones are finalized before construction depending on schedule.

For starting the project, the construction team requires the material to start the work, the material intent chart is filled according to stage, for stage wise construction, the required material indent list is given to store manager.

Purchasing and material issue

Store manager send the required material list to purchase department, purchase order is followed.

The material is checked by the store in charge, and is stored, then material in charge releases goods receipt note.

Purchasing procedure described as below:

Step 1 - Material Indent Step 4 - Vendor Selection and Negotiations

Step 2 - Enquiry to Vendors Step 5 - Purchase Order

Step 3 - Vendor Comparison Step 6 - Vendor Evaluation

Material issue

Engineers issues the material as per requirement from store keeper.

The store in charge gives material issue slip to engineer.

Figure2.On site scenario, Case 1

Case study 2: DEVBHUMI, GUNAWADI ROAD, BARAMATI

No.	Description	Case study 1
1	Project by	'DEVRAJ BUILDERS & DEVELOPERS'
2	Name of the project	'DEVBHUMI'
3	Location	GUNAWADI ROAD, BARAMATI
4	Site area	4 Acre
5	Total no. of blocks	4
6	Total no. of floors	P + 3
7	No. of flats on every floor	6
8	Constructed area/ plinth area	3000 sq. m
9	Block consists	Residential Apartments (1,2,3 BHK)
10	Zoning as per corporation by laws	Residential
11	Land use	Residential
12	Starting of the project	August, 2018
13	Duration of the project	5 years
14	Delay in the construction	Expected by June 2023
15	Completion of the project	6 months

Devbhoomi at Baramati

Devbhoomi offers Affordable 168 Homes in 2-acre area among 6 acres in Baramati, Pune, bringing elevated lifestyle in the town. This RERA registered project is well equipped with basic modern amenities and is blessed with green surroundings.

- Project Amenities-

Area 2 acre, 168 homes, Children's play area, Basketball Court, Jogging Track, Senior citizen park, Central Bus stand 5min, School, 2min, Hospital 5min, Main Market (Bhaji mandai) 5min

Figure3.On site scenario, Case 2

Case study 3: DEVRAJ NISARGA, GUNAWADI ROAD, BARAMATI

No.	Description	Case study 1
1	Project by	'DEVRAJ BUILDERS & DEVELOPERS'
2	Name of the project	'DEVRAJ NISARGA'
3	Location	KASBA, BARAMATI
4	Site area	3.5 Acre
5	Total no. of blocks	4
6	Total no. of floors	P + 6
7	No. of flats on every floor	6
8	Constructed area/ plinth area	2850 sq. m
9	Block consists	Residential Apartments (1,2,3 BHK)
10	Zoning as per corporation by laws	Residential
11	Land use	Residential
12	Starting of the project	June, 2015
13	Duration of the project	5 years
14	Delay in the construction	Expected in August 2020
15	Completion of the project	9 months

Devraj Nisarg at Baramati

Devbhoomi offers Affordable Homes in 3.5-acre area among 6 acres in Baramati, Pune, bringing elevated lifestyle in the town. This RERA registered project is well equipped with basic modern amenities as follows

- Project Amenities-

3.5-acre area, Bigger and secure entrance gate, Swimming pool, Children's play area, Basketball court, Senior citizen garden, Excellent connectivity with schools, colleges and ST stands. Easily accessible by local transport.

Figure4. On site scenario, Case 3

V. COMPARATIVE ANALYSIS

• Project identification				
		Case study 1	Case study 2	Case study 3
1	Name of the project:	URBANGRAM	DEVBHUMI	DEVRAJ NISARGA
2	Location of the project:	JALOCHI, BARAMATI	GUNAWADI ROAD,BARAMATI	KASBA, BARAMATI
3	No. of the buildings:	03	04	04
4	Type of apartments:	04	04	04
5	Area of the site:	5 Acre	4 Acre	3.5 Acre
6	Total Plinth area:	3150 sq. m	3000 sq. m	2850 sq. m
• Personal identification				
1	Name of person	Tushar Raut	Mayur Mane	Sanjay Atole
2	Designation	Site Engineer	Site Engineer	Site Engineer
3	Qualification	Civil Engineer	Civil Engineer	Civil Engineer

Figure5. General Questionnaire

• Project identification				
		Case study 1	Case study 2	Case study 3
1	Name of the project:	URBANGRAM	DEVBHUMI	DEVRAJ NISARGA
2	Location of the project:	JALOCHI, BARAMATI	GUNAWADI ROAD,BARAMATI	KASBA, BARAMATI
3	No. of the buildings:	03	04	04
4	Type of apartments:	04	04	04
5	Area of the site:	5 Acre	4 Acre	3.5 Acre
6	Total Plinth area:	3150 sq. m	3000 sq. m	2850 sq. m
• Personal identification				
1	Name of person	Tushar Raut	Mayur Mane	Sanjay Atole
2	Designation	Site Engineer	Site Engineer	Site Engineer
3	Qualification	Civil Engineer	Civil Engineer	Civil Engineer

Figure6. General Questionnaire

Material management				
		Case study 1	Case study 2	Case study 3
1	What is the type materials that you usually buy from suppliers?	Cement, Steel, Finishing materials	Cement, Steel, Sand, Finishing materials	Cement, Steel, Finishing materials
2	How do you typically place an order?	Store Visits or On calls	On calls	On calls
3	Who monitors the process?	Store Manager	Purchase & Store Manager	Purchase & Store Manager
4	Do you use Just in Time (JIT) delivery?	NO	NO	NO
5	What are the major problems that you can identify in the system	Delivery time	Quantities	Delivery time
6	Where are the materials are stored?	On Site	On Site	On Site
7	Where do you keep material installed/ remaining?			
	• Open area on the site	ON SITE		
	• Within the structure		WITHIN STRUCTURE	WITHIN STRUCTURE

Figure7. Questionnaire for material management

• Material handling				
		Case study 1	Case study 2	Case study 3
8	What are the major difficulties when Handling material on-site?	Material wastage	Material wastage	Material wastage
9	What happens if there are problems with materials shortages or materials damaged?	Work Stops	Buffer Stock	Buffer Stock
• Technology				
10	Do you use a computer in your company for material ordering, material tracking?			
	• Yes	YES	YES	YES
	• No			
11	Do you use any technology for inventory control on site?	NO	NO	NO
12	Do you use JIT delivery?	NO	NO	NO

Figure8. Questionnaire for Material handling and Technology

Problems of the Construction Supply Chains

Client, Design Interface: difficulties in finding out client's wishes, changes of client's wishes, long procedures to discuss changes, interfaces with other relevant parties throughout feed and design period.

Design Interface: incorrect documents, design changes, extended time for design changes and approval, wrong calculations, designs not in accordance with the well-known construction methods, no constructability.

Procurement, Vendors Interface: inaccurate data, engineering drawings not fit for use.

Site Interface: engineering team not present on site for the field engineering.

Procurement, Vendors interface: Inaccurate data, technical specifications not met, other changes, lack of coordination, collaboration and commitment between suppliers, poor quality of materials and components.

Logistics / Site Interface: large shipments, not proper packing, bad weather or political conditions, long storage period. Main Contractor- Subcontractors Interface: deliveries not according to planning late deliveries of permanent materials, wrong and defective deliveries, large shipments, long storage period, interfaces with several subcontractors and suppliers, poor training of contractor's suppliers, subcontractors and workers, inadequate management within the supply chain, mainly poor.

Site/ Project Completion / Commissioning Interfaces: problematic completion due to quality or safety problems, problems with local communities. This generic model of the problems in the construction process, the term "supply chain" refers to the stages through which construction materials factually proceed before having become a permanent part of the project.

Areas of Focus and Roles of Supply Chain Management in Construction

Following can be the Areas of Focus and Roles of Supply Chain Management in Construction:

- The focus is on the impacts of the supply chain on site activities. The goal is to reduce costs and duration of site activities. In this case, the primary consideration is to ensure dependable material and labour flows to the site to avoid disruption to the workflow. This may be achieved by simply focusing on the relationship between the site and direct suppliers. The contractor, whose main interest is in site activities, is in the best position to adopt this focus.
- The focus is on transferring activities from the site to earlier stages of the supply chain and on the integrated management

and improvement of the supply chain and the site production. Thus, site production is included into SCM. Clients, suppliers or contractors may initiate this focus.

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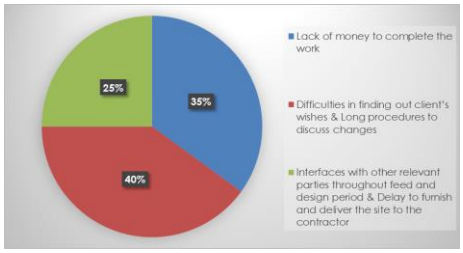
VI. FINDINGS AND PROPOSALS

Results (from case study)

Here the results from questionnaires are presented.

This illustrates the characteristics of the current construction materials supply chain management, contactor-supplier relationship, some concepts that mitigate the uncertainties and risks in the construction industry which affects the supply chain in the construction industry are discussed here.

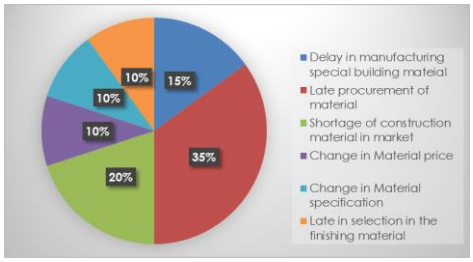
A. Client related factors



The Fig. explains, how client related factors affects the supply chain management in construction.

It is found that the majority of people think that delay to in finding out client's wishes and long procedures to discuss changes are the major problems for the supply chain process and it was affected 40% clearly shown.

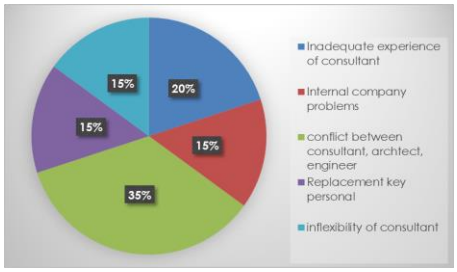
B. Manufacturer related factors



The Fig. explains, how manufacturer related factors affects the supply chain management in construction.

The major causes that will affect the supply chain process are late procurement of materials, change in the material specifications and late procurement of materials which is in the percentage of 35%.

C. Consultant related factors



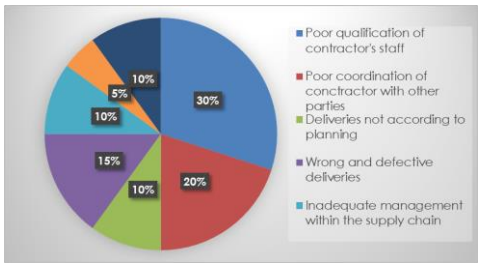
The Fig. explains, how consultant related factors affects the supply chain management in construction.

It is found that major causes which affect the supply chain process is conflict between consultant, architect, engineers.

To reduce this causes the following necessary step should be taken in the project.

Qualified personnel should be selected before rejecting the present key personnel.

D. Contractor related factors

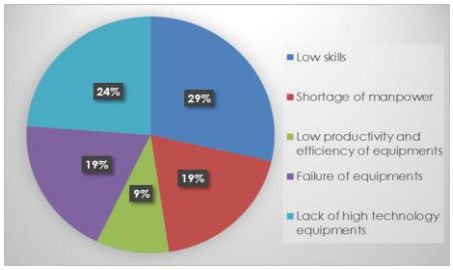


The Fig. explains, how contractor related factors affects the supply chain management in construction.

It is found that the major causes that were affected the supply chain process is poor coordination by poor qualification of staff by 30%

To reduce this problem the contractors should take the following steps.

E. Labour related factors



The Fig. explains, how labor related factors affects the supply chain management in construction.

It is found that there are two major causes which affect the supply chain process among the 10 causes with the percentage of 11.21 and 10.76.

The techniques used for to reduce these causes is Planning and Scheduling using MS Office Project

VII. CONCLUSIONS AND RECOMMENDATIONS

Construction is a productive process that has various and complex interfaces between participants and many problems originated by the lack of coordination of these participants. SCM provides several principles to address this fragmentation and reduce it. Even though SCM in the manufacturing industry has been widely researched and developed, the application of these same principles to the construction industry shows waste and problems in construction supply chains are extensively present and persistent.

Solutions/ Suggestions

Methods to Improve Construction Supply Chain Management

The subsections below is an attempt to propose a se t of managerial practices in order to improve construction supply chain management.

- Manufacturer related factors

Measure the performance of the processes is an ongoing challenge for companies from all sectors. Research regarding performance measurement is recent and provided frameworks that provide guidelines for managers in implementing performance measurement.

Also, at the operations level (purchasing, stocking, handling, etc.) some efforts could be done in order to identify redundant activities and eliminate them. The application of this philosophy throughout the many tiers of supply chain can deliver great results from a systemic point of view, given that the interaction between the companies is constant and their individual results influence the overall performance of supply chain.

- Contractor related factors

The interfaces between construction companies and their contractors is continuous through the whole duration of a project. In this sense, the performance delivered by the contractors influences the overall performance of the project. Major companies related to manufacturing have developed initiatives concerned about suppliers' development.

- Consultant related factors

In a typical supply chain, the suppliers develop knowledge not only about their products and services but also about supply chain management. Even though there are many suppliers in a single supply chain, it is rare to observe a focal (major) company that gather knowledge from its suppliers.

In this sense, clearly is established an opportunity for implementing knowledge management in supply chain.

- Labour related factors

The importance of human factor is very important and qualified employees are required. In this sense, companies should periodically prepare an extensive and comprehensive training program to equip the best employees with proper training benefiting as a result the supply chain processes.

- Recommendation to increase the use of Information Technology for more efficient systems

The application of IT in SCM has significant benefits. The use of web-based information system in SCM will reduce interfacing barriers between the several parties on the supply chain.

The information and communication technology (ICT) will improve supply chain performance, support supply chain efficiency, and enable greater supply chain integration. The several supply chain participants (i.e. Contractor, Suppliers, Subcontractors, etc.) should develop compatible IT application software and common analysis methods of the complex data.

VIII. ACKNOWLEDGEMENT

I would like to take this opportunity to express my profound gratitude and deep regard to my Guide Ar. Saniya Khan, and Ar. Aparna Panganti ma'am for exemplary guidance, valuable feedback and constant encouragement throughout the duration of the project. Their valuable suggestions were of immense help throughout my project work. Their perceptive criticism kept me working to make this project in a much better way. Working under her was an extremely knowledgeable experience for me.

IX. REFERENCES

I. *Akintoye, A., Macintosh, G., Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry, European Journal of Purchasing and Supply Management, Special Issue.*

II. *Mark Gannon. "Construction Supply Chain Management - Concepts and Case Studies." ICE publishing, vol. 165, November 2012, pp. 259-260.*

III. *William T. Walker. "Supply Chain Construction: The Basics for Networking the Flow of Material, Information, and Cash." Apple Academic Press Inc.*

IV. *Stephen Pryk. "Successful Construction Supply Chain Management: Concepts and Case Studies." John Wiley and Sons Ltd, 25 Feb 2020*

V. *Beamon, B. (1999). "Measuring supply chain performance".*

VI. *International Journal of Operations & Production Management, 19(3), pp.275-292.*

VII. *http://lcm.csa.iisc.ernet.in/scm/supply_chain_intro.html.*

VIII. *Garcia, F., Marchetta, M., Camargo, M., Morel, L., Forradellas, R. (2012). "A framework for measuring logistics performance in the wine industry". International Journal of Production Economics, 135(1), pp.284-298.*

IX. *Gunasekaran, A., Patel, C., McGaughey, R. (2004). "A framework for supply chain performance measurement". International Journal of Production Economics, 87(3), pp.333347.*

X. *Hong-Minh, S.M., Disney, S.M., Naim, M.M. (2000). The dynamics of emergency transhipment supply chains. International Journal of Physical Distribution and Logistics Management 30 (9), 788-815.*