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Proposed framework of Supply Chain Management in Construction Industry.

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Abstract

Construction Industry in India accounts for 11% percent of GDP, second largest industry after agriculture. It is the backbone for urban and infrastructure development in India. It is marred by the several problems may it be political or social or environmental, starting from land acquisition to financial credit? The issues are deemed to be arising due to poor supply chain management in construction industry. Supply chains are omni-present. However, the nature of supply chain in construction industry is relatively unexplored. It discusses the vital issues of managing supply chain in construction industry using a comprehensive literature survey. This paper aims to analyze the framework of supply chain in construction industry. It identifies the core issues responsible for poor supply chain management in construction industry. The issues pointed out are the coordination issues, integration issues, selection issues (procurement) and buyer-supplier relationship. It put forwards a framework of normative research (prescriptive) in the construction industry. The broad objective of this paper is to unfold and address the various research issues responsible for poor supply chain management in construction Industry. In this regard, this paper is an attempt to put forward the proposed framework of research to investigate the nature of Supply chain in Construction Industry.

Introduction

Supply chain management is a concept originated from the supply system by which Toyota has seen to coordinate its supplies, and manage its suppliers. In the terms of lean production, SCM is closely related to lean supply. The basic concept of SCM includes tools like Just in time delivery (JIT) and logistic management. The concept of supply chain management is broader but still dominated by logistics. Until now in construction, initiatives belonging to the domain of SCM have been rather partial covering a subset of issues (e.g. transportation cost) in a limited part of construction supply chain (e.g. the construction site).In most cases, the issues are regarding the contractor's point of view. The suppliers and subcontractor are responsible for 75% of the turnover. As a consequence, main contractor become more and more reliant upon suppliers and subcontractors in the construction supply chain. Hence client and contractor need to revise their supply strategy and trading relationships with the suppliers and subcontractors. The supply chain has been defined as the network of organizations that are involved upstream and downstream linkages, in the different

processes and activities that produce value in the form of products and services in the hands of ultimate customer. SCM looks across the entire supply chain, rather than just at the next entity or level, and aims to increase transparency and alignment of the supply chain coordination and configuration, regardless of functional and corporate boundaries.

Nature of supply chain in Construction Industry

Supply chain management has emerged as popular concept in construction industry and research community since mid 1990s.Research in construction supply chain management draws a broad range of discipline, notably: Industrial Organization economics to better understand the market structure, forces and their effect on a firm and supply chain behavior and analytic modeling of supply chain to improve supply chain performance along metrics such as speed, cost, reliability, quality etc. Both industrial organization and analytic modeling provide useful but ultimately incomplete perspectives and prescriptions for construction supply chain management. Concurrent with the development of lean approaches in construction, there has been increasing interest and research in supply chain management as a field of study and application. Supply chain management focuses on understanding and improving the coordination of multiple firms that compose a supply chain. Figure1 depicts the activities in supply chain management of Construction Industry. The severity of the issues responsible for poor supply chain at activity level and supply chain member level in construction industry, is also depicted in the figure. On the first hand, we need to understand the nature of supply chain prevailing in construction industry. According to Fisher's Model of supply chain, nature of product decides the design of supply chain, but supply chain in context of project is not entirely a product focused supply chain. According to SCOR model, the process within the supply chain decides the nature of supply chain as process focused supply chain. However the nature of supply chain is neither entirely a product focused or process focused, but it goes through the several transitions of product to process to envisage a project supply chain. These several transitions demands to maintain the smoother flows; material, information and financial flow to evolve a bottleneck free supply chain. However, it is difficult to develop a bottleneck free supply chain in project centric environment.

Need of the study

Construction Industry in India accounts for 11% percent of GDP, second largest industry after agriculture. It is the backbone for urban and infrastructure development in India. It is marred by the several problems may it be political or social or environmental, starting from land acquisition to financial credit? Every construction project may it be Golden Quadrilateral Expressway or Konkan Railway or Bandra – Worli sea link goes through several hassles and chaotic conditions which leads to jeopardize the completion of projects within cost and time frame. Making the sense of supply chain or partnership in construction may be an elusive concept.Construction industry is facing numerous challenges which are listed as follows:

i) Time overrun and cost overrun
ii) Highly fragmented industry
iii) Large number of service providers
iv) One-off project
v) Price based selection
vi) Low barrier to entry
vii) Lack of trust, communication among partners.

viii) Adverse conditions-Political, Economical, Social, Technological etc.

Relevance of the study

According to Indian Infrastructure Report 2008, an average economic growth of 8.6 percent over the past three has India bursting at the seams, so as to speak with its infrastructure sector stretched way beyond the capacity. Spiraling demand for air travel, reliable power supply and efficient ports, roads and railways has not been matched by a proportionate increase in supply. It is widely recognized that severe supply side bottlenecks can retard the economy's potential rate of growth. These supply side bottlenecks are due to poor supply management practices demonstrated by the construction industry. The performance of construction industry in cost and time frame can be improved if it manages to employ effective purchasing and supply management framework to remove several supply side bottlenecks.

Literature Survey:

Research in Supply chain of construction Industry began with the work of Egan (Egan Report) in UK construction Industry. Construction research involving supply chain concept is a relatively new field and it emerged in the mid 1990s.More importantly Nishiguchi*(1987)*,Ellarm*(1991)*,Hines*(1994)*,Harland *(1996)* and Lamber et.al.*(1998)*, have found the lack of construction industry research involving supply chain and industrial organization field. The figure 2 shows the supply chain movement in construction industry, following evolution in manufacturing sector, beginning with 1980s up to 2000.

However in this paper we have made an attempt to explore the literature on Construction supply chain management from 2000 to 2008. The literature review is categorized into four broad sections; first sections focus on basic framework of supply chain in construction industry; second section discusses the necessity of integration in Construction Supply chain; third section discusses the procurement and partnering issues and the last section elaborates on buyer-supplier relationships in construction supply chain. The following section broadly discusses the core issues (challenges) of project centric supply chain. The results of an in-depth literature survey are depicted in table 1.

Basic Framework of supply chain in construction industry

Basic framework of supply chain mainly explains how construction as a production can be completed through various stages of production. Several authors have attempted to describe basic nature of supply chain in construction. This section primarily discusses this basic framework. Saad M., Jones Martyn and James Peter *(2002)* investigated supply chain management as fifth generation innovation in construction industry. Cox and Townsend *(1998)* argue that there has been no theoretical framework underpinning the development of these procurement approaches. Construction lacks a systematic and strategic approach to change which requires innovation, is regarded as the multi-factor innovation which can help construction overcome its fragmentation and adversarial culture, improve its relationship and better integrate its processes. Partnering is adopted upstream between clients, consultants and main contractor and yet to be expanded to the downstream. Ruben V. and Koskela L. *(2000)* have clarified the roles and possibilities of SCM in the construction industry. Four roles of SCM in construction include the impact of supply chain on site activities, focus on supply chain itself, transferring activities from the site to the earlier stages of the supply chain and integrated management and

improvement of the supply chain. The study has put forward the need to develop supply chain framework pertaining to particular characteristics and specific situation of construction industry. It has pointed out the two issues; lagging productivity development and the increased economic weight of the supply chain. Childerhouse P.and Towill D. *(2003)* has delivered twelve rules for simplified material flows have been validated through case studies to integrate the supply chain process to attain effectiveness. David G.and Holt G.*(2000)* have presented a model for minimizing construction labor costs based on European best practice and discusses the implications of the same on supply chain. Contractors can only apply to the production process those methods and materials that are readily available in the market place. This is being the result of product focused suppliers. Downstream strategic alliances (DSA) must encourage contractors to be more proactive in driving their suppliers at market place to challenge the present product focused supply chain model. Dubois Anna, Gadde Lars-Erik *(2000)* explored the occurrence of network effects in the construction industry**.** It explores how firms within the construction industry take advantage of their opportunities to make use of external resources through co-operation. The first research issue is concerned with the kind of relationships there are between primary contractor and suppliers. The second issue deals with network effects achieved through adaptations in the supply network of primary contractor. Research on these issues will provide insight into efficiency and effectiveness in the construction industry. The conclusion of the study is that the prevailing focus of transactional exchange hampers the development of network substance both in permanent and temporary network. Increasing reliance on relational exchange would enhance conditions for adoption among firms in the permanent network. Ruben V., Koskela L. *(2000)* have referred supply chain in construction industry as having myopic control and characterized by interdependency. They emphasized that the bottom-line is the effective resolution of interdependency caused issues in the construction supply chain including basic problems and myopic control. It is also found that each actor of the supply chain adds a time buffer for himself in the schedule and often produces in a different sequence or speed than the next or previous actor, optimizing just his own activities. Fearne A. and Nicholas F. highlighted the potential danger of applying lean thinking to construction industry. With the help of two case studies, the author indicated the scope for cost reduction in construction projects using the principles of lean thinking. But the results of cost savings were not consistent on all activities. Moreover the attempt of cost reduction resulted into low response and low flexibility. The research does not provide the specific conditions apt for implementing lean thinking. Naim M. and Barlow J. *(2003)* have explored the use of lean and agile production in UK house building industry. The numbers of hot spots were identified, which includes *Hot spot 1:* No use of market knowledge, *Hot spot 2:* Lack of supply chain integration, *Hot spot 3:* No time compression strategy, *Hot spot 4*: Inability to rapidly re-configure and *Hot spot 5:* Excessive waste (muda.). The authors found that lean emphasis on technical efficiency of the processes while agility focuses on process responsiveness.

Integration issues:

In supply chain of manufacturing organization integration can be referred as forward integration and backward integration. In project centric supply chain, it is vital to consider structural integration, physical, administrative, economic, technical and social integration. It is the important process of change in supply chain. According to Ludvigsen *(2000)* integration of supply chain would involve information sharing,

common standard, common culture, coordination of interdependent flows, joint planning, joint product development and an increase in social contracts. In construction, integration is used to describe the introduction of working practices, methods and behaviors that create a culture of efficient and effective collaborations of individuals and organizations. Sussane Hertz *(2003)* discussed how integration changes in the supply chain are influenced by the overlap between chains. It is found that the overlap between supply chain in terms of actors, resources and activities could seriously delay, hinder and increase cost to the process when changing the degree of integration in one chain. This supply chain myopia may lead to increase in total cost of a firm. There is a trade-off between the cost of integration in the focal chain and cost arising from decreased integration in the overlapping chains.

Briscoe Dainty, Millett *(2001)* put forward new perspectives on construction supply chain integration. The study proposed to focus on how supply chain management practices can be implemented effectively by clients, contractors and consultant. However little attention has been paid to the integration of small and medium size enterprises in the subcontractor and material supply sectors. It was found that significant barriers exist to supplier integration within the construction industry.

Dainty, Brooke *(2004)* explored the efficacy of measures used to minimizing waste in the high profile UK based projects. The most effective measures were deemed to be those that foster waste minimization partnerships throughout the supply chain. The problem lies in whether the industry is culturally prepared for collaborative relationships for radical improvement. Briscoe and Dainty *(2005)* carried out empirical study to investigate the problems encountered in trying to integrate supply chain in U K Construction industry. The findings reveal that the large number of supply chain partners and significant level of fragmentation limits the level of integration that is achievable. The environment specific and procurement related factors are the main impediments. However this study has put forward some key principal to be followed to achieve the illusive goal of construction supply chain integration. It is revealed in the research that the degree of integration varied significantly across various client organizations and are constrained by the policies of client organization with regard to interface with the other supply chain members during entire project life cycle. Contractors are supposed to develop the downstream relationships with inefficient trust to allow partnering.

Partnering in Construction supply Chain

The National Economic Development Council provides the following definition of

Partnering:

A long term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each of the participants.

Naoum S. *(2003)* suggested that the partnering improves productivity and lowers cost and provides the product of construction of satisfactory standard and time. It is been further recommended that partnering will facilitate value based procurement, single point responsibility, means of dispute resolution and longer term relationship. Voordijk H., Haan J. and Joosten G. *(2000)* have explained the paradox that deregulation has inspired more hierarchical forms of organizing supply chain of construction industry. Wood G.D. and Ellis R. *(2005)* have investigated the views of a body of commercial managers with experience partnering relationships within the UK

construction industry.This study confirms a number of assertions since the findings indicate the broad agreement that the both the process and outcome of partnering projects are beneficial. The survey indicates the positive attitude towards it as an alternative procurement method.

Errasti A., Beach R., Oyarbide A., Santos J. *(2007)* have explored the implementation of partnership development process. The methodology and supplier integration tools used in the course of this investigation has been demonstrated to be an effective means of building appropriate structures that can facilitate inter-firm communication. Mike Bresnen *(2007)* attempted to deconstruct more prescriptive accounts of partnering and suggest a more realistic understanding of the intricacies and dynamics of partnering. Construction partnering is a fragile phenomenon. Continuous absence of systematic research that unambiguously points to its benefits constitutes a leap of faith. Black C., Akintoye A. and Fitzgerald E. *(2000)* evaluated the views of contractors, clients and consultant empirically for adopting partnering. General opinion provides that partnering has future and it brings tangible benefits. Respondents do not believe that there is equitable sharing of the benefits which are derived from the use of partnering. Partnering implies the need for the trust, good communication, commitment, a clear understanding of roles and flexible attitude. However the risks and barriers are real and must be considered. Overall the barriers to construction partnering are rated less significant than the potential benefits.

Chen W.T., Chen T.T. *(2007)* analyzed and compared the critical success factors and the roles of various professionals. No difference of opinions exists among the perspectives of government employees, owner, design firm and construction firm regarding the four clusters of construction partnering. This study has analyzed the perspectives in local firms only and lacks the aspect of international project partnership. The study has put forward following important dimensions of partnering- Collaborative team culture, long term quality focus, consistent objective and resource sharing.

Lu S., Yan H. *(2007)* addressed the issue of applicability of partnering in construction scenario. Contractors are more conscious of getting continuous work whereas consultant put more emphasis on profit. The proposed model needs to be more dynamic and interactive. Systematic assessment of partnering use is necessary before partnering procurement. It provides following factors for partnering i) Management mechanism and ii) Involved organization and iii) Project dimensions.

Wood D. and Ellis R. *(2005)* found that the supply chain members are optimistic about the partnering but enthusiasm is seldom sustained throughout the life cycle. However trust for partnering is hard earned and relationships are still cost driven. Bresnen M.and Marshall N. *(2002)* found that the problems like lack of user responsiveness, contractor input into the design and coordination are needed to handle collaboratively, efficiently and effectively. Partnering alone will not be able to solve all problems. Briscoe G., Dainty A., Millett S. *(2001)* examined the skills that are currently available in the small and medium size *(SME)* companies that are the main suppliers of subcontracting service in the industry. Attention to the skills aspect of supply chain network has been relatively neglected. There is a need to discover more about what skills already exist in the construction supply chain and how these skills are developed to facilitate construction partnering. This study has also suggested that it is not just skill deficiencies, but also attitudes that pose effective barrier to the efficient operation of supply chain. Errasti, Beach, Oyarbide and Javier (2007)

conducted an action research and suggested that subcontractor can implement partnership development with fewer suppliers and can gain significant value addition by involving suppliers in product design stage.

Procurement: Partner Selection issues on supply side of Construction Supply Chain

Mohan Kumaraswamy, Ekambaram Palaneeswarn, Paul Humphreys *(2001)* have investigated the factors affecting the performance of construction industry in Hong Kong. They found that the selection methodologies and decisions are critical both at upstream formulation of procurement and operational systems and downstream selection of various project participants. Palaneeswaran E., Kumarswamy M.and Zhang X. *(2001)* focused on the on the selection of the optimal value adding sources (partners) at each link of the supply chain and achieving the synergies between suppliers through better integration. It is found that the various procurement practices in construction supply chain –DBB, DB, DBM, DBO and BOT and DBM. The continuity of simple supply chain has been extended by forging stronger links to design in DB to financing and operation in BOT and to maintenance in DBM. This approach demonstrates more integrated and synergistic supply chains in the construction industry.

Briscoe G., Dainty A., Millet S., Neale R. *(2004)* have explored how the client can influence construction supply chain integration. The environmental variables that affected the construction procurement decision made by the clients' construction specialists were grouped as personal, department, organization and external. The complexity of the organization was reflected in the departmental structures.It was found that the frequent change in the form and terms of the contract and the preference for the competitive price tendering is detrimental to supply chain relationships. The case studies suggested that the continuity of client workload was a dominant factor in securing high levels of commitment and collaboration through the supply chain. It is difficult to attain full integration, at least accelerating change to develop integrated supply chain in construction, must be a move to seek re-engineering of supply chain.

Khalfan M.,Anumba C.J.,Carys S., Sinclair *(2001)* argued that it is important to establish the readiness of the construction supply chain for the adoption of concurrent engineering prior to its full implementation. There is the need for improvement to the way the construction supply chain delivers the project to achieve client satisfaction, improvement in efficiency, effectiveness and profitability. Need to carry out CE assessment study prior to its implementation. Nicolini D., Holti R., and Smalley M. *(2001)* attempted to improve the performance of the industry in terms of quality, cost and profitability. It requires radical innovation in perception setting and management of the relationship between the clients, builders and suppliers. A full fledged application of the clustering approach will require the introduction of deep modifications to the forms of the contract used between parties and the way professional indemnity is allocated within the projects.

Buyer supplier relationship

Buyer-supplier relationship is a major driver, needed to understand and sustain supply chain relationships in overlapping supply chains. Here various authors have valued the role of subcontractors in construction supply chain. Eriksson, Dickinson, Khalfan *(2007)* investigated how client's cooperative procurement procedures influence

subcontractor involvement, value creation and innovation. It was found that client's procurement procedures affect the level of subcontractor involvement but not necessarily increase subcontractor value creation and innovation. Khlfan, Mcdermott (2006) studied how innovative procurement practices are necessary to integrate the supply chain partners. The case studies demonstrated how organizations involved have promoted innovative thinking across the supply chain through innovative procurement. The case study also highlights some of the critical factors that motivated people within those firms to move from traditional way of procurement and search, innovate and implement the new procurement thoughts and models.

Karim, Marosszeky,Davis*(2006)* provided a decision support tool for long term management of subcontractor supply chain for achieving better quality in construction. Paul Ireland *(2004)* investigated the impact of lean and partnering approaches to supply chain management in construction industry. The paper demonstrated with the help of two case studies that the regularity of demand is absolutely fundamental pre-requisite for the development of effective supply chain management approaches in power regimes of extended buyer dominance and interdependence. In construction the regularity of spend is a critical factor in the selection of appropriate sourcing and relationship management choices.

Errasti A, Beach R., Odouza C. Apaolaza V.*(2008)* have investigated the close coupling value chain functions to improve subcontractor, manufacturing performance. The principles of close coupling value chains functions can be applied to subcontractor operations that are primarily manufacturing oriented and that in production and assembly productivity are possible with the result that the total cots can be reduced and delivery performance are improved. Davis P. *(2008)* investigated the usefulness of relationship marketing to construction supply chain. The survey covered equal portions of the construction supply chain and shows that construction actors differentiate between relationship and marketing factors. Relationship marketing helps construction stake holders to develop long term relationship.

Discussion:

The above discussion on supply chain in construction has suggested the need to study the nature of supply chain in construction. Then think about addressing the integration issues as the interface between basic framework and integration is need to be explored. Similarly the understanding of buyer-supplier relationship and procurement issues with basic framework of supply chain is also need to be investigated. Therefore the interfaces (interaction) 1, 2 and 3 of the basic framework with each of the issues, offers the scope for research. In this regard, the framework as shown in figure 3 can navigate further research in supply chain of construction industry

Conclusion:

The industry in which suppliers and subcontractors are responsible for 75% of turnover, it is difficult to deny the existence of supply chain. However the supply chain in construction is myopic and fragmented and result into poor supply chain management. Barriers to supply chain management are nothing but the age old issues of construction supply chain which are generic to typical project supply chain. However opportunity lies in better management of issues of lack of integration, coordination, procurement and partnering.

References:

1. Akintoye, McIntosh G., Fitzgerald (2000) “A survey of supply chain collaboration and management in the UK construction industry”
2. Anumba C. Siemieniuch C.and Sinclair M. (2000) “Supply chain implications of concurrent engineering” International Journal of Physical Distribution and Logistics Management,Vol.30,No.7/8,pp566-597.
3. Baiden B. K., Price A.D. and Dainty A.R. (2006) “The extent of team integration within construction projects” Journal of Project Management, Vol.24, pp13-23.
4. Barker R., Childerhouse P., Naim M., Masat J. and Wilson D. (2004), “Potential of total cycle time compression in construction: Focus on program development and design” Journal of Construction Engineering and Management, Vol.130, No.2, pp177-187.
5. Barker R., Hong-Minh, and Naim M. (2000), "The terrain scanning methodology .Assessing and improving construction supply chains" European Journal of Purchasing and Supply Management, Vol.06, pp 179-193.
6. Black C., Akintoye A. and Fitzgerald E. (2000) “An analysis of success factors and benefits of partnering in construction” Journal of Project Management, pp, Vol.18, 423-43.4
7. Briscoe G., Dainty A. (2005), “Construction supply chain integration: an elusive goal?” *International Journal of supply chain management*, Vol.10, No.4, pp.319-326.
8. Briscoe G., Dainty A., Millet S., Neale R. (2004),“Client-led strategies for supply chain improvement” Construction Management and Economics,Vol.22,No.193-201.
9. Briscoe G., Dainty A., Millett S. (2001), “Construction supply chain partnerships: skills, knowledge and attitudinal requirements.”
10. Chen H and Chen W. (2005), “Clarifying the behavioral patterns of contractor supply chain payment conditions.” International Journal of Project Management, Vol.23, pp 463-473.
11. Chen W.T., Chen T.T. (2007), “Critical success factors for construction partnering in Taiwan.”Journal of Project Management, Vol.25, pp 475-484.
12. Chenng S., Thomas S.T., Wong S., Henry, C. H. Seun (2003), “Behavioral aspect of the participants in construction partnering.” Journal of project Management, Vol.21, pp 333-343.
13. Childerhouse P. and Towill D. (2003) “Simplified material flow holds the key to supply chain integration” International Journal of Management Science Omega, Vol.31, pp17-27.
14. Childerhouse P., Lewis F., Naim M. and Towill R.(2003), “Re-engineering a construction supply chain : a material flow control approach”, *International Journal of supply chain management*, Vol.8, No.4, pp.395-406.
15. Cox A & Ireland P. (2002), “Managing construction supply chain: the common sense approach” Engineering, Construction & Architectural Management.Vol.9,No.5/6,pp409-418.
16. Dainty A., Briscoe G. and Millett S. (2001), “New perspectives on construction supply chain integration”, *International Journal of supply chain management*, Vol.6, No.4, pp.163-173

17. Dainty A., Brooke R. (2004), “Towards improved waste minimization: a need for improved supply chain integration?” *Structural Survey*, Vol.22, No.1, pp20-29
18. David G., Holt G. (2000) “Reducing construction costs: European best practice supply chain implications.”
19. Davis P. (2008) “A relationship approaches to construction supply chain.”
20. Dubois Anna,Gadde Lars-Erik(2000), “Supply strategy and network effects – purchasing behavior in the construction industry.”
21. Eriksson P, Dickinson M. and Khalfan M. (2007), “The influence of partnering and procurement on subcontractor involvement and innovation” *Facilities*, Vol.25, No.5/6, pp.203-214
22. Errasti A, Beach R., Odouza C.,Apaolaza V.(2008) “Close coupling value chain functions to improve subcontractor, manufacturing performance.”
23. Errasti A., Beach R., Oyarbide A., Santos J.(2007) “A process for developing partnership with subcontractors in construction industry: An empirical study.”
24. Fernie S., Thorpe A. (2007), “Exploring change in construction: supply chain management”, *Journal of Engineering, Construction and Architectural Management*, Vol.14, No.4, pp.319-333.
25. Green S., Fernie S., and Weller S. (2005) “Making sense of supply chain management: a comparative study of aerospace and construction” Construction management and economics, Vol.23, pp 579-593.
26. Indian Infrastructure Report 2008, Oxford University Press.
27. Kamann D., Snijders C. Tazelar F., and Welling (2006), “The ties that bind: Buyer-supplier relations in the construction industry” Journal of purchasing & supply management, Vol.12, pp28-38.
28. Karim K., Marosszeky M. and Davis S. (2006), “Managing subcontractor supply chain for quality in construction” *Journal of Engineering, Construction and Architectural Management*, Vol.3, No.1, pp.27-42.
29. Khalfan M., Anumba C.J.,Carys S., Sinclair(2001), “Readiness Assessment of the construction supply chain for concurrent engineering.”
30. Khalfan M., McDermott P. (2006), “Innovating for supply chain integration within construction”, *Construction Innovation*, Vol.6, pp.143-157.
31. London K., and Kenley R. (2001) “An industrial organization economic supply chain approach for the construction industry: a review” Construction Management and Economics.Vol.19, pp777-788.
32. Love P., Edwards D. and Smith J. (2005) “A forensic examination of the causal mechanism of rework in a structural steel supply chain” Managerial Auditing Journal, Vol.20, No.02, pp187-197.
33. Love P., Irani Z and Edwards D.(2004), “A seamless supply chain management model for construction” *International Journal of supply chain management*, Vol.9, No.1, pp.43-56.
34. Lu S., Yan H. (2007), “A model for evaluating the applicability of partnering in construction.” Journal of project management, Vol.25, pp164-170
35. Mazet F, Ghauri P. (2007) “Co-development as a marketing strategy in the construction industry.”
36. Mike Bresnen (2007), “Deconstructing partnering in project –based organization: seven pillars, seven paradoxes and seven deadly sins.”
37. Minh S.M., Barker R.and Naim N.M. (2001) "Identifying supply chain solutions in the UK house building sector" European Journal of Purchasing and Supply Management, Vol.07, pp 49-59.

38. Modig N.(2007) “The division of responsibility for project supply.” Journal of Purchasing and Supply Management, Vol.13, pp 87-97
39. Naim M. and Barlow J. (2003), “An innovative supply chain strategy for customized housing” Construction Management and Economics, Vol.21, 593-602.
40. Palaneeswaran E., Kumarswamy M.and Zhang X. (2001), "Reforging construction supply chains a source selection perspective" European Journal of Purchasing and Supply Management, Vol.07, pp165-178.
41. Palaneeswaran, Kumarawamy M.and Thomas N.G.(2003), “Formulating a framework for relationally integrated construction supply chain” Journal of Construction Research Vol.04, No.02. Pp189-205.
42. Paul Ireland (2004), “Managing appropriately in construction power regimes: understanding the impact of regularity in the project environment.” *International Journal of supply chain management*, Vol.9, No.5, pp.372-382.
43. Ruben V. and Koskela L. (2000) "The four roles of supply chain management in construction" European Journal of Purchasing and Supply Management, Vol.06, pp169-178.
44. Saad M., Jones Martyn and James Peter (2002), "A review of the progress towards the adoption of supply chain management (SCM) relationships in construction" European Journal of Purchasing and Supply Management, Vol.08, pp173-183.
45. Voordijk H., Haan J. and Joosten G. (2000), "Changing governance of supply chains in the building industry: a multiple case study" European Journal of Purchasing and Supply Management, Vol.06, pp 217-225.
46. Wickramatillake C., Koh L., Gunasekaran A., and Arunachalam Subramanium (2007), “Measuring performance within the supply chain of a large scale project.” *International Journal of supply chain management*, Vol.12, No.1, pp.52-59.
47. Wood G.D., Ellis R. (2005), “Main contractor experiences of partnering relationships on UK construction projects.” Construction management and Economics, Vol.23, pp 317-325
48. Yeung J., Chan A., Chan D. (2007) “The definition of alliancing in construction as a Wittgenstein family –resemblance concept”, Journal of project management, Vol.25, pp 219-231.

Table 1: Issues in supply chain of Construction Industry.

Issues	Author and Year
Basic framework of supply Chain in Construction Industry.	Fernie S., Thorpe A. *(2007),*Childerhouse et.al.*(2001)* Naim M. and Towill R.*(2003),*Love P., Irani Z and Edwards D.*(2004),* Saad M., Jones Martyn and James Peter *(2002),* Palaneeswaran E., Kumarswamy M.and Zhang X. *(2001),* Ruben V. and Koskela L. *(2000),*Voordijk H., Haan J. and Joosten G. *(2000),* Minh S.M., Barker R.and Naim N.M. *(2001)* Barker R., Hong-Minh, and Naim M. *(2000),* Briscoe G., Dainty A., Millet S., Neale R. *(2004),* Naim M. and Barlow J. *(2003),*Barker R., Childerhouse P., Naim M., Masat J. and Wilson D. *(2004),*Green S., Fernie S., and Weller S. *(2005)* David G., Holt G. *(2000),*Akintoye, McIntosh G., Fitzgerald *(2000)* Cox A & Ireland P. *(2002)*
Integration issues	Briscoe G., Dainty A. *(2005),*Dainty A., Brooke R. *(2004),* Dainty A., Briscoe G. and Millett S. *(2001),* Khalfan M., McDermott P. *(2006)* Baiden B. K., Price A.D. and Dainty A.R. *(2006)* Childerhouse P. and Towill D. *(2003)* Nicolini D.,Holti R.,and Smalley M.*(2001)* Palaneeswaran, Kumarawamy M.and Thomas N.G.*(2003),* D.P.Van Donk, T.Vander Vaart *(2004)*
Partnering and Procurement issues	Eriksson P, Dickinson M. and Khalfan M. *(2007)* Wood G.D., Ellis R. *(2005),*Wang Y., Yu X., and X. *(2007),* Micheli G.Cagno E.and Giulio A.*(2009)* Errasti A., Beach R., Oyarbide A., Santos J.*(2007)* Elfving J. Tommelein I.,Ballard G.*(2005)* Mike Bresnen *(2007),*Dubois Anna,Gadde Lars-Erik*(2000),* Briscoe G., Dainty A., Millett S. *(2001),* Black C., Akintoye A. and Fitzgerald E. *(2000)* Chen W.T., Chen T.T. *(2007)*Lu S., Yan H. *(2007),* Chenng S., Thomas S.T., Wong S., Henry, C. H. Seun *(2003),* Boer L., Harink J., and Heijboer G. *(2002),* Modig N.*(2007)*
Buyer-supplier relationship (Role of subcontractors and suppliers)	Karim K., Marosszeky M. and Davis S. *(2006)* Paul Ireland (2004),London K., and Kenley R. *(2001)* Kamann D., Snijders C. Tazelar F., and Welling *(2006),* Chen H and Chen W. *(2005)* Errasti A, Beach R., Odouza C.,Apaolaza V.*(2008)* Davis P. *(2008)* Danilovic M *(2006)*

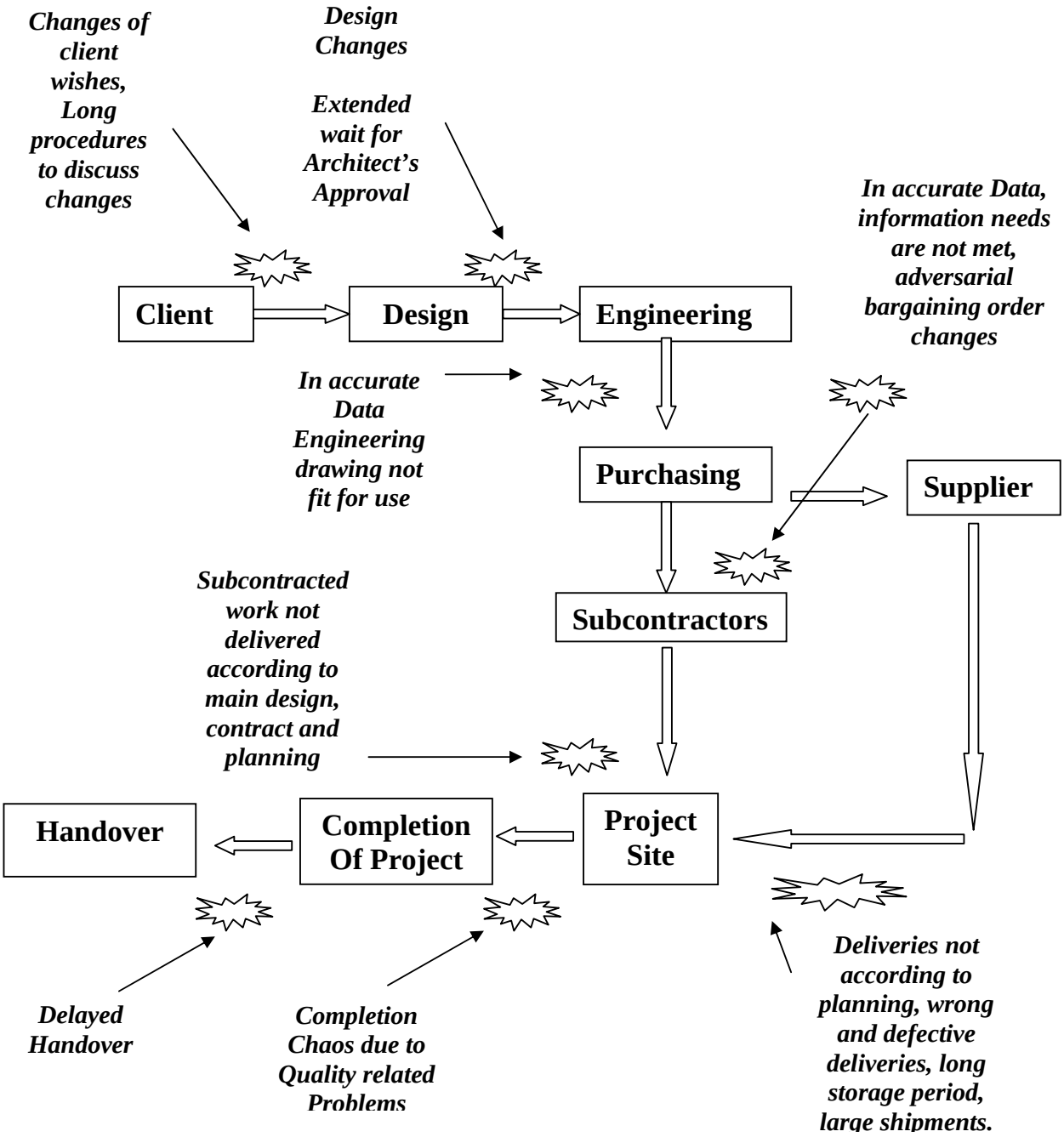

Figure 1: Supply Chain in Construction Industry. *(Modified from Ruben V. and Koskela L., 2000)*

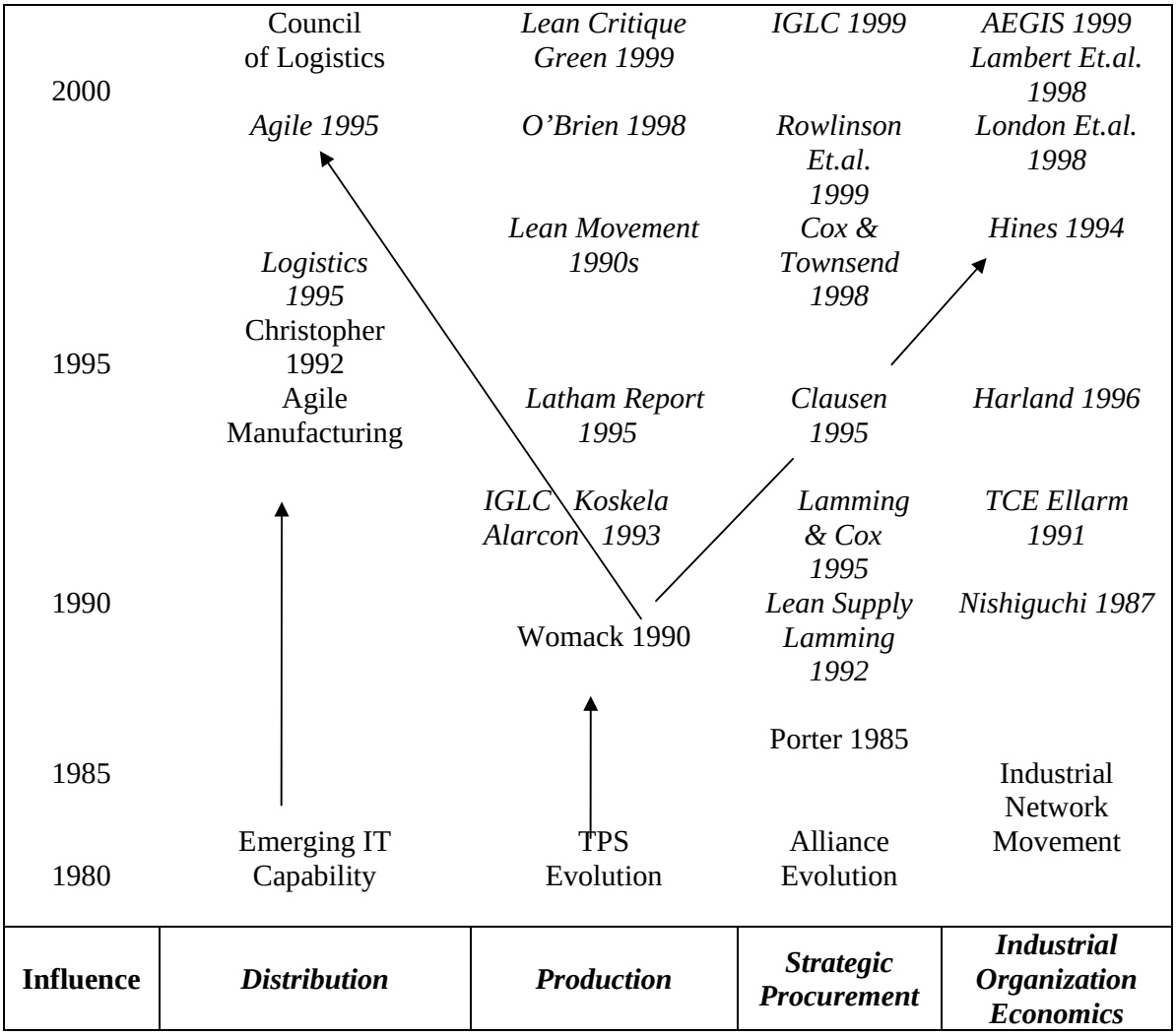

Figure 2: Chart of supply chain stream of research 1980-1999 *(London & Kenley 2001)*

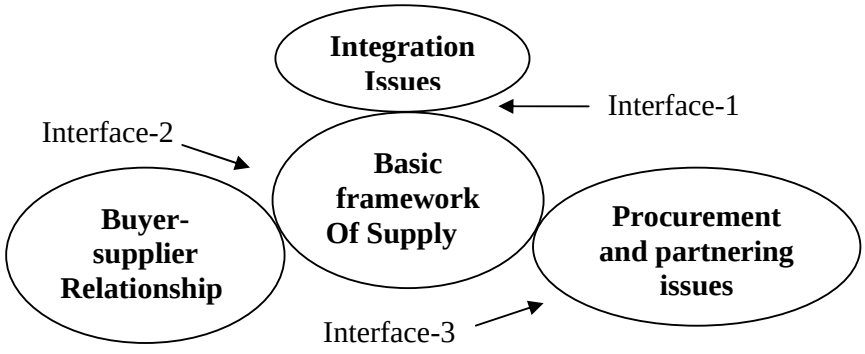

Figure 3: Proposed framework of research in supply chain of construction industry. (Construct by: Author)